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 Limestone 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.

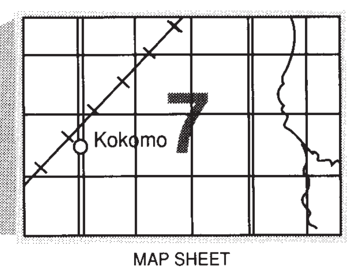
Detailed Soil Maps

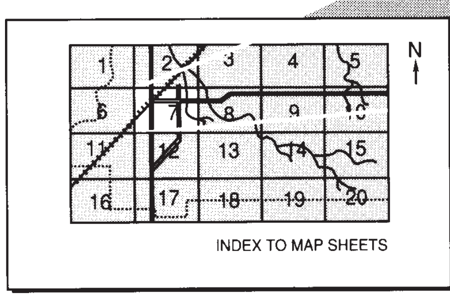
The detailed soil maps can be useful in planning the use and management of small areas.

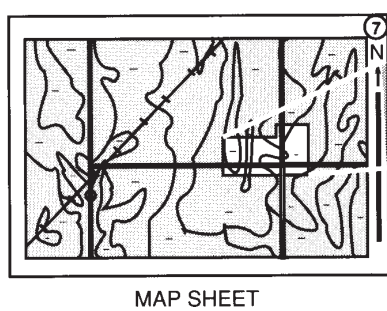
To find information about your area of interest, locate that area on the **Index to Map Sheets**. Note the number of the map sheet and turn to that sheet.

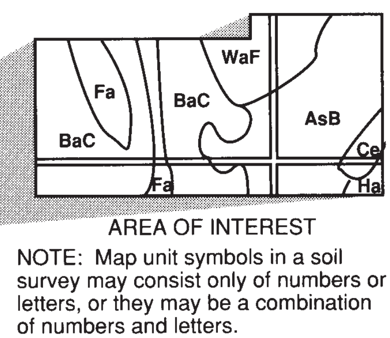
Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Contents**, which lists the map units by symbol and name and shows the page where each map unit is described.

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 1991. 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 Limestone-Falls 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.

All programs and services of the Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Wildflowers are abundant in Limestone County in the spring. The soil is Robco loamy fine sand, 0 to 2 percent slopes. The pond in the background is on Rader fine sandy loam, 0 to 2 percent slopes.

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Issued September 1997

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Limestone County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, 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, 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
Limestone County, Texas

By Edward L. Griffin, Natural Resources Conservation Service

Fieldwork by Edward L. Griffin, Donald J. Sabo, Dennis N. Brezina, and Edward F. Janak, soil scientists, 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

Limestone County is in the eastern part of Central Texas (fig. 1). The total area, which includes water areas, is 597,088 acres, or 933 square miles. The county is about 40 miles long and 26 miles wide. The topography is nearly level to rolling and generally slopes to the southeast. The elevation ranges from about 690 feet above sea level in the northwestern part to about 325 feet above sea level in the southeastern part where the Navasota River crosses the county line. The county is drained by numerous creeks and streams. Several join the Navasota River, which flows through the central part of the county.

Parts of two Major Land Resource Areas are in Limestone County. About two-thirds of the county is in the Texas Blackland Prairie and about one-third, the southeastern part, is in the Texas Claypan Area. Major Land Resource Areas are geographic areas of the United States that have particular patterns of soils, potential natural vegetation, water resources, climate, and land uses. The Texas Blackland Prairie consists mainly of dark colored loamy and clayey soils that formed under native grassland vegetation of mid and tall grasses. The dominantly light colored loamy and sandy soils of the Texas Claypan Area formed under native savannah vegetation of oak trees and mid and tall grasses.

About 55 percent of the county is used as rangeland, about 21 percent is used as cropland, about 17 percent is used as pasture or hayland, and about 7 percent is used for purposes other than agriculture such as urban development, transportation facilities, recreation, and wildlife habitat.

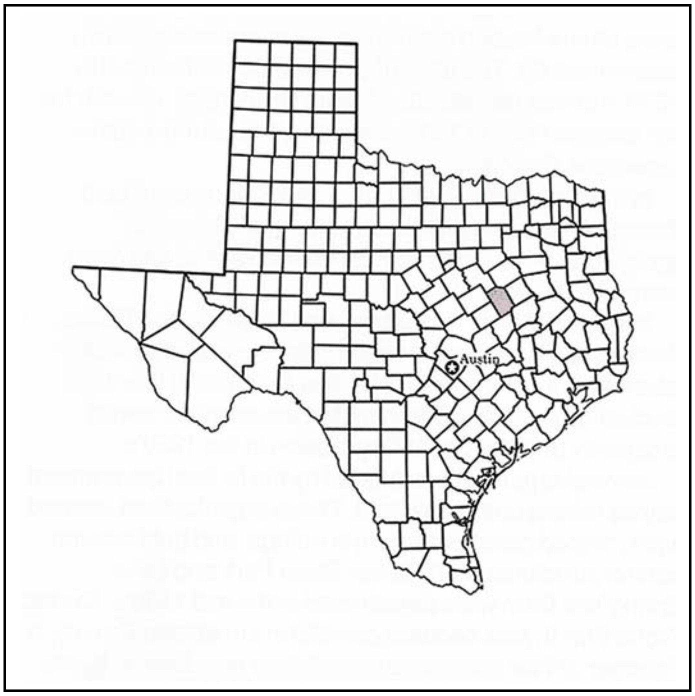

Figure 1.—Location of Limestone County in Texas.

General Nature of the County

This section gives general information about Limestone County. It describes settlement and population, agriculture, natural resources, and climate.

Settlement and Population

The Tehuacana Indians, a tribe of the Caddoan family, lived in areas of Limestone County *(13)*. They were hunter-gatherers and were considered a friendly tribe.

James W. Parker and several families settled near the Navasota River in 1834 and built a fort of split cedar logs on about an acre of land. They lived off the land by hunting and farming.

In 1835, a war broke out among the Indians. In 1836, Parker's Fort was attacked by the Comanches and several of the settlers at the fort were killed *(23)*. A young girl, Cynthia Ann Parker, was taken captive. She was adopted by a Comanche family and later became the mother of Quanah Parker, Chief of the Comanches.

In 1838, the town of Springfield was established beside the Navasota River *(8)*. Limestone County was created in 1846 from Robertson County and was named after the limestone rock that was found there *(13)*. Springfield was named the county seat, and in 1847, a U.S. Post Office was established.

A railroad was built through Limestone County in 1869. Several new towns were established along the railroad, while others located away from the railroad were slowly abandoned *(8)*. The town of Groesbeck was founded in 1870 and was named after Abram Groesbeck, director for the railroad *(13)*. In 1873, it became the county seat for Limestone County.

In the early 1900's, several new railroads were built through Mexia and provided rail services to a wide agricultural area. Cotton production increased and more communities were formed.

In the 1920's, oil was discovered in Mexia and Kosse. Businesses flourished in these little towns and provided jobs for many of the men returning from World War I. Oil production gradually declined, but the county enjoyed prosperity until the Great Depression in the 1930's.

Several organizations funded by the federal government helped relieve unemployment. These organizations created work, helped construct public buildings, and built erosion control structures. Fort Parker State Park and Lake Springfield Dam were constructed in the mid 1930's. During World War II, jobs became plentiful in Limestone County. A Prisoner of War camp was established near Mexia. It was converted into a school for mentally retarded children in 1947.

The population of Groesbeck, the county seat, was 3,287 in 1990. Other towns in the county are Coolidge, Kosse, Mexia, Prairie Hill, Tehuacana, and Thornton. The county population in 1990 was 20,902.

Agriculture

Livestock, hay, and crops are the main agricultural enterprises in Limestone County. Crop production, mainly cotton and corn, was once the primary land use. However, a significant conversion of land from cultivation of crops to production of forage grasses has greatly increased the importance of the livestock industry in the county. This conversion of land use has been mostly on the less productive, cultivated soils in the central and southern parts of the county.

The production of beef cattle, primarily from cow-calf operations, is the most important source of agricultural income. Livestock are pastured year-round but require hay and feed supplements in winter. Improved cool-season grasses and legumes may be provided for grazing in the winter and spring.

Most crops are grown on the very deep, clayey soils of the Blackland Prairie except small grains, which are grown throughout the county. Grain sorghum, corn, cotton, and wheat are the major crops produced. Small areas are planted in truck crops and orchards. Water erosion is a major concern when these soils are cultivated because it reduces much of the productivity of the land.

Natural Resources

Soil is the most important natural resource in Limestone County. It supports all the agricultural production, which is the major source of income.

Numerous oil and gas wells provide a source of income for some landowners. Drilling and servicing of these wells provide jobs for many people.

Deposits of lignite coal are in the southern part of Limestone County. Some of the land in this area has been leased or purchased for lignite mining. Mining operations, power generation, and mined land reclamation are activities expected to continue well into the next century.

Limestone bedrock and sand, mined for road and highway materials, provide another source of employment.

Water is also an important natural resource in the county. Lake Limestone, in the southeastern part, supplies cooling water for electric generating plants. It also provides flood control, fishing, and other recreational activities. Other lakes that provide public recreation are Lake Mexia and Fort Parker State Park Lake, in the central part of the county. The Navasota River and many smaller streams, creeks, and lakes provide abundant water supplies for the county. Farm ponds, many spring-fed, are numerous. Most of the southern and eastern parts of the county have ample supplies of good quality underground water.

Fish and wildlife are other important natural resources in Limestone County. Most of the southern part of the county is leased for deer hunting, which provides added income to landowners.

Climate

Limestone County is hot in summer and cool in winter when an occasional surge of cold air causes a sharp drop in otherwise mild temperatures. Rainfall is uniformly distributed throughout the year, reaching a slight peak in spring. Snowfalls are infrequent. Annual total precipitation is normally adequate for grain sorghum, corn, cotton, and wheat.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Mexia, Texas 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 48 degrees F and the average daily minimum temperature is 36 degrees. The lowest temperature on record, which occurred on December 23, 1989, is -5 degrees. In summer, the average temperature is 82 degrees and the average daily maximum temperature is 94 degrees. The highest recorded temperature, which occurred on July 26, 1954, is 110 degrees.

Growing degree days are shown in table 1. 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 40 inches. Of this, 21 inches, or about 51 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 8 inches. The heaviest 1-day rainfall during the period of record was 8.7 inches on February 4, 1986. Thunderstorms occur on about 45 days each year, and most occur in spring.

The average seasonal snowfall is about 1.3 inches. The greatest snow depth at any one time during the period of record was 5 inches. The number of days with at least 1 inch of snow on the ground varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 13 miles per hour, in spring.

Tornadoes and severe thunderstorms occur occasionally. These storms are local and of short duration, and the pattern of damage is variable and spotty.

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 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.

1. Crockett-Normangee

Nearly level to moderately sloping, very deep, moderately well drained, loamy soils; on uplands

In this map unit, the Crockett soils are on broad, nearly level to gently sloping interstream divides and gently sloping side slopes. The Normangee soils are on very gently sloping to moderately sloping side slopes.

This map unit makes up about 22 percent of the county. It is about 62 percent Crockett soils, about 10 percent Normangee soils, and about 28 percent soils of minor extent (fig. 2).

Typically, the surface layer of the Crockett soil is dark grayish brown loam. The subsoil is clay that is mottled in shades of brown. The underlying material is clay loam interbedded with shale and mottled in shades of gray, brown, and yellow.

Typically, the surface layer of the Normangee soil is dark grayish brown clay loam. The subsoil is dark brown and olive brown clay that has mottles in shades of brown and red. The underlying material is light yellowish brown clay loam.

Soils of minor extent in this map unit are the Axtell, Edge, Ellis, Ferris, Heiden, Lamar, Lavender, Mabank, Silawa, Tabor, Tinn, Whitesboro, and Wilson soils. The Axtell and Tabor soils are strongly acid in the upper part of the subsoil. Edge soils are more acid in the subsoil. The Ellis, Ferris, and Heiden soils are clayey in all layers and are in higher landscape positions. Lamar and Silawa soils have a loamy subsoil. The Lavender soils are moderately deep and are in higher positions. The Mabank and Wilson soils have more gray in the subsoil and are in lower positions. The Tinn soils are clayey and calcareous in all layers and are on flood plains. The Whitesboro soils have a darker surface layer and are on flood plains.

The soils of this map unit are mainly used as pasture or rangeland. A few areas are being cultivated for cotton, grain sorghum, and small grains. These soils are well suited to improved pastures of coastal bermudagrass and kleingrass and are well suited to native grasses. They are moderately suited to cropland, but the hazard of erosion is the limiting factor. These soils are moderately suited to most native wildlife habitat.

The soils in this map unit are moderately suited to urban and recreational uses. Low strength, shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and slope are the main limitations.

2. Houston Black-Ferris-Heiden

Very gently sloping to moderately steep, very deep, moderately well drained and well drained, clayey soils; on uplands

In this map unit, the moderately well drained Houston Black soils are on broad, very gently sloping areas. The well drained Ferris soils are on gently sloping to moderately steep, eroded side slopes. The well drained Heiden soils are on very gently sloping and gently sloping areas.

This map unit makes up about 22 percent of the county. It is about 25 percent Houston Black soils, 23 percent Ferris soils, 21 percent Heiden soils, and 31 percent other soils. (fig. 3).

Typically, the surface layer of the Houston Black soil is black clay. The subsoil is clay that is black in the upper part, very dark gray in the middle part, and grayish brown in the lower part.

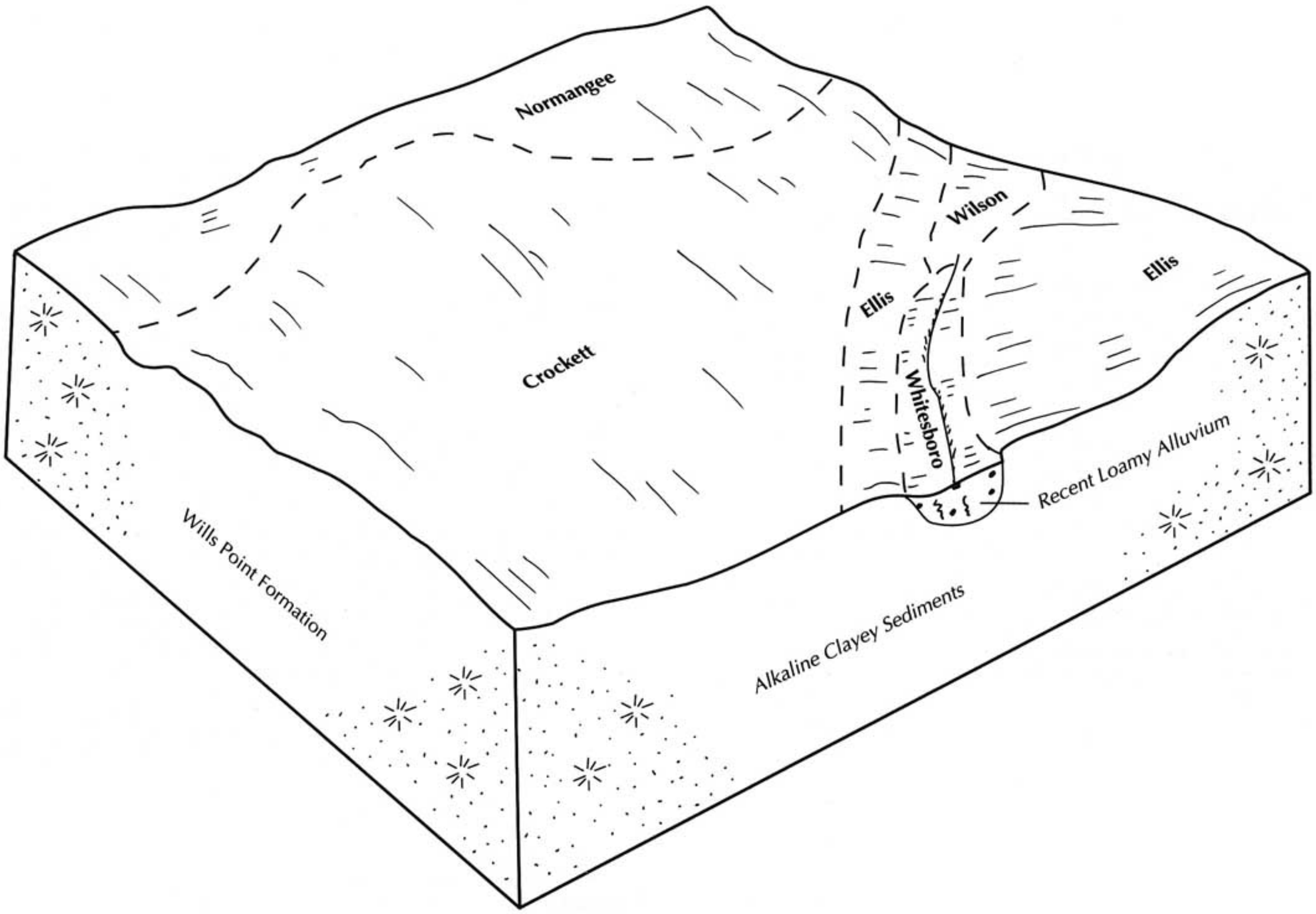

Figure 2.—Pattern of soils and underlying material in the Crockett-Normangee general soil map unit.

Typically, the surface layer of the Ferris soil is very dark grayish brown clay. The subsoil is olive clay. The underlying material is clay that is light olive brown with mottles in shades of brown and olive. Shale fragments are in the lower part.

Typically, the surface layer of the Heiden soil is very dark grayish brown clay. The subsoil is clay that is very dark grayish brown in the upper part, olive gray in the middle part, and olive in the lower part. The underlying material is pale olive clay that has shale fragments.

Soils of minor extent in this map unit are the Branyon, Bremond, Burleson, Ellis, Leson, Tabor, Tinn, Whitesboro, and Wilson soils. The Branyon and Burleson soils are in terrace positions and Burleson soils are noncalcareous in the surface layer. The Bremond soils have a loamy surface layer and are in lower positions on the landscape. The Ellis soils are noncalcareous and are in positions similar to the Ferris soils. The Leson soils are noncalcareous in the surface layer and are in positions similar to the Houston Black soils. The Tabor and Wilson soils have a loamy surface layer. Tinn soils are on flood plains and are somewhat poorly drained. The Whitesboro soils are loamy and are on flood plains.

The soils of this map unit are used mainly as cropland or pasture. The Houston Black and Heiden soils are well suited to cropland. The Ferris soils are poorly suited to producing crops because of their eroded condition and the severe hazard for further erosion. Houston Black and Heiden soils are well suited to pasture and rangeland. Ferris soils are well suited to rangeland but are poorly suited to improved pasture because of the erosion hazard and slope. The soils of this map unit are moderately suited to well suited to wildlife habitat.

These soils are poorly suited to most urban uses and poorly suited to moderately suited to most recreational uses. The main limitations are shrinking and swelling with changes in moisture, very slow permeability, and clayey texture.

3. Silstid-Gasil-Padina

Very gently sloping to strongly sloping, very deep, well drained sandy soils; on uplands

The Silstid soils are on broad, very gently sloping divides and on moderately sloping side slopes. Gasil soils are on gently sloping uplands. The Padina soils are on gently sloping high terraces, broad divides, and strongly sloping side slopes. Padina soils are generally on the highest part of the landscape.

This map unit makes up about 18 percent of the county. It is about 28 percent Silstid soils, 21 percent Gasil soils, 18 percent Padina soils, and 33 percent other soils (fig. 4).

Typically, the surface and subsurface layers of the Silstid soil are dark brown and brown loamy fine sand. The subsoil is sandy clay loam that is yellowish brown in the upper part and mottled in shades of yellow and brown in the lower part.

Typically, the surface layer of the Gasil soil is brown loamy fine sand. The subsoil is sandy clay loam that is yellowish brown in the upper part and mottled in shades of gray, yellow, red, and white in the lower part.

Typically, the surface layer of the Padina soil is dark brown loamy fine sand. The subsurface layer is pale brown loamy fine sand. The upper part of the subsoil is yellowish brown fine sandy loam that has mottles in shades of red. The middle part is brownish yellow sandy clay loam that has mottles in shades of red and gray. The lower part is light gray sandy clay loam that has mottles in shades of red and yellow.

Soils of minor extent in this map unit are the Axtell, Edge, Lufkin, Personville, Rader, Robco, Silawa, Styx, Tabor, Uhland, and Whitesboro soils. The Axtell, Edge, Lufkin, and Tabor soils have clayey subsoils and are in landscape positions similar to the Silstid soils. The Personville soils are underlain by limestone bedrock and are in lower landscape positions. Rader soils are loamy and are in lower positions. The Robco and Styx soils are in lower positions and have grayer colors in the subsoil. The Uhland soils are loamy and are on flood plains. Whitesboro soils are loamy, have a thick, dark surface layer, and are on flood plains.

The soils of this map unit are mainly used as rangeland. They are used as pasture or hayland in many of the less

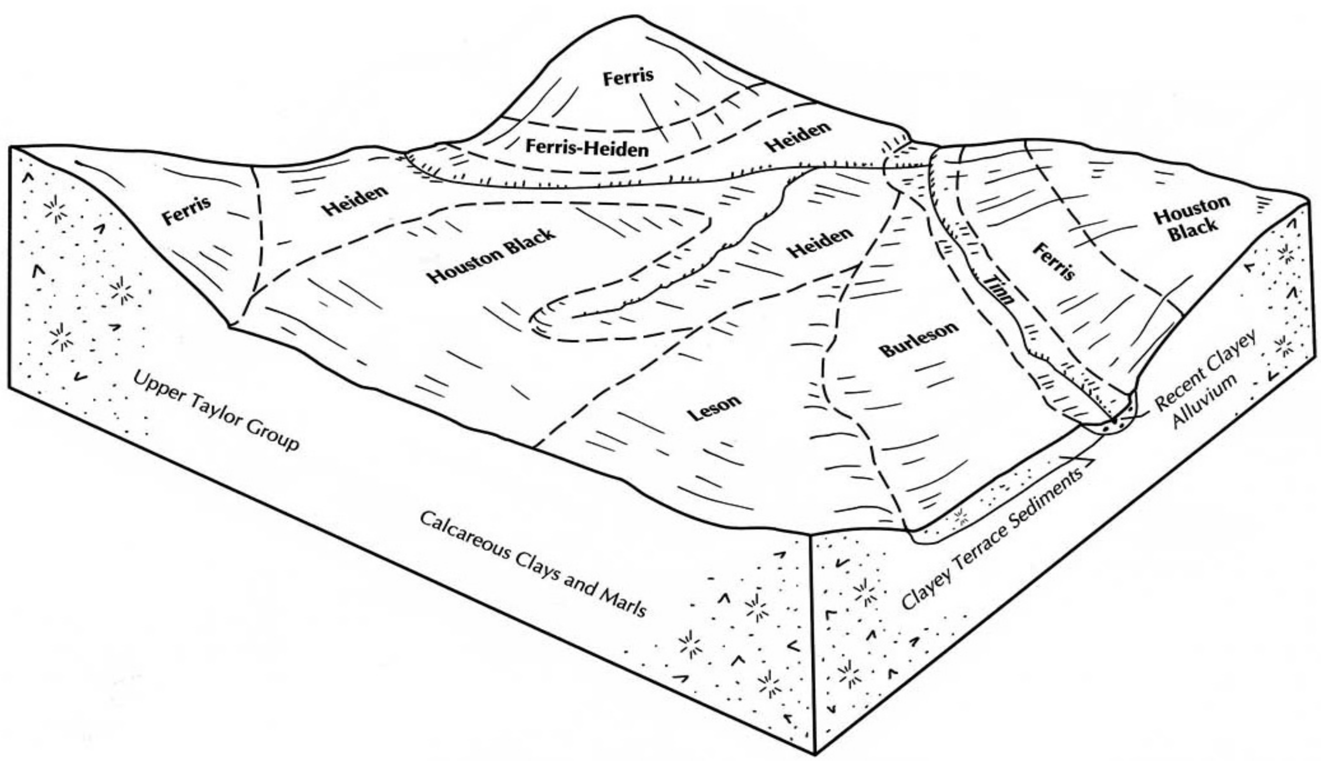

Figure 3.--Pattern of soils and underlying material in the Houston Black-Ferris-Heiden general soil map unit.

sloping areas. These soils are moderately suited to well suited to native grass production. Droughtiness is the major limitation. These soils are moderately suited to improved pastures of coastal bermudagrass and weeping lovegrass. Droughtiness is the major limitation of these soils for pasture and hay.

Soils of this map unit are moderately suited to crop production. Droughtiness and the erosion hazard are the major limitations. These soils are moderately suited to rangeland wildlife habitat.

These soils are well suited to urban uses and moderately suited to most recreational uses. The sandy surface layer of these soils is the main limiting feature.

4. Edge-Tabor

Nearly level to strongly sloping, very deep, well drained and moderately well drained loamy soils; on uplands and high stream terraces.

In this map unit, the well drained Edge soils are on gently sloping to strongly sloping uplands and interstream divides. The moderately well drained Tabor soils are on broad, nearly level stream terraces and very gently sloping terrace remnants on uplands.

This map unit makes up about 12 percent of the county. It is about 59 percent Edge soils, 16 percent Tabor soils, and 25 percent other soils (fig. 5).

Typically, the surface layer of the Edge soil is dark brown fine sandy loam. The subsoil is red clay in the upper part, red clay loam in the middle part, and strong brown sandy clay loam in the lower part. The middle and lower parts of the subsoil have mottles in shades of yellow and red. The underlying material is yellowish red weakly consolidated mudstone that has a sandy clay loam texture.

Typically, the surface layer of the Tabor soil is dark brown fine sandy loam. The subsoil is yellowish brown clay in the upper part, light olive brown and light yellowish brown clay in the middle part, and light yellowish brown clay loam in the lower part. There are mottles in shades of red and brown throughout. The underlying material is light yellowish brown clay loam that contains light gray shale fragments.

Soils of minor extent in this map unit are the Axtell, Crockett, Gasil, Lavender, Lufkin, Nahatche, Oletha,

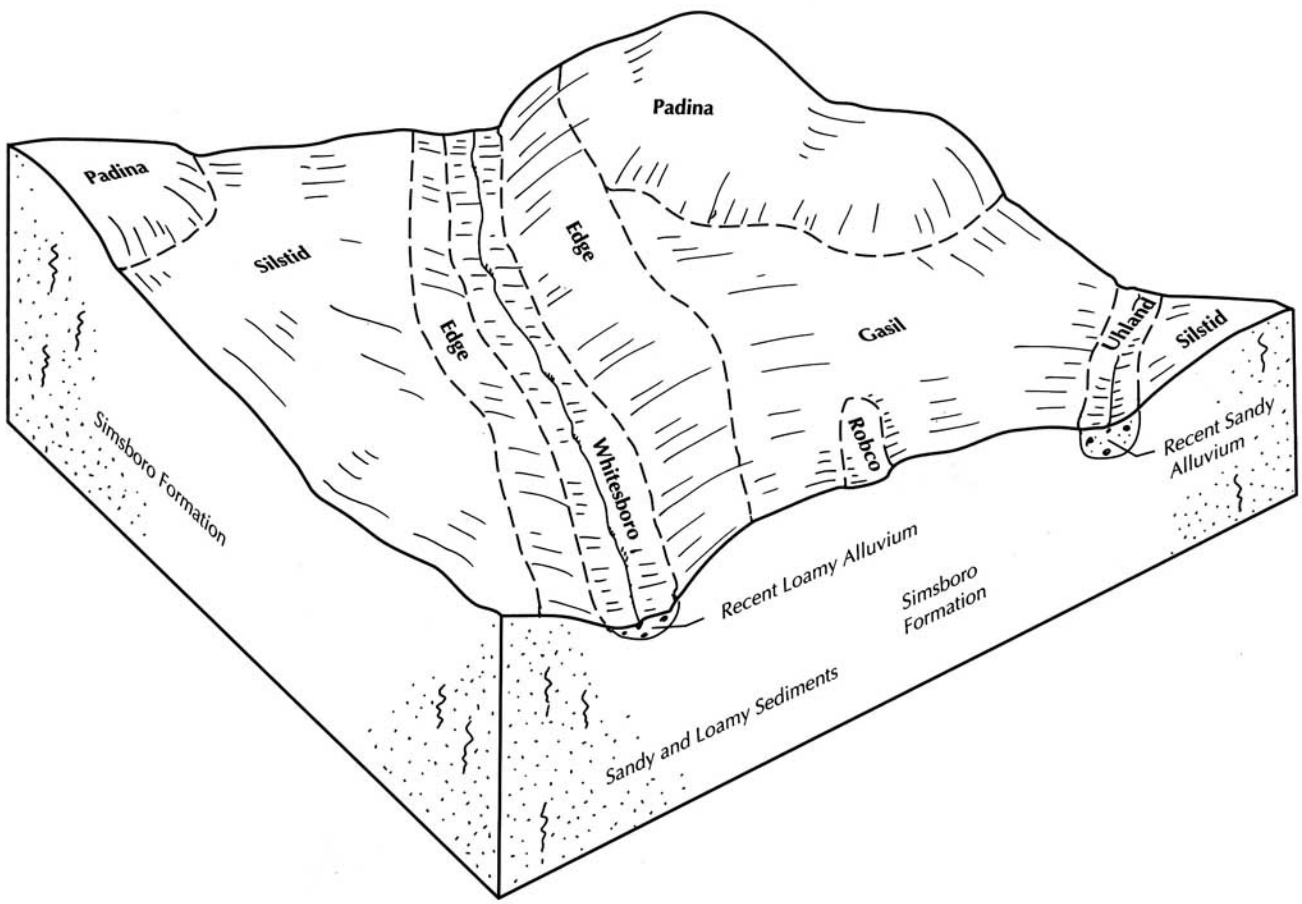

Figure 4.—Pattern of soils and underlying material in the Silstid-Gasil-Padina general soil map unit.

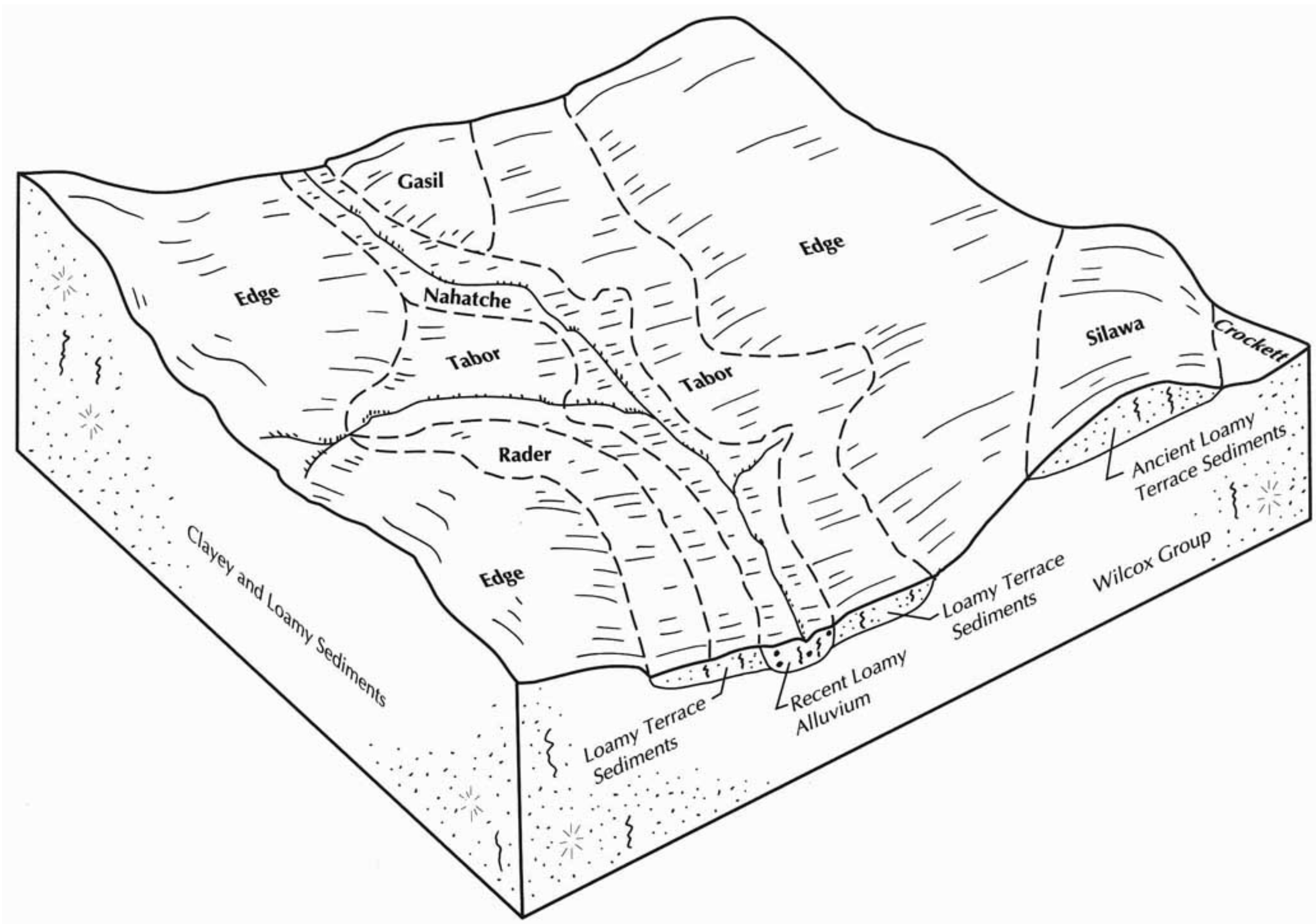

Figure 5.—Pattern of soils and underlying material in the Edge-Tabor general soil map unit.

Rader, Silawa, and Silstid soils. The Axtell and Crockett soils have a clayey subsoil that shrinks and swells. Gasil soils have a loamy subsoil. Lavender soils are moderately deep to bedrock. The Lufkin soils have a grayer subsoil and are in lower positions. The Nahatche and Oletha soils have sandy and loamy strata throughout and are on flood plains. The Rader soils have a more loamy subsoil and are in lower positions. Silawa soils have a loamy subsoil. Silstid soils have a thick sandy surface layer and are in slightly higher positions.

The soils of this map unit are used as pasture or rangeland. A few areas are cultivated for small grains. The Edge soils are moderately suited and Tabor soils are well suited to improved pastures of coastal bermudagrass and kleingrass. Limitations are the erosion hazard and droughtiness. Edge soils are moderately suited to native grasses. The erosion hazard and droughtiness are the limitations. The Tabor soils are well suited to this use.

Edge soils are poorly suited to cropland because of the erosion hazard and slope. The Tabor soils are moderately suited to this use because of droughtiness and the erosion hazard. These soils are moderately suited to well suited to wildlife habitat.

The soils in this map unit are poorly suited to urban and recreational uses. Shrinking and swelling with changes in moisture, low strength, very slow permeability, corrosivity to uncoated steel, and slope are the main limitations.

5. Wilson-Mabank

Nearly level and very gently sloping, very deep, moderately well drained loamy soils; on ancient stream terraces

In this map unit, the Wilson and Mabank soils are in very similar landscape positions.

This map unit makes up about 12 percent of the county. It is about 60 percent Wilson soils, 22 percent Mabank soils, and 18 percent other soils (fig. 6).

Typically, the surface layer of the Wilson soil is very

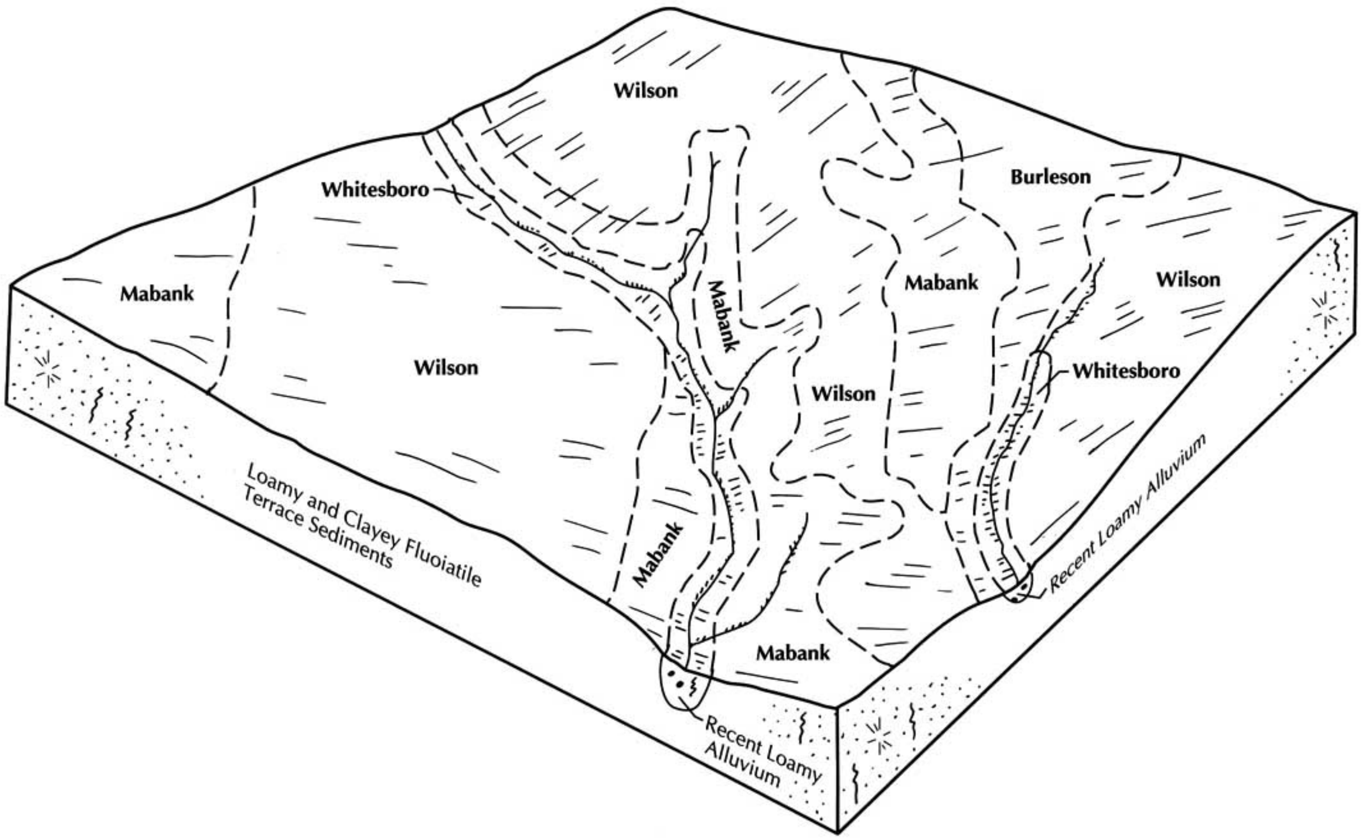

Figure 6.—Pattern of soils and underlying material in the Wilson-Mabank general soil map unit.

dark gray clay loam. The subsoil is clay that is black in the upper part, gray in the middle part, and gray to light gray in the lower part.

Typically, the surface layer of the Mabank soil is dark grayish brown fine sandy loam. The subsoil is very dark gray and dark gray clay in the upper part, gray clay loam in the middle part, and grayish brown clay loam in the lower part.

Soils of minor extent in this map unit are the Branyon, Bremond, Burleson, Crockett, Ferris, Heiden, Houston Black, Leson, and Whitesboro soils. The Branyon, Burleson, Heiden, Houston Black, and Leson soils are clayey throughout and are in landscape positions similar to Wilson soils. The Bremond and Crockett soils have a brownish subsoil and are in slightly higher positions. Ferris soils are clayey and calcareous throughout and are in higher positions. Whitesboro soils have a loamy subsoil and are on flood plains.

The soils of this map unit are used as cropland or pasture. They are moderately suited to cropland because of the erosion hazard and droughtiness. These soils are moderately suited to improved pastures and native grasses. Soils of this map unit are moderately suited to most wildlife habitat.

The soils in this map unit are poorly suited to urban and recreational uses. Shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and clayey surface layer are the main limitations.

6. Axtell-Rader

Nearly level and very gently sloping, very deep, moderately well drained loamy soils; on stream terraces

In this map unit, the Axtell and Rader soils are on broad, smooth, nearly level and very gently sloping stream terraces. The Rader soils are generally in the lower parts of the landscape.

This map unit makes up about 4 percent of the county. It is about 57 percent Axtell soils, about 14 percent Rader soils, and about 29 percent other soils.

Typically, the surface layer of the Axtell soil is dark grayish brown fine sandy loam. The subsoil is reddish brown and light olive brown clay in the upper part, light yellowish brown clay in the middle part, and light yellowish brown clay loam in the lower part. Mottles in shades of brown and red are in the upper part of the subsoil.

Typically, the surface layer of the Rader soil is dark brown fine sandy loam. The subsurface layer is brown fine sandy loam. The subsoil is strong brown sandy clay loam in the upper part, light brownish gray clay loam in the middle part, and light gray sandy clay loam in the lower part. Mottles in the subsoil are in shades of red, gray, yellow, and brown.

Soils of minor extent in this map unit are the Crockett, Gasil, Lufkin, Silawa, and Tabor soils. Crockett soils are less acid in the upper part of the subsoil. Gasil soils have a more loamy subsoil. The Lufkin soils have a grayer subsoil and are in flats or shallow depressions. The Silawa soils have a subsoil that is not mottled. The Tabor soils have a yellowish or brownish subsoil.

The soils of this map unit are used as pasture or rangeland. A few areas are cultivated for small grains. These soils are well suited to coastal bermudagrass and kleingrass. They are moderately suited to native grass and crop production. Soils of this map unit are moderately suited to well suited to most wildlife habitat.

Axtell soils are poorly suited to urban uses and moderately suited to recreational uses. Rader soils are moderately suited to both urban and recreational uses. Limitations are restricted permeability, the high shrink-swell potential of the Axtell subsoil, and the seasonal high water table of the Rader soil.

7. Whitesboro

Nearly level, very deep, moderately well drained, loamy soils; on flood plains

This map unit makes up about 3 percent of the county. It is about 58 percent Whitesboro soils and 42 percent other soils.

Typically, the surface layer of the Whitesboro soil is very dark grayish brown loam. The subsoil is very dark grayish brown clay loam in the upper part. The lower part is sandy clay loam that is mottled in shades of brown, yellow, and red. The underlying material is stratified yellowish brown sandy clay loam.

Soils of minor extent in this map unit are Axtell, Crockett, Edge, Kaufman, Nahatche, Oletha, Tinn, and Uhland soils. The Axtell, Crockett, and Edge soils have a clayey subsoil and are on slightly higher upland positions. The Kaufman and Tinn soils are clayey throughout and are in slightly lower landscape positions on flood plains. The Nahatche and Uhland soils have a grayer subsoil and are on the flood plains of smaller tributary streams. The Oletha soils have a grayer subsoil and are in sloughs and depressional areas on flood plains.

Whitesboro soils are used as pasture or rangeland. They are well suited to improved pasture. Legumes, such as clover and singletary peas, grow well. These soils are also well suited to native grasses. They are suited to cropland only where they are protected by levees or floodwater retarding structures. Native and improved varieties of pecan trees are grown on these soils. Whitesboro soils are moderately suited to rangeland wildlife habitat.

These soils are not suited to urban and recreational uses. Wetness and the hazard of flooding are the limitations.

8. Kaufman-Tinn

Nearly level, very deep, somewhat poorly drained and moderately well drained clayey soils; on flood plains

The Kaufman soils formed in clayey alluvium in the Navasota River flood plain and in flood plains of large creeks. The Tinn soils formed in calcareous clayey alluvium in flood plains of mostly small creeks and in the flood plain of the northern part of the Navasota River.

This map unit makes up about 3 percent of the county. It is about 48 percent Kaufman soils, about 27 percent Tinn soils, and about 25 percent other soils.

Typically, the surface layer of the Kaufman soil is very dark gray clay in the upper part and black clay in the lower part. The subsoil is black clay in the upper part and very dark gray clay in the lower part. Mottles of very dark grayish brown are in the upper part of the subsoil.

Typically, the surface and subsurface layers of the Tinn soil are black clay. The subsoil is clay that is black in the upper part, very dark gray in the middle part, and very dark grayish brown in the lower part.

Soils of minor extent in this map unit are the Nahatche, Oletha, and Whitesboro soils. These soils are loamy and are on natural levees and alluvial fans next to surrounding uplands.

The soils of this map unit are used mainly as pasture or range. These soils are well suited to pasture. The main pasture grasses are kleingrass and coastal bermudagrass. Some pastures are overseeded in clovers or singletary peas. These soils are also used for native grass production and are well suited to this use.

These soils are not suited to cropland because of the hazard of flooding. Kaufman soils are moderately suited to well suited to woodland and wetland wildlife habitat. Tinn soils are moderately suited to these uses.

These soils are not suited to urban and recreational

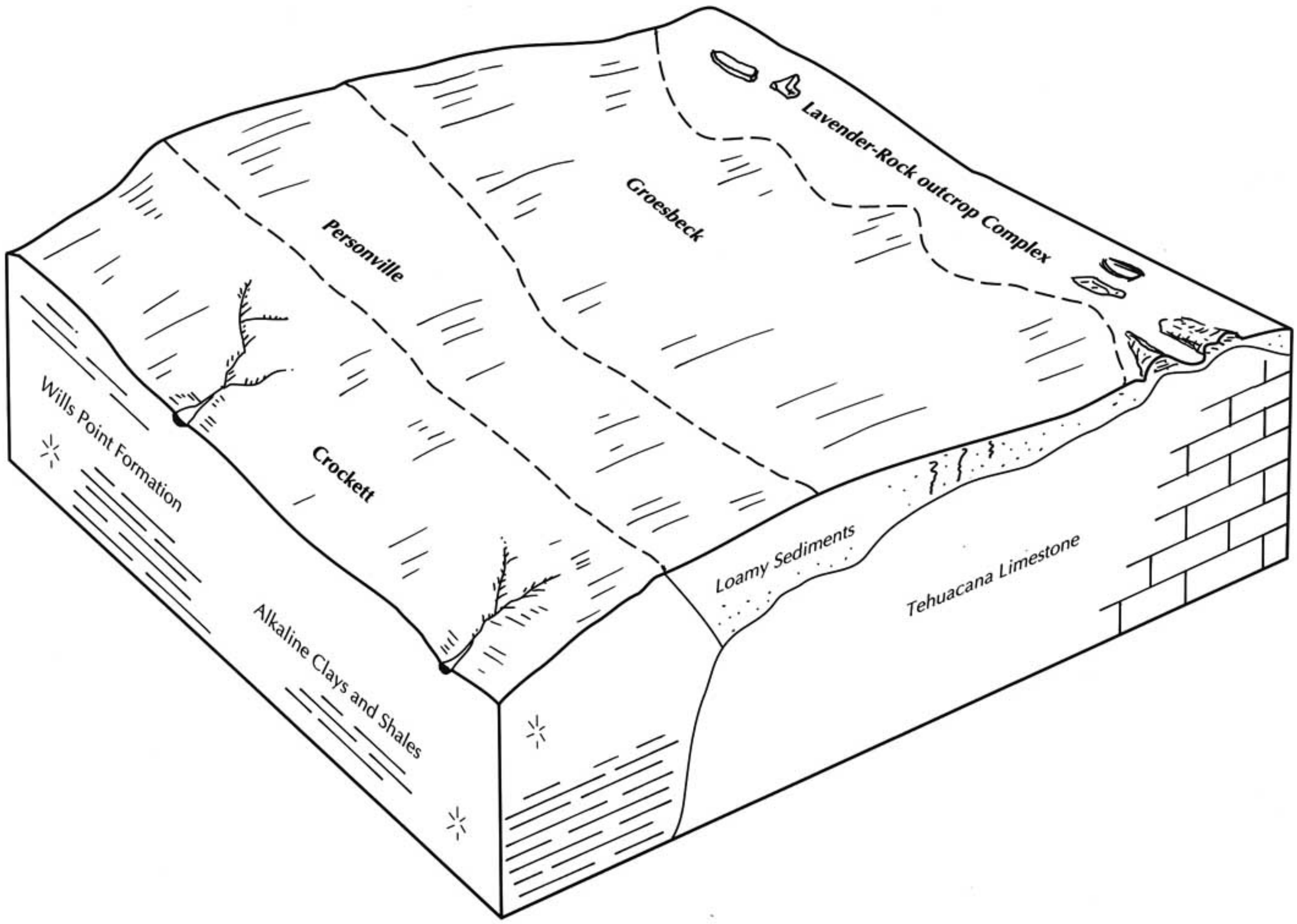

Figure 7.—Pattern of soils and underlying material in the Groesbeck-Personville-Lavender general soil map unit.

uses because of wetness, shrinking and swelling with changes in moisture, and the hazard of flooding.

9. Groesbeck-Personville-Lavender

Nearly level to gently sloping, moderately deep and deep, moderately well drained and well drained, sandy soils; on uplands

In this map unit, the moderately well drained Groesbeck soils are on broad, nearly level to gently sloping uplands and side slopes above drainageways. The moderately well drained Personville soils are on very gently sloping and gently sloping uplands. The well drained Lavender soils are on very gently sloping and gently sloping uplands and side slopes.

This map unit makes up about 2 percent of the county. It is about 34 percent Groesbeck soils, 22 percent Personville soils, 16 percent Lavender soils, and about 28 percent other soils (fig. 7).

Typically, the surface layer of the Groesbeck soils is very dark grayish brown loamy fine sand. The subsoil is light olive brown sandy clay loam in the upper part and light brownish yellow sandy clay loam in the lower part. The underlying material is limestone bedrock.

Typically, the surface layer of the Personville soil is dark yellowish brown loamy fine sand. The subsoil is dark brown sandy clay loam in the upper part, yellowish brown sandy clay loam in the middle part, and brownish yellow fine sandy loam in the lower part. The underlying material is limestone bedrock.

Typically, the surface layer of the Lavender soil is dark brown loamy fine sand. The subsoil is yellowish red loamy fine sand in the upper part and strong brown and dark brown sandy clay loam in the lower part. The underlying material is limestone bedrock.

Soils of minor extent in this map unit are the Axtell, Crockett, Gasil, Oglesby, Rader, and Styx soils. The Axtell and Rader soils are very deep and are in landscape positions similar to the Groesbeck and Lavender soils. The Oglesby soils are clayey throughout and are in slightly lower positions. The Gasil and Styx soils are very deep and are in positions similar to the Personville soils. The Crockett soils are very deep and are in lower positions on side slopes.

The soils of this map unit are used mainly as pasture or range. These soils are moderately suited to improved pasture and are moderately suited to well suited to native grasses. The hazard of erosion, rock outcrop, and slope are the main limitations in the gently sloping areas.

These soils are moderately suited to crops such as corn, cotton, grain sorghum, and small grains. The hazard of erosion, rock outcrop, and slope are the main limitations. The soils of this map unit are moderately suited to well suited to wildlife habitat.

The Groesbeck and Lavender soils are poorly suited to urban uses because of depth to rock, droughtiness, and slope. The Personville soils are well suited to urban uses. These soils are well suited to most recreational uses.

10. Uhland-Nahatche

Nearly level, very deep, moderately well drained and somewhat poorly drained, loamy soils; on flood plains

In this map unit, the moderately well drained Uhland soils are on pointbars, natural levees along stream channels, and alluvial fans. The somewhat poorly drained Nahatche soils are on broad flood plains of large creeks and in backwater areas on flood plains of smaller creeks.

This map unit makes up about 2 percent of the county. It is about 60 percent Uhland soils, about 20 percent Nahatche soils, and about 20 percent other soils.

Typically, the surface layer of the Uhland soil is dark brown fine sandy loam. The underlying material is fine sandy loam that is very pale brown in the upper part and light gray in the middle and lower parts.

Typically, the surface layer of the Nahatche soil is dark grayish brown loam. The underlying material is brownish loam in the upper part, light brownish gray loam in the middle part, and light brownish gray silt loam in the lower part.

Soils of minor extent in this map unit are the Oletha, Silstid and Whitesboro soils. The Oletha soils have a clayey surface layer and are in landscape positions similar to Nahatche soils. The Silstid soils are sandy and in upland positions. The Whitesboro soils have a darker surface layer and are in positions similar to Uhland soils.

The soils of this map unit are mainly used as pasture or rangeland. These soils are well suited to improved pastures. Legumes, such as clovers and singletary peas, grow well. The Nahatche soils are moderately suited and the Uhland soils are well suited to native grass production.

These soils are not suited to cropland because of the hazard of flooding. The Nahatche soils are moderately suited to openland wildlife habitat and well suited to woodland wildlife habitat. The Uhland soils are moderately suited to these uses. These soils are not suited to urban and recreational uses because of wetness and the hazard of flooding.

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.

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. Wilson-Bremond complex, 0 to 2 percent slopes, is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries 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.

AxA—Axtell fine sandy loam, 0 to 1 percent slopes

This very deep, nearly level soil is on broad stream terraces. Slopes are plane or slightly convex. Soil areas are irregular in shape and range from about 20 to 500 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 9 inches, dark grayish brown fine sandy loam

Subsoil:
9 to 18 inches, reddish brown clay that has red and dark yellowish brown mottles
18 to 32 inches, light olive brown clay that has red mottles
32 to 60 inches, light yellowish brown clay that has brownish yellow mottles in the lower part
60 to 80 inches, light yellowish brown clay loam

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Edge, Gasil, Lavender, Lufkin, Mabank, Rader, Silawa, and Tabor soils. Crockett soils are alkaline in the upper part of the subsoil and are in landscape positions similar to those of the Axtell soils. Edge soils have less clay in the lower part of the subsoil and are in similar positions. Gasil, Rader, and Silawa soils have a loamy subsoil and are in similar positions. Lavender soils have bedrock within a depth of 20 to 40 inches and are in similar positions. Lufkin and Mabank soils have dominantly gray colors and are in slightly lower positions. Tabor soils have a thicker surface layer, are not as red in the upper part of the subsoil, and are in positions similar to those of the Axtell soils. Also included are soils similar to Axtell soils that have up to 40 percent siliceous pebbles and cobbles in the surface layer and upper part of the subsoil. Included soils make up less than 15 percent of this map unit.

This Axtell soil is mainly used as pasture or rangeland. A few small areas are used as cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass, lovegrass, and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This practice adds nitrogen to the soil and provides early spring grazing. Lime may be needed to decrease soil acidity.

This soil is moderately suited to native grass production. The limiting feature is the dense, clayey subsoil that impedes roots and causes droughtiness during the summer. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

Only a few areas of this soil are used as cropland. It is moderately suited to crops such as cotton, corn, oats, and grain sorghum. The dense, clayey subsoil and droughtiness in the summer are the limiting features. Leaving crop residue on or near the surface aids water infiltration, maintains organic matter, conserves moisture, and improves tilth. Crops respond well to fertilization.

This soil is moderately suited to openland and well suited to woodland and rangeland wildlife habitat.

This soil is poorly suited to most urban uses. The most limiting features are shrinking and swelling with changes in moisture content, very slow permeability, and corrosivity to uncoated steel. This soil is moderately suited to recreational uses. Very slow permeability is the limiting feature for this use. Good design and proper installation can reduce the effects of these limitations.

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

AxB—Axtell fine sandy loam, 1 to 3 percent slopes

This very deep, very gently sloping soil is on broad stream terraces. Slopes are slightly convex. Soil areas are irregular in shape and range from about 15 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 5 inches, dark brown fine sandy loam

Subsurface layer:
5 to 8 inches, brown fine sandy loam

Subsoil:
8 to 21 inches, yellowish red clay
21 to 53 inches, light olive brown clay that has grayish brown, yellowish brown, and yellowish red mottles
53 to 80 inches, mottled grayish brown, yellowish brown, light brownish gray, and light olive brown sandy clay loam

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Edge, Gasil, Lavender, Lufkin, Mabank, Rader, Silawa, and Tabor soils. Crockett soils are alkaline in the upper part of the subsoil and are in landscape positions similar to those of Axtell soils. Edge soils have less clay in the lower part of the subsoil and are in similar positions. Gasil, Rader, and Silawa soils have a loamy subsoil and are in similar positions. Lavender soils have bedrock within a depth of 20 to 40 inches and are in similar positions. Lufkin and Mabank soils have dominantly gray colors and are in slightly lower positions. Tabor soils have a thicker surface layer, are not as red in the upper part of the subsoil, and are in similar positions. Eroded areas of Axtell soils that are on steeper slopes are included. Also included are soils similar to Axtell soils that have up to 40 percent siliceous pebbles and cobbles. Included soils make up less than 15 percent of this map unit.

This Axtell soil is used mainly as pasture or rangeland. A few small areas are used as cropland.

This soil is moderately suited to pasture and hayland grasses. The limiting features are the erosion hazard, a clayey subsoil that impedes roots, and droughtiness during the summer. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil, helps control erosion, and provides grazing in the early spring. Lime may be needed to decrease soil acidity.

This soil is only moderately suited to rangeland because of the erosion hazard, the clayey subsoil, and droughtiness during the summer. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit is used as cropland in only a few areas. It is moderately suited to crops such as small grains, grain sorghum, and hay crops. The most limiting features are the very slow permeability, moderate erosion hazard, clayey subsoil, and droughtiness. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. The application of a complete fertilizer improves yields.

This soil is moderately suited to openland wildlife and well suited to rangeland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling with changes in moisture, very slow permeability, and corrosivity to uncoated steel. Good design and proper installation can reduce the effects of these limitations.

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

BnA—Branyon clay, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on ancient stream terraces. Slopes are plane or slightly concave. Soil areas are irregular in shape and range from about 50 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, very dark gray clay

Subsoil:
6 to 14 inches, very dark gray clay
14 to 48 inches, dark gray clay
48 to 62 inches, gray clay
62 to 80 inches, light brownish gray clay that has yellowish brown mottles

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Burleson and Wilson soils. Burleson soils are not calcareous in the upper part. Wilson soils have a loamy surface layer. Also included are Branyon soils that have 15 to 25 percent siliceous pebbles and cobbles on the surface and within the surface layer. Included soils make up less than 15 percent of this map unit.

This Branyon soil is used mainly as cropland and is well suited to crops such as cotton, corn, grain sorghum, and small grains (fig. 8). However, it is difficult to till when wet and it cracks severely during dry periods. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation

Figure 8.—Wheat and grain sorghum are two of the crops grown on Branyon clay, 0 to 2 percent slopes.

tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to pasture. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This practice adds nitrogen to the soil, helps control erosion, and provides grazing in the early spring.

This map unit is well suited to native range grass production. The climax vegetation is medium and tall grasses with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to openland and rangeland wildlife habitat.

This soil is poorly suited to most urban uses. The most limiting features are the very high shrink-swell potential, very slow permeability, corrosivity to uncoated steel, and low strength. This soil is moderately suited to recreational uses. Limiting features are the clayey surface layer and very slow permeability. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Branyon soil is in capability subclass IIe and in the Blackland range site.

BuA—Burleson clay, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on ancient stream terraces. Slopes are plane or slightly concave. Soil areas are irregular in shape and range from about 50 to 1000 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 18 inches, black clay

Subsoil:
18 to 29 inches, black clay
29 to 42 inches, very dark gray clay
42 to 80 inches, grayish brown clay that has light yellowish brown mottles

Important soil properties—

Permeability: very slow, however water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Branyon and Wilson soils. Branyon soils are calcareous throughout and Wilson soils have a loamy surface layer. Also included are small areas of Burleson soils that contain cobbles and gravels. Included soils make up less than 15 percent of this map unit.

This Burleson soil is used mainly as cropland and is well suited to crops such as cotton, corn, grain sorghum, and small grains. However, it is difficult to till when wet, and it cracks severely during dry periods. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to pasture. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil, helps control erosion, and provides grazing in the early spring.

This map unit is well suited to native grass production. The climax vegetation is medium and tall native grasses with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to openland wildlife habitat.

This soil is poorly suited to urban uses. The most limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and low strength. This soil is moderately suited to recreational uses. Very slow permeability and the clayey surface layer are the limiting features. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Burleson soil is in capability subclass IIe and in the Blackland range site.

CrA—Crockett loam, 0 to 1 percent slopes

This very deep, nearly level soil is on uplands. Slopes are plane to slightly convex. Soil areas are irregular in shape and range from 10 to 150 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, brown loam

Subsoil:
6 to 12 inches, dark yellowish brown clay that has reddish brown mottles
12 to 24 inches, dark grayish brown clay that has reddish brown mottles
24 to 40 inches, light yellowish brown clay that has yellowish brown mottles
40 to 56 inches, olive yellow clay loam that has brownish yellow and red mottles

Underlying material:
56 to 80 inches, light brownish gray weakly consolidated shale interbedded with silty clay loam

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Edge, Lavender, Mabank, Silawa, Tabor, Whitesboro, and Wilson soils. Axtell, Edge, and Tabor soils are acidic in the upper subsoil. Mabank and Wilson soils are dominantly gray in the subsoil and are in lower, wetter landscape positions. Lavender soils are moderately deep to bedrock. Silawa soils have a loamy subsoil. Whitesboro soils are on flood plains. Also included are Crockett soils that have a fine sandy loam surface layer. These soils make up less than 15 percent of this map unit.

This Crockett soil is used mainly as pasture or rangeland. A few small areas are in cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass, common bermudagrass, and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early spring grazing.

This soil is well suited to native grass production. The climax vegetation is medium and tall native grasses, forbs, and shrubs with scattered oak and hackberry trees mainly along drainageways. Controlled grazing and brush control are needed for maximum production.

Although a few areas of this soil are used as cropland, it is only moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The main limiting features are the very slow permeability and the dense, clayey subsoil. Leaving crop residue on or near the surface aids in water infiltration, maintains organic matter, and improves tilth.

This soil is well suited to openland and rangeland wildlife habitat.

This soil is moderately suited to urban and recreational uses. Limiting features are shrinking and swelling with changes in moisture, very slow permeability, low strength, and corrosivity to uncoated steel. The effects of these limitations can be reduced by good design and proper installation.

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

CrB—Crockett loam, 1 to 3 percent slopes

This very deep, very gently sloping soil is on uplands. Slopes are slightly convex. Soil areas are irregular in shape and range from about 15 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 5 inches, dark grayish brown loam

Subsoil:
5 to 16 inches, mottled reddish brown, yellowish brown, and light olive brown clay
16 to 35 inches, dark grayish brown clay that has reddish brown, yellowish brown, and light olive brown mottles
35 to 47 inches, mottled strong brown, olive brown, light olive brown, and olive yellow clay
47 to 54 inches, mottled brownish yellow, olive brown, olive gray, and light gray clay

Underlying material:
54 to 80 inches, mottled olive gray, light olive brown, and brownish yellow clay loam interbedded with weakly consolidated shale

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Lavender, Mabank, Normangee, Tabor, and Wilson soils. Edge soils have a redder, more acid subsoil and are less clayey in the lower part. Lavender soils have bedrock within 20 to 40 inches of the surface. Mabank and Wilson soils are mostly in lower, wetter landscape positions and are dominantly gray. Normangee soils have a clay loam surface layer. Tabor soils have a thicker surface layer and are more acid in the upper part of the subsoil. Also included are small eroded areas of Crockett soils and soils similar to Crockett soils that have a fine sandy loam surface texture. Included soils make up less than 15 percent of this map unit.

This Crockett soil is used mainly as pasture or rangeland. A few small areas are in cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass, lovegrass, and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the early spring.

This map unit is well suited to native grass production. The climax vegetation is medium and tall native grasses, forbs, and shrubs with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

Although a few areas of this soil are used as cropland, they are only moderately suited to crops such as cotton, corn, grain sorghum, and small grains. Limiting features are the very slow permeability, clayey subsoil, and moderate erosion hazard. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion.

This soil is well suited to openland and rangeland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, low strength, and slope. The effects of these limitations can be reduced by good design and proper installation.

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

CrC2—Crockett loam, 2 to 5 percent slopes, eroded

This very deep, very gently sloping and gently sloping soil is on side slopes of drainageways on uplands. In most all areas of this soil, sheet erosion has reduced the thickness of the surface layer to 5 inches or less. Rills and a few, shallow gullies are in some areas. The gullies are about 2 to 5 feet wide and 75 to 300 feet apart. Most are 1 foot or less deep and can be crossed with farm machinery. Soil areas are long and narrow or irregular in shape, and range from about 10 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 3 inches, dark brown loam

Subsoil:
3 to 13 inches, mottled dark reddish brown and yellowish brown clay
13 to 33 inches, light olive brown clay that has dark reddish brown, grayish brown, and yellowish brown mottles
33 to 45 inches, light yellowish brown clay that has grayish brown, light brownish gray, and yellowish brown mottles

Underlying material:
45 to 80 inches, mottled light yellowish brown, grayish brown, gray, light brownish gray, and yellowish brown weakly consolidated weathered shale that has a clay loam texture.

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: high
Water erosion hazard: severe
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Ellis, Ferris, Heiden, Lamar and Normangee soils. Edge soils have a redder, more acid subsoil which is less clayey in the lower part. The Ellis, Ferris, and Heiden soils are in slightly higher landscape positions and are clayey throughout. Lamar soils are in higher positions. Normangee soils have more clay in the surface layer and do not have an abrupt change in texture between the surface layer and the subsoil. Also included are similar soils that have limestone bedrock within a depth of 20 inches and similar soils that have a fine sandy loam surface texture. Included soils make up less than 15 percent of this map unit.

This Crockett soil is used mainly as pasture or rangeland. A few small areas are in cropland.

This map unit is moderately suited to pasture and hayland grasses. The severe erosion hazard and dense, clayey subsoil are the limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass, and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the early spring. Lime may be needed to decrease soil acidity.

This soil is well suited to native grass production. The climax vegetation is medium and tall native grasses, forbs, and shrubs with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This Crockett soil is poorly suited for use as cropland. A few areas are used for crops such as grain sorghum and small grains. The limiting features are the severe erosion hazard, thin surface layer, very slow permeability, and the clayey subsoil. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion.

This soil is well suited to openland and rangeland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, low strength, and slope. The effects of these limitations can be reduced by good design and proper installation.

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

EgB—Edge fine sandy loam, 1 to 5 percent slopes

This very deep, very gently sloping and gently sloping soil is on ridgetops and broad interstream divides of uplands. Slopes are smooth or slightly convex. Areas are irregular in shape and range from about 20 to 500 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 9 inches, dark brown fine sandy loam

Subsoil:
9 to 26 inches, red clay
26 to 38 inches, red clay loam that has reddish yellow mottles

38 to 51 inches, strong brown sandy clay loam that has red mottles

Underlying material:
51 to 80 inches, yellowish red weakly consolidated mudstone that has a sandy clay loam texture with red, brown, and gray mottles.

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: well drained
Runoff: medium to high
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Crockett, Gasil, Lavender, Lufkin, Nahatche, Oletha, Padina, Rader, Silawa, Silstid, and Tabor soils. The Axtell, Crockett, and Tabor soils are more clayey in the lower part of the subsoil and are in similar landscape positions. Gasil, Padina, and Silstid soils have a sandy surface layer and loamy subsoil and are in slightly higher positions. Lavender soils have bedrock within a depth of 20 to 40 inches and are in similar positions. Lufkin soils are mostly gray throughout the subsoil and are in lower landscape positions. Nahatche and Oletha soils are on flood plains. Rader soils are in slightly lower positions and have gray mottles. Silawa soils have a loamy subsoil and are in similar positions. Also included are soils similar to Edge soils that have gray mottles in the upper part of the subsoil and Edge soils that have a gravelly surface layer. Included soils make up less than 15 percent of this map unit.

This soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The dense, clayey subsoil and moderate erosion hazard are the limiting features. A complete fertilizer and controlled grazing is needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This Edge soil is also used as rangeland and is moderately suited to this use. The dense, clayey subsoil and erosion hazard are the limiting features. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is poorly suited to crops such as cotton, corn, grain sorghum, and small grains. The moderate erosion hazard, clayey subsoil, and high runoff are the limiting features. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This map unit is moderately suited to openland wildlife habitat and well suited to woodland and rangeland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling of the soil with changes in moisture, corrosivity to uncoated steel, very slow permeability, slope, and low strength. Good design and proper installation can reduce the effects of these limitations.

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

EgC2—Edge fine sandy loam, 2 to 5 percent slopes, eroded

This very deep, very gently sloping and gently sloping soil is on ridgetops and broad interstream divides of uplands. The surface layer has been thinned by sheet erosion and is less than 5 inches thick in most places. Some areas have rills and shallow gullies that can be crossed with farm machinery. Other areas have gullies that are 1 to 3 feet deep, 5 to about 15 feet wide, and 75 to 300 feet apart. Soil areas are long and narrow or irregular in shape, and range from about 20 to 300 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 3 inches, light brownish gray fine sandy loam

Subsoil:
3 to 13 inches, yellowish red clay that has yellowish brown mottles
13 to 31 inches, mottled yellowish red and dark brown clay
31 to 60 inches, light brownish gray sandy clay loam that has yellowish brown and dark brown mottles

Underlying material:
60 to 80 inches, mottled light brownish gray and yellowish brown weakly consolidated mudstone that has a sandy clay loam texture

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: well drained
Runoff: high
Water erosion hazard: severe
Shrink-swell potential: high

Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Gasil, Lavender, Silstid, Silawa, and Tabor soils. Crockett and Tabor soils have more clay in the lower part of the subsoil. Tabor soils are in lower landscape positions. Gasil soils are loamy and are in slightly lower positions. Lavender soils are underlain by limestone within a depth of 20 to 40 inches. Silstid soils have a thick, sandy surface layer. Silawa soils have a loamy subsoil. Also included are small areas of Edge soils that have a gravelly surface layer, and soils similar to Edge soils that have gray mottles in the upper part of the subsoil. Included soils make up less than 15 percent of this map unit.

This Edge soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The severe erosion hazard, clayey subsoil, and thin surface layer are the limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This map unit is moderately suited to native grass production. The most limiting features are the severe erosion hazard, clayey subsoil, and thin surface layer. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is poorly suited to crops such as cotton, corn, grain sorghum, and small grains. The most limiting features are the severe erosion hazard, clayey subsoil, and thin surface layer. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is moderately suited to openland wildlife habitat and well suited to woodland and rangeland wildlife habitat.

This soil is poorly suited to urban and recreational uses. The limiting features are shrinking and swelling of the soil with changes in moisture, corrosivity to uncoated steel, very slow permeability, slope, and low strength. Good design and proper installation can reduce the effects of these limitations.

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

EgD—Edge fine sandy loam, 5 to 12 percent slopes

This very deep, moderately sloping and strongly sloping soil is on side slopes of uplands. Slopes are plane or convex. Areas are irregular in shape, generally conforming to drainage patterns, and range from 50 to about 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 9 inches, brown fine sandy loam

Subsoil:
9 to 25 inches, dark red clay
25 to 37 inches, mottled red, pale brown, and yellowish brown clay
37 to 49 inches, grayish brown clay loam that has red and brownish yellow mottles
49 to 53 inches, light brownish gray clay loam that has red mottles

Underlying material:
53 to 68 inches, mottled red and gray weakly consolidated mudstone that has a sandy clay loam texture
68 to 80 inches, strong brown weakly consolidated mudstone that has a fine sandy loam texture

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: well drained
Runoff: very high
Water erosion hazard: severe
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are Crockett, Gasil, Silawa, and Silstid soils. Crockett soils have more clay in the lower part of the subsoil and are on side slopes of drainageways. Silawa soils are loamy and are in slightly lower terrace positions. Silstid soils have a thick, sandy surface and are in lower positions. Also included are eroded areas of Edge soils that have a very gravelly surface layer. Included soils make up less than 15 percent of this map unit.

This Edge soil is used mainly as rangeland or pasture.

This soil is moderately suited to native grass production. The limiting features are the severe erosion hazard, clayey subsoil, and runoff. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is poorly suited to improved pasture and hayland. The severe erosion hazard, clayey subsoil, and runoff are limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the early spring. Lime may be needed to decrease soil acidity.

This map unit is not suited to cropland. The main limiting features are slope, severe erosion hazard, and very high runoff.

This soil is well suited to woodland and rangeland wildlife habitat.

This soil is poorly suited to urban and recreational uses. Shrinking and swelling with changes in moisture, very slow permeability, and slope are the limiting features. Good design and proper installation can reduce the effect of these limitations.

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

EhC3—Edge-Gullied land complex, 3 to 8 percent slopes

This map unit consists of the very deep, gently sloping and moderately sloping Edge soil and areas of Gullied land, on uplands. The Edge soil is between the gullies. The Gullied land consists of U-shaped gullies that are 3 to 30 feet deep, 10 to 100 feet wide, and 10 to 150 feet apart. The bottoms of the gullies are mostly barren of vegetation and are actively eroding. The gullies tend to increase in width by mass slumping and cut headward in a branchlike pattern. Areas of this map unit are irregular in shape and range from 5 to 35 acres.

This unit is about 60 percent Edge soils, 35 percent Gullied land and 5 percent other soils. These areas are so intricately mixed that separating the soil and the Gullied land is not practical at the scale used.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 3 inches, brown fine sandy loam

Subsoil:
3 to 15 inches, red clay
15 to 25 inches, yellowish red clay that has pale brown and yellowish brown mottles
25 to 32 inches, mottled yellowish red, pale brown, and yellowish brown clay
32 to 42 inches, mottled light brownish gray and yellowish brown sandy clay loam

Underlying material:
42 to 61 inches, mottled gray and yellowish brown weakly consolidated mudstone that has a sandy clay loam texture
61 to 80 inches, light brownish gray weakly consolidated mudstone that has a sandy clay loam texture

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: well drained
Runoff: high to very high
Water erosion hazard: severe
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Reclamation of the gullied areas is difficult and expensive. Most areas do not have a nearby source of suitable topsoil. Revegetation using ground cover plants is possible. Some areas have been shaped and used as pond sites.

The Edge soil in this complex is used mainly as rangeland. It is poorly suited to pasture and hayland grasses because of the severe erosion hazard and deep gullies.

The Edge soil in this complex is not suited to cultivation because of the gullies and the hazard of erosion. Most areas of this soil have been cultivated in the past, and most of the gullies formed as the soil was cropped.

This soil is moderately suited to native grass production. The severe erosion hazard and gullies are the limiting features. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

The Edge soil is moderately suited to openland wildlife habitat and well suited to woodland and rangeland wildlife habitat.

The Edge soil is poorly suited to urban and recreational uses because of the erosion hazard, shrinking and swelling of the soil with changes in moisture, gullies, slope, corrosivity to uncoated steel, very slow permeability, and low strength. Good design and proper installation can reduce the effects of these limitations.

This Edge soil is in capability subclass VIe and in the Claypan Savannah range site. The Gullied land is in capability subclass VIIe and is not assigned a range site.

EsC2—Ellis Clay, 3 to 5 percent slopes, eroded

This very deep, gently sloping soil is on side slopes of uplands above drainageways. Some areas have rills and shallow gullies that can be crossed with farm machinery. Other areas have gullies that are 1 to 3 feet deep, 3 to about 10 feet wide, and 60 to 200 feet apart. Soil areas are long and narrow or irregular in shape, and range from about 50 to 500 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, brown clay

Subsoil:
6 to 13 inches, yellowish brown clay
13 to 40 inches, light olive brown clay

Underlying material:
40 to 60 inches, light brownish gray weakly consolidated shale that has clay texture
60 to 80 inches, light gray weakly consolidated shale that has clay texture

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: well drained
Runoff: high
Water erosion hazard: severe
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Ferris, Heiden, Lamar, and Normangee soils. Crockett soils are on divides between secondary drainageways and have a loamy surface layer. Ferris soils are in higher landscape positions, are calcareous throughout, and have a higher shrink-swell potential. Heiden soils are calcareous. Lamar soils have a loamy subsoil. Normangee soils have a loamy surface layer. Also included are soils similar to Ellis soils that do not shrink and swell with changes in moisture. Generally, included soils make up less than 20 percent of this map unit.

This Ellis soil is used mainly as pasture or rangeland. A few small areas are used as cropland.

This soil is moderately suited to pasture and hayland grasses. The most limiting feature is the severe erosion hazard. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the spring.

This soil is moderately suited to native grass production. The severe erosion hazard is the most limiting feature. The climax vegetation is medium and tall grasses with an overstory of scattered mesquite, oak, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is poorly suited to crops such as cotton, corn, grain sorghum, and small grains. The limiting features are severe erosion hazard and high runoff. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, improves tilth, and maintains organic matter content. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion.

This soil is moderately suited to openland and rangeland wildlife habitat.

This Ellis soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling with changes in moisture content, very slow permeability, corrosivity to uncoated steel, and clay texture. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Ellis soil is in capability subclass IVe and in the Eroded Blackland range site.

EsE2—Ellis clay, 5 to 15 percent slopes, eroded

This very deep, strongly sloping to moderately steep soil is on side slopes of uplands above drainageways. Some areas have rills and gullies, mainly at mid-slope. The gullies are 1 to 2 feet deep, 10 to 40 feet wide, and 10 to 50 feet apart. A few gullies at the heads of drainageways are too deep to cross with farm equipment. In some areas there are no gullies. Sheet erosion has removed one-fourth to one-half of the original surface layer between the gullies. Soil areas are mostly long and narrow in shape and range from about 50 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, olive brown clay

Subsoil:
6 to 37 inches, light olive brown clay that has yellowish brown mottles

Underlying material:
37 to 80 inches, grayish brown weakly consolidated shale that has clay texture

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: well drained

Runoff: very high
Water erosion hazard: severe
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Ferris, Lamar, and Normangee soils. The Crockett and Normangee soils have a loamy surface layer and are in lower landscape positions. The Ferris soils are calcareous throughout with a very high shrink-swell potential. Lamar soils have a loamy texture. Also included are soils similar to Ellis soils that do not shrink and swell with changes in moisture. Included soils make up less than 15 percent of this map unit.

This Ellis soil is used mainly as rangeland or pasture.

This soil is moderately suited to native grass production. The limiting features are the severe erosion hazard and very high runoff. The climax vegetation is medium and tall native grasses, forbs, and shrubs with an overstory of scattered oak, mesquite, and hackberry trees. Controlled grazing and brush control are needed for maximum production.

This soil is poorly suited to improved pasture and hayland grasses. The very high runoff and severe erosion hazard are limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the early spring.

This map unit is not suited to cropland because of the severe erosion hazard, very high runoff, and steepness of slope.

This soil is moderately suited to openland and rangeland wildlife habitat.

This soil is poorly suited to urban and recreational uses. The limiting features are shrinking and swelling with changes in moisture content, corrosivity to uncoated steel, very slow permeability, and slope. Good design and proper installation can reduce the effect of those limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Ellis soil is in capability subclass VIe and in the Eroded Blackland range site.

FeD2—Ferris clay, 5 to 15 percent slopes, eroded

This very deep, strongly sloping to moderately steep soil is on side slopes above drainageways on uplands. Gullies make up about 5 percent of the map unit. Most are at mid-slope. They are mostly 1 to 2 feet deep, 15 to 30 feet wide, and 40 to 200 feet apart. A few gullies at the heads of drainageways are too deep to cross with farm equipment. Erosion has removed 50 to 75 percent of the original surface layer between the gullies. Soil areas are mainly long and narrow in shape, and range from about 20 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 4 inches, very dark grayish brown clay

Subsoil:
4 to 45 inches, olive clay that has light olive brown mottles

Underlying material:
45 to 80 inches, clay mottled with various shades of olive, gray, brown, and yellow and containing fragments of shale

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: well drained
Runoff: very high
Water erosion hazard: severe
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Ellis and Heiden soils. Ellis soils are noncalcareous. Heiden soils have a darker surface layer and are in lower positions. Also included are Ferris soils on steeper slopes that are severely eroded. Included soils make up less than 15 percent of this map unit.

This Ferris soil is used mainly as rangeland or pasture. Most areas were formerly used as cropland and have been allowed to revegetate with native plants and weeds.

This soil is well suited to rangeland. The climax vegetation is a mixture of medium and tall native grasses, forbs and shrubs with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing, brush control, and other management practices are needed to increase the coverage of native grasses and to control erosion.

This map unit is poorly suited to improved pasture and hayland. The high clay content, severe erosion hazard, steepness of slope, and gullies are limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil, helps control erosion, and provides grazing in the early spring.

This soil is not suited to cropland. The limiting features are severe erosion hazard, very high runoff, and slope.

This soil is moderately suited to openland and rangeland wildlife habitat.

This Ferris soil is poorly suited to urban and recreational uses. The most limiting features are very high shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, low strength, and slope. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Ferris soil is in capability subclass VIe and in the Eroded Blackland range site.

FhC2—Ferris-Heiden complex, 2 to 5 percent slopes, eroded

These very deep, very gently sloping and gently sloping soils are mainly on side slopes above drainageways on uplands. The dominant slope is about 3 percent. Some areas have rills and shallow gullies that can be crossed with farm machinery. Other areas have gullies that are 1 to 3 feet deep, 10 to 100 feet wide, and about 50 to 500 feet apart. Soil areas are irregular in shape and range from about 20 to 30 acres.

This complex is 60 percent Ferris soils, 30 percent Heiden soils, and about 10 percent other soils. Areas of these soils are too intricately mixed or too small to be mapped separately at the selected scale.

The typical sequence, depth, and composition of the layers of the Ferris soil are—

Surface layer:
0 to 4 inches, dark grayish brown clay

Subsoil:
4 to 43 inches, light olive brown clay

Underlying material:
43 to 80 inches, light olive brown clay containing fragments of weakly consolidated weathered shale

The typical sequence, depth, and composition of the layers of the Heiden soil are—

Surface layer:
0 to 20 inches, very dark grayish brown clay

Subsoil:
20 to 35 inches, dark grayish brown clay
35 to 60 inches, light olive brown clay

Underlying material:
60 to 80 inches, olive clay containing fragments of weathered shale

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: well drained
Runoff: high
Water erosion hazard: severe
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with these soils in mapping are small areas of Houston Black and Leson soils. Houston Black soils are in lower positions and have a thicker and darker surface layer. Leson soils are noncalcareous in the upper part and are in lower positions. Also included are small areas of Ferris and Heiden soils on slopes greater than 5 percent. Included soils make up less than 15 percent of this map unit.

The Ferris and Heiden soils are used mainly as cropland or pasture.

These soils are poorly suited to cropland. The limiting features are the severe erosion hazard and high runoff. Close growing crops are best suited to these erosive soils. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, improves tilth, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion.

The Ferris and Heiden soils are moderately suited to pasture and hayland grasses. Limitations are the erosion hazard and high runoff. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the early spring.

These soils are well suited to rangeland. The climax vegetation is medium and tall grasses, with an overstory of scattered mesquite, oak, and hackberry trees along fence rows and drainageways. Controlled grazing and brush control are needed for maximum production.

These soils are moderately suited to openland and rangeland wildlife habitat.

These soils are poorly suited to urban uses and moderately suited to recreational uses. The limiting features are shrinking and swelling with changes in moisture, corrosivity to uncoated steel, clay texture, and slope. These limitations are difficult and costly to overcome, and require careful design and proper installation procedures. Trench sidewalls become very unstable in these soils under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

The Ferris soil in this map unit is in capability subclass IVe and is in the Eroded Blackland range site. The Heiden soil is in capability subclass IIIe and is in the Blackland range site.

GfB—Gasil loamy fine sand, 1 to 5 percent slopes

This very deep, very gently sloping and gently sloping soil is on broad uplands. Slopes are plane or slightly convex. Areas are irregular in shape and range from 5 to about 150 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 16 inches, brown loamy fine sand

Subsoil:
16 to 46 inches, yellowish brown sandy clay loam that has red and reddish yellow mottles
46 to 60 inches, mottled light gray, brownish yellow, and red sandy clay loam
60 to 80 inches, mottled white, brownish yellow, and red sandy clay loam

Important soil properties—

Permeability: moderate
Available water capacity: moderate
Drainage: well drained
Runoff: very low to low
Water erosion hazard: moderate
Shrink-swell potential: moderate
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Personville, Rader, Silstid, and Tabor soils. Edge, Rader, and Tabor soils have a loamy surface layer. Rader and Tabor soils are in slightly lower positions. Personville soils have bedrock at 40 to 60 inches. Silstid soils have a sandy surface layer more than 20 inches thick and are in slightly higher positions. Also included are soils similar to the Gasil soil that have a surface layer of fine sandy loam and some soils that have a clayey subsoil. Included soils make up as much as 15 percent of this map unit.

This Gasil soil is used mainly as pasture or rangeland (fig. 9). A few small areas are used as cropland.

This soil is moderately suited to pasture and hayland grasses. The moderate available water capacity and low natural fertility are the major limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass, lovegrass, and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is well suited to native grass production. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

Only a few areas of this soil are used as cropland. This Gasil soil is moderately suited to crops such as cotton, grain sorghum, wheat, and small grains. The most limiting feature is the erosion hazard. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, grassed waterways, contour farming, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to openland and rangeland wildlife habitat.

This soil is well suited to urban and recreational uses. The shrinking and swelling with changes in moisture content is a minor limiting feature. Good design and proper installation can reduce the effects of this limitation.

This Gasil soil is in capability subclass IIIe and in the Sandy Loam range site.

GsA—Groesbeck loamy fine sand, 0 to 2 percent slopes

This moderately deep, nearly level and very gently sloping soil is on uplands. Slopes are generally smooth. Areas are irregular in shape and range from 10 to about 500 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 15 inches, very dark grayish brown loamy fine sand

Subsoil:
15 to 29 inches, light olive brown sandy clay loam that has brownish yellow and strong brown mottles
29 to 32 inches, light brownish yellow sandy clay loam that has brownish yellow mottles

Underlying material:
32 inches, indurated limestone bedrock

Important soil properties—

Permeability: moderate
Available water capacity: low
Drainage: moderately well drained

Figure 9.—Gasil loamy fine sand, 1 to 5 percent slopes is suited to coastal bermudagrass pasture.

Runoff: very low
Water erosion hazard: moderate
Shrink-swell potential: low
Water table: none within a depth of 6.0 feet
Bedrock: 32 inches

Included with this soil in mapping are small areas of Lavender, Oglesby, Personville, and Styx soils. Lavender soils have a redder subsoil. Oglesby soils are in higher landscape positions and have bedrock within 20 inches of the surface. Personville soils are in slightly higher positions and have bedrock at a depth of 40 to 60 inches. Styx soils have a thick, sandy surface layer. Also included are soils less than 10 inches deep that are stony in some areas, and soils similar to Groesbeck soils that have limestone below 40 inches. Generally, included soils make up less than 15 percent of this map unit.

This Groesbeck soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The low available water capacity and low natural fertility are the limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is also used as rangeland and is well suited to this use. The climax vegetation is medium and tall grasses with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to corn, cotton, grain sorghum, small grains, and truck crops. The low available water capacity is the major limitation. The erosion hazard is a minor limiting factor. Leaving crop residue on or near the surface helps control erosion, conserves moisture, and maintains organic matter content. Contour farming and conservation tillage help reduce soil erosion.

This soil is well suited to openland, woodland, and rangeland wildlife habitat.

This Groesbeck soil is poorly suited to urban uses and well suited to recreational uses. The main limiting features are depth to rock and seepage. Good design and proper installation can reduce the effects of these problems.

This Groesbeck soil is in capability subclass IIIe and in the Sandy Loam range site.

GsC—Groesbeck loamy fine sand, 2 to 5 percent slopes

This moderately deep, very gently sloping and gently sloping soil is on uplands. Slopes are generally convex. Areas are irregular in shape and range from 10 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 16 inches, very dark grayish brown loamy fine sand

Subsoil:
16 to 30 inches, light olive brown sandy clay loam

Underlying material:
30 inches, indurated limestone bedrock

Important soil properties—

Permeability: moderate
Available water capacity: low
Drainage: moderately well drained
Runoff: low
Water erosion hazard: moderate
Shrink-swell potential: low
Water table: none within a depth of 6 feet
Bedrock: 30 inches

Included with this soil in mapping are small areas of Lavender, Oglesby, and Personville soils. Lavender soils have a redder subsoil. Oglesby soils have bedrock within 20 inches of the surface. Personville soils are in slightly higher positions and have bedrock at a depth of 40 to 60 inches. Also included are soils similar to Groesbeck soils, but less than 20 inches deep, that are stony in some areas. In addition are similar soils that have limestone bedrock below 40 inches. Generally, included soils make up less than 15 percent of this map unit.

This Groesbeck soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The low available water capacity and low natural fertility are the limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is well suited to rangeland. The climax vegetation is medium and tall grasses with an overstory of scattered oaks and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This Groesbeck soil is moderately suited to crops such as corn, cotton, grain sorghum, and small grains. This use is limited because of moderate erosion hazard, low available water capacity, and slope. Leaving crop residue on or near the surface helps control erosion, conserves moisture, and maintains organic matter content. Terracing, contour farming, and conservation tillage help reduce soil erosion.

This soil is well suited to openland, woodland, and rangeland wildlife habitat.

This map unit is poorly suited to urban uses and moderately suited to recreational uses. The main limiting features are depth to rock, slope, and seepage. Good design and proper installation can reduce the effects of these problems.

This Groesbeck soil is in capability subclass IIIe and in the Sandy Loam range site.

HeB—Heiden clay, 1 to 3 percent slopes

This very deep, very gently sloping soil is on erosional uplands. Slopes are plane or slightly convex. Undisturbed areas have gilgai microrelief. Soil areas are irregular in shape and range from 100 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 18 inches, very dark grayish brown clay

Subsoil:
18 to 46 inches, very dark grayish brown clay
46 to 56 inches, olive gray clay that has brownish yellow mottles
56 to 65 inches, olive clay that has strong brown and brownish yellow mottles

Underlying material:
65 to 80 inches, pale olive clay that has dark grayish brown mottles and contains fragments of weathered shale

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: very high
Water table: none within a depth of 6 feet

Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Ferris, Houston Black, Leson, Tinn, Whitesboro, and Wilson soils. Ferris soils have a light colored surface layer and are in slightly higher landscape positions. Houston Black soils have a thick, black surface layer. Leson soils are noncalcareous in the surface layer. Tinn and Whitesboro soils are on flood plains. Wilson soils have a loamy surface layer and are in slightly lower positions.
Also included are a few small eroded areas of Heiden soils. Included soils make up less than 15 percent of this map unit.

This Heiden soil is used mainly as cropland and is well suited to this use. It is difficult to till when wet and it cracks severely during dry periods. Adapted crops are cotton, corn, grain sorghum, and small grains. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to pasture. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil, helps control erosion, and provides grazing in the early spring.

This map unit is well suited to native grass production. The climax vegetation is a mixture of native grasses, forbs, shrubs, and an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is well suited to openland wildlife habitat and moderately suited to rangeland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and the clay surface layer. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Heiden soil is in capability subclass IIe and in the Blackland range site.

HoB—Houston Black clay, 1 to 3 percent slopes

This very deep, very gently sloping soil is on uplands. Slopes are plane or slightly convex. Undisturbed areas have gilgai microrelief. Soil areas are irregular in shape and range from about 15 to more than 1,000 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 21 inches, black clay

Subsoil:
21 to 45 inches, black clay
45 to 56 inches, very dark gray clay that has yellowish brown mottles
56 to 80 inches, grayish brown clay that has brownish yellow mottles and shale fragments

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Branyon, Bremond, Burleson, Heiden, Leson, Tabor, Tinn, Whitesboro, and Wilson soils. Branyon soils formed from alluvium and are on stream terraces. The Bremond soils have a loamy surface layer and are in lower landscape positions. Burleson and Leson soils are noncalcareous in the surface layer and Burleson soils are on terraces. Heiden soils have a thinner and lighter colored surface layer. Tabor and Wilson soils have a loamy surface layer and are in slightly lower positions. Tinn and Whitesboro soils are on flood plains. Included soils make up less than 15 percent of the map unit.

This Houston Black soil is used mainly as cropland and is well suited to this use (fig. 10). It is difficult to till when wet and it cracks severely during dry periods. Adapted crops are cotton, corn, grain sorghum, and small grains. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to pasture. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to

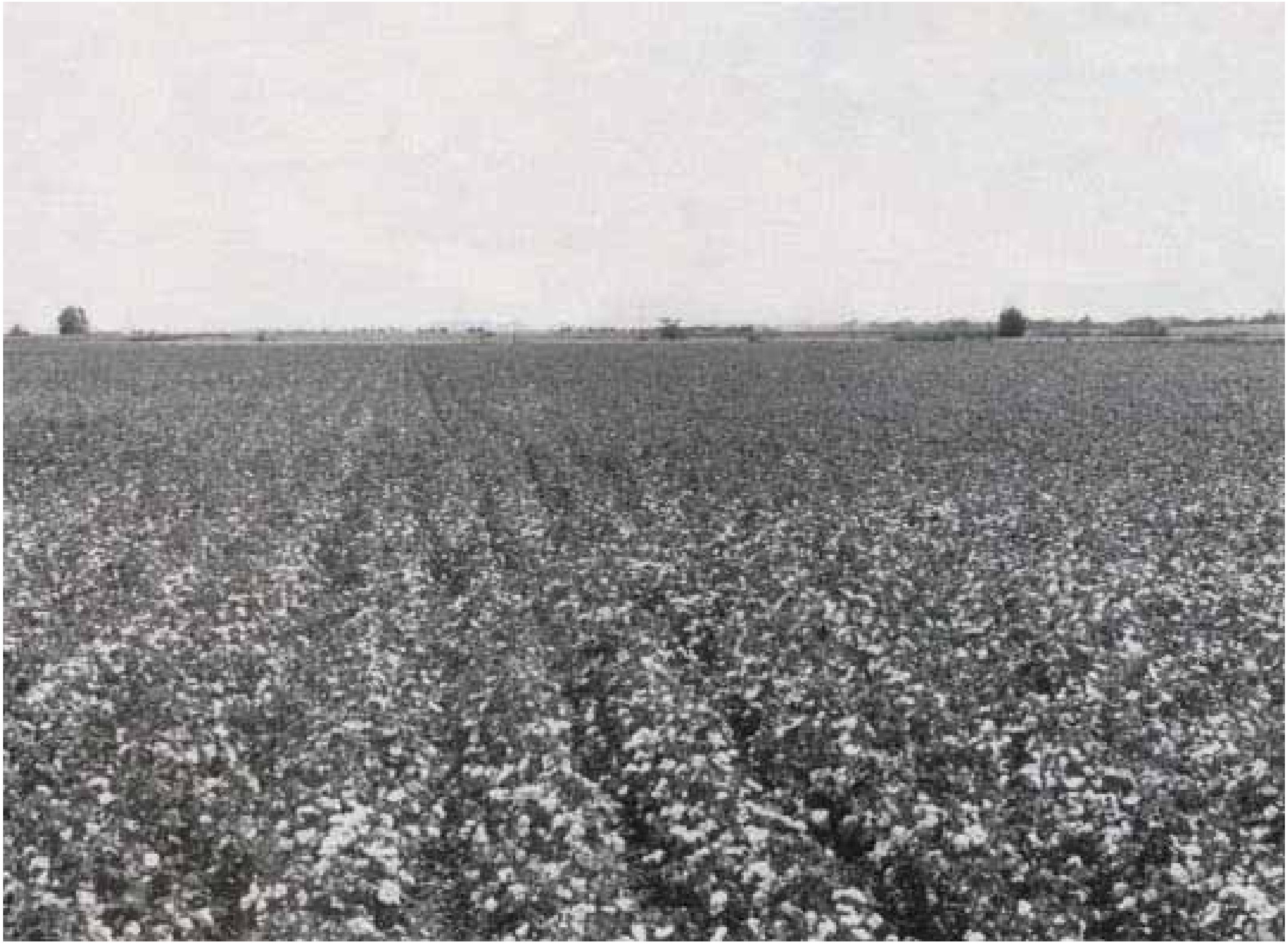

Figure 10.—Cotton is one of the major crops grown on Houston Black clay, 1 to 3 percent slopes. This soil is used mainly for cropland.

the soil, helps control erosion, and provides grazing in the early spring.

This map unit is well suited to native grasses. The climax vegetation is a mixture of native grasses, forbs, and shrubs, with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to openland and rangeland wildlife habitat.

This Houston Black soil is poorly suited to urban uses. The most limiting features are very high shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and low strength. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This soil is moderately suited to recreational uses. Limiting features are very slow permeability and clay texture.

This Houston Black soil is in capability subclass IIe and in the Blackland range site.

Kc—Kaufman clay, occasionally flooded

This very deep, nearly level soil is on flood plains of the Navasota River and its larger tributaries. Slopes are less than 1 percent. In some areas, this soil is flooded one or two times in an average 5-year period. It remains flooded for 1 to 2 days. In other areas, the soil is flooded less often, depending on protection provided by levees and flood prevention dams. Soil areas range from 50 to 300 acres. Undisturbed areas have gilgai microrelief.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 5 inches, black clay

Subsoil:
5 to 45 inches, black clay
45 to 52 inches, very dark gray clay
52 to 80 inches, dark gray clay that has yellowish brown mottles

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Nahatche, Oletha, Tinn, and Whitesboro soils. Nahatche soils are loamy and are in lower landscape positions. The Oletha soils are in lower positions and have a dark surface layer less than 10 inches thick. Tinn soils are calcareous. Whitesboro soils are loamy and are in higher positions. Also included are soils similar to Kaufman soils but wetter, and areas of Kaufman soils in slightly lower positions that flood frequently. Included soils make up less than 15 percent of this map unit.

This Kaufman soil is used mainly as pasture. A few areas are used as cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and tall fescue. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This Kaufman soil is well suited to cropland. It is difficult to till when wet and it cracks severely during dry periods. Adapted crops are corn, cotton, grain sorghum, and small grains. Leaving crop residue on or near the surface improves water infiltration, maintains the organic matter content, improves tilth, and prevents compaction. Crops respond well to fertilization.

This soil is well suited to native grass production. The climax vegetation is a mixture of medium and tall native grasses, forbs, and shrubs, with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is well suited to woodland wildlife habitat and moderately suited to openland wildlife habitat.

This soil is not suited to most urban and recreational uses. The major limitation is the flooding hazard. Other limitations include very slow permeability, clay texture, low strength, and very high shrink-swell potential. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

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

Kd—Kaufman clay, frequently flooded

This very deep, nearly level soil is on flood plains of the Navasota River and its larger tributaries. This soil is flooded once or twice during most years and remains flooded for 2 to 7 days after heavy rains. Flooding is most likely to occur during February through May. Slopes are less than 1 percent. Undisturbed areas have gilgai microrelief. Areas are irregular in shape and range from 100 to 500 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, very dark gray clay
6 to 17 inches, black clay

Subsoil:
17 to 40 inches, black clay that has very dark grayish brown mottles
40 to 80 inches, very dark gray clay

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Nahatche, Oletha, Tinn, and Whitesboro soils. Nahatche soils are loamy and are in lower landscape positions. Oletha soils are in lower positions and have a dark surface layer less than 10 inches thick. Tinn soils are calcareous. Whitesboro soils are loamy and are in higher positions. Also included are small areas of Kaufman that are occasionally flooded and soils similar to Kaufman soils that are poorly drained. Included soils make up less than 15 percent of this map unit.

This Kaufman soil is used mainly as pasture and is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and tall fescue. To add nitrogen, some pastures are overseeded with legumes, such as clovers and singletary peas. This also provides early grazing for livestock in the spring.

This soil is well suited to native grass production. The climax vegetation is a mixture of native grasses, forbs, and shrubs, with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is well suited to woodland wildlife habitat.

This soil is not suited to cropland because of flooding (fig. 11).

This soil is not suited to most urban and recreational uses. The major limitation is the flooding hazard. Other limitations include very slow permeability, clay texture, low strength, and very high shrink-swell potential. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

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

LaE2—Lamar clay loam, 5 to 15 percent slopes, eroded

This very deep, strongly sloping to moderately steep soil is on side slopes of uplands above drainageways. Most of the original surface layer has been removed by erosion. Gullies are in some areas of this map unit. Most are at the middle of the slope. They are 4 to 15 feet wide, and 40 to 100 feet apart. A few gullies at the heads of drainageways are too deep to cross with farm equipment. Soil areas are

Figure 11.—Because of the flood hazard, Kaufman clay, frequently flooded, is best suited to pasture.

mostly long and narrow in shape and range from about 20 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 3 inches, olive brown clay loam

Subsoil:
3 to 18 inches, light olive brown clay loam that has yellowish brown mottles
18 to 27 inches, light olive brown clay loam

Underlying material:
27 to 42 inches, mottled grayish brown and brownish yellow clay loam
42 to 80 inches, grayish brown clay loam that has yellowish brown mottles

Important soil properties—

Permeability: moderate
Available water capacity: moderate
Drainage: well drained
Runoff: medium
Water erosion hazard: severe
Shrink-swell potential: moderate
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Ellis, and Normangee soils. Crockett soils have an abrupt texture change between the surface layer and subsoil and are on narrow divides between secondary drainages. Ellis soils are clayey throughout. Normangee soils have a loamy surface layer and clayey subsoil. Also included are small areas of noneroded Lamar soils. Included soils generally make up less than 15 percent of this map unit.

This Lamar soil is used mainly as pasture or rangeland. Most areas were formerly used as cropland and have been allowed to revegetate with native plants and weeds.

This soil is poorly suited to improved pasture and hayland. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This helps control erosion and provides grazing in the early spring.

This Lamar soil is moderately suited to native grass production. The climax vegetation is a mixture of medium and tall native grasses, forbs, and shrubs with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing, brush control, and other management practices are needed to increase the coverage of native grasses and to control erosion.

This soil is not suited to cropland. The limiting features are the severe erosion hazard, medium runoff, and deep gullies.

This map unit is moderately suited to openland and rangeland wildlife habitat.

This soil is moderately suited to urban and recreational uses. The most limiting features are low strength, slope, and the shrink-swell potential. Good design and proper installation can reduce the effects of these limitations.

This Lamar soil is in capability subclass VIe and in the Clay Loam range site.

LrB—Lavender-Rock outcrop complex, 1 to 5 percent slopes

This map unit consists of the moderately deep, very gently sloping and gently sloping Lavender soil and areas of Rock outcrop, on uplands. Rock outcrop areas are exposed limestone bedrock or bedrock with less than 4 inches of overlying soil material. These outcrops are in long, narrow bands about 10 to 50 feet wide and 50 to 100 feet apart. They are closer together on the steeper slopes. Many limestone fragments up to 48 inches across lie on the surface. Areas of this complex are irregular in shape and range from 20 to 500 acres.

This map unit is about 58 percent Lavender soils, 26 percent Rock outcrop, and 16 percent other soils. Areas of the soils and Rock outcrop are so intricately mixed that separating them is not practical at the scale used.

The typical sequence, depth, and composition of the layers of Lavender soil are—

Surface layer:
0 to 7 inches, dark brown loamy fine sand

Subsoil:
7 to 13 inches, yellowish red loamy fine sand
13 to 22 inches, strong brown sandy clay loam that has brown mottles
22 to 31 inches, dark brown sandy clay loam that has strong brown mottles

Underlying material:
31 inches, hard limestone bedrock

Important soil properties—

Permeability: moderate
Available water capacity: low
Drainage: well drained
Runoff: low
Water erosion hazard: moderate
Shrink-swell potential: low
Water table: none within a depth of 6 feet
Bedrock: within 31 inches

Included in mapping are small areas of Axtell, Groesbeck, Personville, Rader, and Styx soils. Axtell soils have a more clayey subsoil. Groesbeck soils are in slightly higher landscape positions and have a darker surface layer. Personville and Styx soils are in slightly higher positions and have a thick, sandy surface layer. Rader soils are in slightly lower positions on the landscape and have gray mottles in the upper part of the subsoil. Also included are small areas of soils 4 to 20 inches deep over bedrock that are stony in places and small areas of soils that have bedrock below 40 inches.

The Lavender soil in this map unit is used mainly as rangeland or pasture.

This map unit is poorly suited to native grass production. The rock outcrops, stoniness, depth to bedrock, and low available water capacity are the limiting features. Controlled grazing and brush control are needed for maximum production.

This map unit is not suited to cropland or to pasture and hayland grasses. The rock outcrops, depth to rock, and stoniness are the limiting features.

This map unit is moderately suited to openland wildlife habitat and well suited to woodland and rangeland wildlife habitat.

This map unit is poorly suited to most urban and recreational uses. Rock outcrops, depth to rock, and stoniness are limiting features. However good design and proper installation can reduce the effects of these problems for some uses.

The Lavender soil is in capability subclass IIIe and the Sandy Loam range site. The Rock outcrop is in capability subclass VIIIs and is not assigned to a range site.

LsB—Leson clay, 1 to 3 percent slopes

This very deep, very gently sloping soil is on uplands. Slopes are plane or slightly convex. Undisturbed areas have gilgai microrelief. Soil areas are irregular in shape and range from 20 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, black clay

Subsoil:
6 to 33 inches, black clay
33 to 47 inches, very dark grayish brown clay
47 to 57 inches, dark grayish brown clay

Underlying material:
57 to 63 inches, grayish brown clay
63 to 80 inches, mottled light olive brown and yellowish brown weakly consolidated shale that has clay texture

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Burleson, Heiden, Houston Black, and Wilson soils. Burleson soils are grayer throughout the upper 40 inches. Heiden soils have a thinner, lighter colored surface layer. Houston Black soils are calcareous throughout. Wilson soils have a loamy surface layer. Also included are small, eroded areas of Leson soils. Included soils make up less than 15 percent of this map unit.

This Leson soil is used mainly as cropland and is well suited to this use. However, it is difficult to till when wet, and it cracks severely during dry periods. Adapted crops are cotton, corn, grain sorghum, and small grains. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to pasture. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil, helps control erosion, and provides grazing in the early spring.

This soil is well suited to native grass production. The climax vegetation is a mixture of native grasses, forbs, and shrubs with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to openland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and clay texture. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to openland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, and clay texture. Good design and proper installation can reduce the effects of these limitations. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

This Leson soil is in capability subclass IIe and in the Blackland range site.

LuA—Lufkin fine sandy loam, 0 to 1 percent slopes

This very deep, nearly level soil is on ancient high stream terraces or remnants of terraces in upland positions. Slopes are smooth or slightly concave. Soil areas are irregular in shape and range from about 10 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 10 inches, grayish brown fine sandy loam

Subsoil:
10 to 19 inches, dark gray clay that has dark yellowish brown mottles
19 to 40 inches, dark gray clay that has yellowish brown mottles
40 to 66 inches, gray clay that has yellowish brown mottles
66 to 80 inches, light brownish gray clay

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: very low
Water erosion hazard: slight
Shrink-swell potential: very high
Water table: none within a depth of 6 feet; however, soil is saturated in the surface layer for short periods in most years
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Mabank, Rader, Tabor, and Wilson soils. Edge soils have a redder subsoil and are in slightly higher landscape positions. Mabank soils are darker in color in the upper part. Rader soils have a loamy subsoil and are in slightly higher positions. Tabor soils have a brownish subsoil and are in higher positions. Wilson soils lack an abrupt textural change between the surface layer and the subsoil. Included soils make up less than 15 percent of this map unit.

This Lufkin soil is used mainly as pasture or rangeland. A few small areas are in cropland.

This soil is moderately suited to pasture and hayland grasses. The most limiting feature is wetness and the dense, clayey subsoil. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This Lufkin soil is moderately suited to rangeland because of the dense, clayey subsoil and wetness. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. Wetness and the dense, clayey subsoil are the limiting features. Leaving crop residue on or near the surface helps maintain organic matter and improves tilth. Crops respond well to fertilization.

This map unit is moderately suited to openland wildlife habitat.

This soil is poorly suited to urban and recreational uses. The most limiting features are very slow permeability, shrinking and swelling with changes in moisture, and corrosivity to uncoated steel. Good design and proper installation can reduce the effects of these limitations.

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

LxA—Lufkin-Rader complex, 0 to 1 percent slopes

This map unit consists of very deep, nearly level soils on ancient stream terraces. These areas are mounded, and the Lufkin soils are in low areas, or flats, between the mounds. Rader soils are on mounds that range from 50 to 200 feet across, 2 to 4 feet high, and 50 to 300 feet apart. In some areas, Rader soils are on small, low ridges that meander through the lows. The size of the mounds and the pattern of occurrence vary within soil areas and from one soil area to another. Soil areas are irregular in shape and range from 25 to several hundred acres.

This complex is about 57 percent Lufkin soils, 30 percent Rader soils, and about 13 percent other soils. These soils are too intricately mixed or too small to be mapped separately at the selected scale.

The typical sequence, depth, and composition of the layers of the Lufkin soil are—

Surface layer:
0 to 7 inches, grayish brown fine sandy loam

Subsoil:
7 to 29 inches, dark gray clay loam that has dark grayish brown mottles
29 to 41 inches, dark gray clay loam that has grayish brown mottles
41 to 60 inches, grayish brown clay loam that has yellowish brown mottles
60 to 80 inches, light brownish gray clay loam

The typical sequence, depth, and composition of the layers of the Rader soil are—

Surface layer:
0 to 8 inches, dark brown fine sandy loam

Subsurface layer:
8 to 18 inches, brown fine sandy loam

Subsoil:
18 to 27 inches, brownish yellow sandy clay loam
27 to 40 inches, brownish yellow sandy clay loam that has light gray, yellowish brown, and red mottles
40 to 60 inches, yellowish brown clay loam
60 to 80 inches, mottled yellowish brown and light gray clay loam

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: Lufkin—very high; Rader—moderate
Water table: Lufkin—none within a depth of 6 feet; however, soil is saturated in the surface layer for short periods in most years; Rader—perched at a depth of 2 to 4 feet for short periods, mostly during winter and spring
Bedrock: none within a depth of 6 feet

Included in mapping are small areas of Axtell, Edge, Mabank, Styx, and Tabor soils. Axtell, Edge, and Tabor soils are in higher landscape positions and have a brownish or reddish subsoil. The Mabank soils are darker in the upper part of the subsoil. Styx soils are in higher positions and have a thicker surface layer. Also included are small areas of soils similar to Lufkin soils that are in depressions or along small drainageways and are more poorly drained. Some included soils similar to Lufkin soils have less clay in the subsoil. Included soils make up less than 20 percent of this map unit.

The Lufkin and Rader soils are used as pasture or rangeland. A few areas are in cropland.

These soils are moderately suited to pasture and hayland grasses. The most limiting features are wetness and the dense, clayey subsoil. A complete fertilizer and controlled grazing are needed for improved yields of coastal bermudagrass and kleingrass. Some pastures may be overseeded with clovers or singletary peas. This adds nitrogen to the soil and provides grazing in early spring when bermudagrass is dormant. Lime may be needed to decrease soil acidity.

Soils in this map unit are moderately suited to native grass production. Wetness and the dense, clayey subsoil are limiting features. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

These soils are moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The most limiting features are wetness and the dense, clayey subsoil. Leaving crop residue on or near the surface helps maintain organic matter content, aids in increasing water infiltration, improves tilth, and helps prevent compaction. A surface drainage system may be needed to remove excess water. The addition of lime and a complete fertilizer increases yields on these soils.

These soils are moderately suited to both openland and woodland wildlife habitat.

Soils in this map unit are poorly suited to most urban and recreational uses. Shrinking and swelling with changes in moisture, wetness, very slow permeability, and corrosivity to uncoated steel are the limiting features. These limitations are difficult and costly to overcome. However, with careful design and installation procedures, these soils can be used for these purposes.

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

MaA—Mabank fine sandy loam, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on stream terraces and remnants of ancient stream terraces in upland positions. Slopes are plane or slightly concave. Soil areas are irregular in shape and range from 20 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, dark grayish brown fine sandy loam

Subsoil:
6 to 25 inches, very dark gray clay
25 to 37 inches, dark gray clay
37 to 51 inches, gray clay loam
51 to 60 inches, gray clay loam that has light gray and light olive brown mottles
60 to 80 inches, grayish brown clay loam that has light brownish gray and light olive brown mottles

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet; however, soil is saturated in the surface layer for short periods in most years
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett and Wilson soils. Crockett soils have a brownish subsoil and are in slightly higher landscape positions. Wilson soils lack an abrupt textural change between the surface layer and the subsoil. Also included are soils similar to Mabank soils that have a gravelly surface layer. Included soils make up less than 15 percent of this map unit.

This Mabank soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The most limiting feature is the dense, clayey subsoil. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is well suited to rangeland. The climax vegetation is medium and tall native grasses, forbs, and shrubs with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The moderate erosion hazard and dense, clayey subsoil are the limiting features. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Contour farming and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to openland wildlife habitat and moderately suited to rangeland wildlife habitat.

This soil is poorly suited to urban and recreational uses. The most limiting features are very slow permeability, shrinking and swelling with changes in moisture, and corrosivity to uncoated steel. Good design and proper installation can reduce the effects of these limitations.

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

Na—Nahatche loam, frequently flooded

This very deep, nearly level soil is on flood plains of major creeks. Slopes are 0 to 1 percent. The areas of this soil are generally long and narrow and range from 50 to 1,000 acres. This soil is flooded one or two times during most years and remains flooded for 1 to 3 days after heavy rains.

The typical sequence, depth, and composition of this soil are—

Surface layer:
0 to 15 inches, dark grayish brown loam that has strong brown mottles

Subsoil:
15 to 45 inches, grayish brown loam that has yellowish brown mottles
45 to 60 inches, light brownish gray loam that has yellowish brown mottles
60 to 80 inches, light brownish gray silt loam

Important soil properties—

Permeability: moderate
Available water capacity: high
Drainage: somewhat poorly drained
Runoff: negligible
Water erosion hazard: slight
Shrink-swell potential: moderate
Water table: at a depth of 0.5 to 1.5 feet mostly during winter and spring
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Oletha, Uhland, and Whitesboro soils. The Oletha soils have a clayey surface layer and are in slightly lower landscape positions. Uhland soils are on natural levees along stream channels and are moderately well drained. Whitesboro soils have a thick, darker surface layer and are in slightly higher positions. Also included is a soil similar to the Nahatche soil that is grayer and poorly drained. Included soils generally make up less than 15 percent of this map unit.

This Nahatche soil is used mainly as pasture or rangeland.

This soil is well suited to pasture and hayland grasses. Wetness and the hazard of flooding are limitations for hay production. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is also used for rangeland and is well suited to this use. The main limiting features are wetness and the hazard of flooding. The climax vegetation is medium and tall grasses with an overstory of scattered oak, elm, and other hardwood trees. Controlled grazing and brush control are needed for maximum production.

This map unit is not suited to cropland because of the flooding hazard and wetness.

This soil is well suited to woodland wildlife habitat and moderately suited to openland wildlife habitat.

This Nahatche soil is not suited to most urban and recreational uses because of the flooding hazard and wetness.

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

NoB—Normangee clay loam, 1 to 3 percent slopes

This very deep, very gently sloping soil is on uplands. Slopes are slightly convex. Soil areas are irregular in shape and range from about 10 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, dark grayish brown clay loam

Subsoil:
6 to 16 inches, dark brown clay that has strong brown and yellowish red mottles
16 to 38 inches, olive brown clay that has light olive brown, strong brown, and yellowish brown mottles
38 to 51 inches, light olive brown clay loam that has brownish yellow mottles

Underlying material:
51 to 80 inches, light yellowish brown clay loam that has olive yellow and brownish yellow mottles

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Ellis, Lamar, Mabank, and Wilson soils. Crockett soils have a loam surface layer that rests abruptly on a clay subsoil. Ellis soils are clayey throughout. Lamar soils are loamy throughout and in higher landscape positions. Mabank and Wilson soils are grayer and in lower positions. Included soils make up less than 15 percent of this map unit.

This Normangee soil is used mainly as pasture or rangeland. A few small areas are in cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the early spring.

This map unit is well suited to rangeland. The climax vegetation is a mixture of native grasses, forbs, and shrubs with an overstory of scattered mesquite, oak, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

Only a few areas of this soil are used as cropland. It is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. Limiting features are very slow permeability, medium runoff, and the moderate erosion hazard. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion.

This soil is moderately suited to openland and rangeland wildlife habitat.

This soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling with changes in moisture, very slow permeability, and corrosivity to uncoated steel. The effects of these limitations can be reduced by good design and proper installation.

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

NrD2—Normangee gravelly clay loam, 3 to 8 percent slopes, eroded

This very deep, gently sloping and moderately sloping soil is on side slopes above drainageways on uplands. Most of the surface layer has been removed by water erosion. About one-fourth to one-half of the original surface layer remains. A few gullies about 1 foot wide and 1 to 2 feet deep are in some areas of this unit. Soil areas are mostly long and narrow in shape and range from 40 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 3 inches, brown gravelly clay loam

Subsoil:
3 to 20 inches, mottled yellowish brown, dark grayish brown, and dark reddish gray clay.
20 to 39 inches, mottled yellowish brown, grayish brown, and red clay
39 to 43 inches, yellowish brown clay that has red mottles

Underlying material:
43 to 80 inches, brownish yellow clay loam that has yellowish brown mottles

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: moderately well drained
Runoff: high
Water erosion hazard: severe
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Crockett, Ellis, and Lamar soils. Crockett soils are in slightly lower landscape positions and have a loam surface layer. Ellis soils are clayey throughout. Lamar soils are loamy throughout. Included soils make up less than 15 percent of this map unit.

This Normangee soil is used mainly as pasture or rangeland. Most areas were formerly used as cropland and have been allowed to revegetate with native plants and weeds.

This soil is moderately suited to pasture and hayland grasses. The most limiting features are the severe erosion hazard, high runoff, and the clayey subsoil. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides grazing in the spring.

This soil is moderately suited to rangeland. The severe erosion hazard, high runoff, and clayey subsoil are the limiting features. The climax vegetation is medium and tall grasses with an overstory of scattered mesquite, oak, and hackberry trees along drainageways. Controlled grazing, brush control, and other management practices are needed to increase the coverage of native grasses and to control erosion.

This map unit is not suited to cropland. The limiting features are the severe erosion hazard, high runoff, clayey subsoil, and slope.

This soil is moderately suited to openland and rangeland wildlife habitat.

This Normangee soil is poorly suited to urban uses and moderately suited to recreational uses. The most limiting features are shrinking and swelling with changes in moisture, very slow permeability, corrosivity to uncoated steel, low strength, clay content, and slope. The effects of these limitations can be reduced with good design and proper installation.

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

OgB—Oglesby clay, 1 to 3 percent slopes

This shallow, very gently sloping soil is on uplands. Slopes are generally plane or slightly convex. Soil areas are irregular in shape and range from about 20 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 9 inches, very dark gray clay
9 to 18 inches, very dark grayish brown clay

Underlying material:
18 inches, white, hard limestone bedrock

Important soil properties—

Permeability: slow
Available water capacity: very low
Drainage: well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: at a depth of 18 inches

Included with this soil in mapping are small areas of Groesbeck, Leson, and Wilson soils. Groesbeck soils are loamy and moderately deep to bedrock. Leson soils are very deep. Wilson soils are very deep and in slightly lower positions. Included soils make up less than 15 percent of this map unit.

This Oglesby soil is used mainly as rangeland or pasture.

This soil is moderately suited to rangeland. The most limiting feature is shallow depth to bedrock which restricts rooting and limits the available water capacity. The climax vegetation is medium and tall native grasses with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is poorly suited to pasture and hayland grasses because of the shallow root zone and very low available water capacity. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This map unit is poorly suited to crops such as wheat and oats. The shallow root zone and very low available water capacity are its main limiting features. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, and improves tilth. Contour farming, grassed waterways, and conservation tillage help reduce soil erosion.

This soil is moderately suited to openland and rangeland wildlife habitat.

This soil is poorly suited to urban and recreational uses. The most limiting features are depth to bedrock, corrosivity to uncoated steel, and the high clay content. Good design and proper installation can reduce the effects of these limitations.

This Oglesby soil is in capability subclass IVs and in the Shallow Clay range site.

Ot—Oletha silty clay, frequently flooded

This very deep, nearly level soil is on the flood plains of Steele Creek. Slopes are less than 1 percent. Areas are irregular in shape and range from 100 to 500 acres. The soil is flooded once or twice during most years and remains flooded for 2 to 7 days after heavy rains. Flooding is most likely to occur during November through May.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 6 inches, very dark grayish brown silty clay

Subsoil:
6 to 10 inches, dark grayish brown clay loam that has dark yellowish brown and brown mottles
10 to 16 inches, dark grayish brown loam that has dark brown mottles
16 to 25 inches, very dark grayish brown clay loam that has dark grayish brown and dark yellowish brown mottles
25 to 33 inches, dark grayish brown clay loam that has light yellowish brown and yellowish red mottles
33 to 44 inches, grayish brown loam that has brownish yellow and reddish yellow mottles
44 to 59 inches, grayish brown fine sandy loam that has strong brown mottles
59 to 72 inches, mottled brownish yellow and light brownish gray sandy clay loam that has red mottles
72 to 80 inches, mottled brownish yellow and light brownish gray fine sandy loam that has red mottles

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: high
Water table: at a depth of 2.5 to 4 feet, mostly during winter and spring
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Kaufman, Nahatche, and Whitesboro soils. Kaufman soils are clayey throughout. Nahatche and Whitesboro soils are loamy throughout. Also included are small areas of soils similar to Oletha soils that are clayey throughout, some that are more poorly drained, and some in slightly higher positions that flood only occasionally. Included soils make up less than 15 percent of this map unit.

This Oletha soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The most limiting feature is the hazard of flooding. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is well suited to native grass production. The climax plant community is medium and tall grasses with an overstory of scattered oaks and other hardwood trees. Controlled grazing and brush control are needed for maximum production.

This soil is not suited to cropland because of the hazard of flooding and wetness.

This map unit is moderately suited to openland and woodland wildlife habitat.

This soil is not suited to urban and recreational uses. The most limiting features are the flooding hazard, very slow permeability, shrinking and swelling with changes in moisture, corrosivity to uncoated steel, and a clayey surface layer. Good design and proper installation can reduce the effects of these limitations.

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

PaC—Padina loamy fine sand, 1 to 5 percent slopes

This very deep, very gently sloping and gently sloping soil is on uplands and high terraces. Slopes are mainly smooth or convex. Areas are irregular in shape and range from about 50 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 4 inches, dark brown loamy fine sand

Subsurface layer:
4 to 47 inches, pale brown loamy fine sand

Subsoil:
47 to 54 inches, yellowish brown fine sandy loam that has yellowish red mottles
54 to 63 inches, brownish yellow sandy clay loam that has dark red and light gray mottles
63 to 80 inches, light gray sandy clay loam that has dark red and brownish yellow mottles

Important soil properties—

Permeability: rapid in the surface and subsurface and moderate in the subsoil
Available water capacity: low
Drainage: well drained
Runoff: negligible
Water erosion hazard: moderate
Shrink-swell potential: very low
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Gasil, Personville, Robco, Silawa, Silstid, and Styx soils. Edge soils have a clayey subsoil. The Gasil soils are in lower landscape positions and have a sandy surface layer less than 20 inches thick. Personville soils are in lower positions and have bedrock within 40 to 60 inches of the surface. Robco soils have gray mottles within 30 inches of the surface and are in concave depressions and at the head of drainageways. Silawa soils have a redder subsoil and are in lower positions. Silstid soils have a sandy surface layer 20 to 40 inches thick. Styx soils have a surface layer 20 to 40 inches thick and are in lower positions. Also included are soils similar to Padina soils that are sandy to a depth of more than 60 inches and soils that have a more acid subsoil. Included soils make up less than 15 percent of this map unit.

This Padina soil is used mainly as rangeland and is moderately suited to this use. The main limitations are the very low natural fertility and the low available water capacity which causes droughty conditions to occur more readily than in most other soils. The climax vegetation is medium and tall grasses in an oak savannah (fig. 12). Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to pasture and hayland grasses. The most limiting features are very low natural fertility and low available water capacity. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is generally not used for crops because of droughtiness and the hazard of water erosion. However, it is moderately suited to peanuts, watermelons, peas, and small grains. Soil blowing is a hazard if this soil is cropped. Leaving crop residue on or near the surface helps control both wind and water erosion, conserves moisture, maintains fertility, and maintains organic matter. Cover crops, high residue crops, and green manure crops reduce erosion and help maintain fertility. Crops respond well to fertilization.

This map unit is moderately suited to openland and rangeland wildlife habitat.

This Padina soil is moderately suited to most urban and recreational uses. The main limiting features are the sandy surface layer, droughtiness, sidewall sloughing, seepage, and soil blowing. Good design and proper installation can reduce the effects of these limitations.

This Padina soil is in capability subclass IIIe and the Deep Sand range site.

PaE—Padina loamy fine sand, 5 to 12 percent slopes

This very deep, moderately sloping and strongly sloping soil is on uplands and high terraces. Slopes are mainly smooth or convex. Areas are irregular in shape and range from 10 to 800 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 11 inches, brown loamy fine sand

Figure 12.—Oak trees with an understory of medium and tall grasses is the climax vegetation for Padina loamy fine sand, 1 to 5 percent slopes.

Subsurface layer:
11 to 46 inches, pale brown loamy fine sand

Subsoil:
46 to 55 inches, pale brown sandy clay loam that has reddish yellow and light gray mottles
55 to 65 inches, light brownish gray sandy clay loam that has red and reddish yellow mottles
65 to 80 inches, light gray sandy clay loam that has red and reddish yellow mottles

Important soil properties—

Permeability: rapid in the surface and subsurface and moderate in the subsoil
Available water capacity: low
Drainage: well drained
Runoff: low
Water erosion hazard: moderate
Shrink-swell potential: very low
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Gasil, Robco, Silawa, and Silstid soils. Edge soils have a clayey subsoil. Gasil soils are in lower positions and have a surface layer less than 20 inches thick. Robco soils have gray mottles within 30 inches of the surface and are in concave depressions and at the head of drainageways. Silawa soils have a redder subsoil. Silstid soils have a sandy surface layer 20 to 40 inches thick and are in lower positions. Also included are soils similar to Padina soils that are sandy to a depth of more than 60 inches and soils that are extremely acid in the subsoil. Included soils make up less than 15 percent of this map unit.

This Padina soil is used mainly as rangeland and is moderately suited to this use. The main limitations are the very low natural fertility and the low available water capacity which causes droughty conditions to occur more readily than in most other soils. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is poorly suited to pasture and hayland grasses. The limiting features are very low natural fertility and low available water capacity. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as vetch and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is not suited to cropland because of droughtiness and the water erosion hazard. Soil blowing is also a problem if this soil is cropped.

This map unit is moderately suited to openland and rangeland wildlife habitat.

This soil is poorly suited to urban and recreational uses. The main limiting features are the sandy surface layer, slope, droughtiness, sidewall sloughing, seepage, and soil blowing. Good design and proper installation can reduce the effects of these limitations.

This Padina soil is in capability subclass VIe and in the Deep Sand range site.

PeB—Personville loamy fine sand, 1 to 5 percent slopes

This deep, very gently sloping and gently sloping soil is on uplands. Slopes are mainly smooth or slightly convex. Areas are irregular in shape and range from about 15 to 300 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 18 inches, dark yellowish brown loamy fine sand

Subsoil:
18 to 28 inches, dark brown sandy clay loam that has yellowish red mottles
28 to 37 inches, yellowish brown sandy clay loam that has strong brown mottles
37 to 47 inches, brownish yellow fine sandy loam that has strong brown mottles

Underlying material:
47 inches, indurated limestone bedrock

Important soil properties—

Permeability: moderate
Available water capacity: moderate
Drainage: moderately well drained
Runoff: very low to low
Water erosion hazard: moderate
Shrink-swell potential: low
Water table: none within a depth of 6 feet.
Bedrock: at a depth of 47 inches

Included with this soil in mapping are small areas of Gasil, Groesbeck, Lavender, Rader, and Styx soils. Gasil soils are very deep. Groesbeck and Lavender soils are moderately deep to limestone bedrock. Rader soils are very deep and are moderately well drained. Styx soils are very deep and have a sandy surface layer greater than 20 inches thick. Also included are small areas of soils that are very shallow to bedrock and are stony in places. Included soils make up less than 15 percent of this map unit.

This Personville soil is used mainly as pasture. A few small areas are used as cropland.

This soil is moderately suited to pasture and hayland grasses. The moderate available water capacity and low natural fertility are the main limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. The coastal bermudagrass may be overseeded with singletary peas and arrowleaf clover in the fall. These plants add nitrogen to the soil and provide grazing in the early spring.

This soil is moderately suited to crops such as corn, peas, and watermelons. The moderate erosion hazard and moderate available water capacity are the most limiting features. Leaving crop residue on or near the surface helps reduce erosion and maintains organic matter content. The addition of lime and a complete fertilizer increases yields on this soil.

This map unit is moderately suited to native grass production. The moderate available water capacity and low natural fertility are the limiting features. The climax vegetation is medium and tall grasses with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to openland wildlife habitat and well suited to woodland and rangeland wildlife habitat.

This soil is moderately suited to urban and recreational uses. The sandy surface layer and depth to bedrock are the main limiting features.

This Personville soil is in capability subclass IIIe and in the Sandy Loam range site.

Pr—Pits, quarries

This map unit consists of areas where limestone rock has been or is being mined. The size of these quarries ranges from 10 to about 500 acres. Pits smaller than 10 acres are identified on the detailed soil maps with a spot symbol.

Limestone underlies areas of Groesbeck, Lavender, and

Personville soils. It is as much as 40 feet thick near Mexia and thins to the north and south. The quarries are 40 to 60 feet deep and little effort has been made to reclaim them. Many contain water throughout the year (fig. 13). After the rock is removed, it is crushed and used mainly for road material.

Included in this map unit are small gravel pits in areas of Crockett and Normangee soils that are adjacent to the rock quarries. Gravel from these pits was used for road material. Some gravel pits hold water most of the time and are shown as areas of water on the detailed soil maps.

These areas are not suited to rangeland, pasture, cropland, or urban uses.

These areas are poorly suited to wildlife habitat, except for fish.

These areas are in capability subclass VIIIs.

Ps—Pits, sand

This map unit consists of areas where sand has been or is being mined. The size of these pits ranges from 10 to about 100 acres. Pits smaller than 10 acres are identified on the detailed soil maps with a spot symbol.

Sand pits are scattered throughout the south, southwestern, and eastern parts of the county. They were excavated in areas of Silstid, Styx, and Padina soils. These pits range from 6 to 200 feet deep. Most of the sand is being used for topsoil on yards and in other landscaped areas. The largest sand pit being mined is in the

Figure 13.—Limestone is a resource that is mined in the central part of the county. Many of the abandoned quarries collect water.

southwestern part of the county; it produces kaolin and glass sand.

Included in this map unit are a few small clay pits in areas of Edge and Tabor soils that are adjacent to some of the sand pits in the southern part of the county. These pits were a source of clay for bricks.

Pits that contain water most of the time are shown as water areas on the detailed soil maps.

These areas are not suited to rangeland, pasture, cropland, or urban uses.

These areas are poorly suited to most recreational uses and poorly suited to wildlife habitat.

These areas are in capability subclass VIIIs.

RaA—Rader fine sandy loam, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on terraces and at the head of drainageways on uplands. Slopes are broad, slightly mounded, and slightly concave. Areas are irregular in shape and range from 20 to 1,000 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 12 inches, dark brown fine sandy loam

Subsurface layer:
12 to 19 inches, brown fine sandy loam

Subsoil:
19 to 25 inches, strong brown sandy clay loam that has red and yellowish red mottles
25 to 63 inches, light brownish gray clay loam that has grayish brown, strong brown, yellowish red, and red mottles
63 to 80 inches, light gray sandy clay loam that has reddish yellow and yellowish red mottles

Important soil properties—

Permeability: very slow
Available water capacity: moderate
Drainage: moderately well drained
Runoff: very low
Water erosion hazard: slight
Shrink-swell potential: high
Water table: perched at a depth of 2 to 4 feet during periods of prolonged rainfall
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Edge, Gasil, Lavender, Lufkin, Silawa, and Tabor soils. The Axtell, Edge, and Tabor soils have more clay in the subsoil and are in higher landscape positions. The Gasil soils lack gray colors in the upper 30 inches and are in higher positions. The Lavender soils are underlain by bedrock. Lufkin soils are in lower positions and are gray throughout the subsoil. Silawa soils are redder in the subsoil and are in slightly higher positions. Included soils make up less than 15 percent of this map unit.

This Rader soil is used mainly as pasture. A few areas are used as cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The very slow permeability and moderate water holding capacity are the limiting features. Leaving crop residue on or near the surface helps conserve moisture, aids in water infiltration, maintains fertility, improves tilth, and maintains organic matter content. Crops respond well to fertilization.

This Rader soil is moderately suited to native grass production. The very slow permeability and moderate water holding capacity are the limiting features. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is well suited to openland and rangeland wildlife habitat.

This map unit is moderately suited to urban and recreational uses. The limiting features are wetness, shrinking and swelling with changes in moisture, corrosivity to uncoated steel, and very slow permeability. Good design and proper installation can reduce the effects of these limitations.

This Rader soil is in capability subclass IIIe and in the Sandy Loam range site.

RoA—Robco loamy fine sand, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on foot slopes and at the head of drainageways on uplands. Slopes are smooth or slightly concave. Areas are irregular in shape and range from 5 to 50 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 16 inches, dark brown loamy fine sand

Subsurface layer:
16 to 25 inches, pale brown loamy fine sand

Subsoil:
25 to 27 inches, yellowish brown sandy clay loam that has light brownish gray and red mottles
27 to 44 inches, mottled red, brownish yellow, and light gray sandy clay loam
44 to 60 inches, yellowish brown clay loam that has light brownish gray and red mottles
60 to 80 inches, yellowish brown clay that has red mottles

Important soil properties—

Permeability: rapid in the surface and subsurface and slow in the subsoil
Available water capacity: moderate
Drainage: moderately well drained
Runoff: very low
Water erosion hazard: slight
Shrink-swell potential: low
Water table: perched at a depth of 1.5 to 3.5 feet during periods of prolonged rainfall.
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Gasil, Lufkin, Padina, Rader, and Silstid soils. The Gasil, Silstid, and Padina soils do not have gray mottles in the upper 30 inches and are in higher landscape positions. Lufkin soils are gray throughout the subsoil. Rader soils are in higher positions and do not have a thick sandy surface layer. Included soils make up less than 15 percent of this map unit.

This Robco soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The main limitations are moderate water holding capacity and low natural fertility. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is moderately suited to rangeland. The main limitations are moderate water holding capacity and low natural fertility. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit generally is not used for crops because of the lack of moisture in the root zone during the growing season and the hazard of erosion. This soil, however, is moderately suited to drought-tolerant crops such as peanuts, watermelons, peas, and sweet potatoes. Leaving crop residue on or near the surface helps control erosion, conserves moisture, maintains fertility, and maintains organic matter. Crops respond well to fertilization.

This soil is moderately suited to openland wildlife habitat and well suited to rangeland wildlife habitat.

This Robco soil is poorly suited to urban uses and moderately suited to recreational uses. The main limiting features are wetness, the slow permeability of the subsoil, corrosivity to uncoated steel, and the sandy surface layer. Good design and proper installation can reduce the effects of these limitations.

This Robco soil is in capability subclass IIe and in the Sandy range site.

SaB—Silawa fine sandy loam, 1 to 3 percent slopes

This very deep, very gently sloping soil is on high stream terraces. Slopes are smooth or slightly convex. Soil areas are irregular in shape and range from about 30 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 7 inches, brown fine sandy loam

Subsoil:
7 to 24 inches, red clay loam that has yellowish brown mottles
24 to 44 inches, red sandy clay loam
44 to 58 inches, reddish yellow fine sandy loam

Underlying material:
58 to 80 inches, brownish yellow loamy fine sand

Important soil properties—

Permeability: moderate
Available water capacity: moderate
Drainage: well drained
Runoff: very low
Water erosion hazard: moderate
Shrink-swell potential: low
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Edge, Lavender, Padina, Personville, Rader, and Styx soils. The Axtell and Edge soils have a clayey subsoil. The Lavender and Personville soils are underlain by limestone bedrock. Padina soils have a thicker surface layer and are in slightly higher landscape positions. Rader soils have gray mottles within 30 inches and are in slightly lower positions. Styx soils are in slightly lower positions and have a sandy surface layer more than 20 inches thick. Included soils make up less than 15 percent of this map unit.

This Silawa soil is used primarily for pasture or rangeland. A few small areas are used as cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This Silawa soil is well suited to rangeland. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit is well suited to crops such as cotton, corn, grain sorghum, and small grains. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, aids in preventing compaction, and maintains organic matter. Terracing, contour farming, and conservation tillage help to reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to openland and rangeland wildlife habitat.

This Silawa soil is well suited to most urban and recreational uses. Seepage is a limiting feature for some sanitary facilities. Good design and proper installation can reduce the effects of this limitation.

This Silawa soil is in capability subclass IIe and in the Sandy Loam range site.

SaD—Silawa fine sandy loam, 5 to 12 percent slopes

This very deep, moderately sloping and strongly sloping soil is on high stream terraces. Slopes are mostly convex. Areas are irregular in shape and range from about 20 to 100 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 5 inches, brown fine sandy loam

Subsoil:
5 to 25 inches, yellowish red sandy clay loam
25 to 35 inches, strong brown sandy clay loam
35 to 41 inches, brownish yellow fine sandy loam

Underlying material:
41 to 80 inches, mottled pale brown, light yellowish brown, and strong brown fine sandy loam

Important soil properties—

Permeability: moderate
Available water capacity: moderate
Drainage: well drained
Runoff: medium
Water erosion hazard: severe
Shrink-swell potential: low
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Lavender, Silstid, and Padina soils. The Edge soils have a clayey subsoil. Lavender soils are underlain by bedrock. Silstid and Padina soils have a thicker surface layer. Also included are eroded Silawa soils that have gravel on the surface and within the surface layer. Included soils make up less than 15 percent of this map unit.

This Silawa soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The most limiting features are the moderate available water capacity, medium runoff, and severe erosion hazard. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is also used as rangeland and is moderately suited to this use. The moderate available water capacity, medium runoff, and severe erosion hazard are limiting features. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit is not suited to cropland because of slope, erosion hazard, and runoff.

This soil is well suited to openland and rangeland wildlife habitat.

This Silawa soil is moderately suited to urban and recreational uses. The limiting features are slope and seepage. Good design and proper installation can reduce the effects of these limitations.

This Silawa soil is in capability subclass VIe and in the Sandy Loam range site.

SsB—Silstid loamy fine sand, 1 to 3 percent slopes

This very deep, very gently sloping soil is on broad uplands. Slopes are smooth or slightly convex. Areas are irregular in shape and range from about 30 to 300 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 5 inches, dark brown loamy fine sand

Subsurface layer:
5 to 27 inches, brown loamy fine sand

Subsoil:
27 to 43 inches, yellowish brown sandy clay loam

43 to 60 inches, yellowish brown sandy clay loam that has strong brown and red mottles
60 to 80 inches, mottled yellowish brown and reddish yellow sandy clay loam

Important soil properties—

Permeability: rapid in the surface and subsurface and moderate in the subsoil
Available water capacity: low to moderate
Drainage: well drained
Runoff: negligible
Water erosion hazard: slight
Shrink-swell potential: low
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Edge, Gasil, Lufkin, Padina, Personville, Rader, Robco, Silawa, Styx, Tabor, Uhland, and Whitesboro soils. The Gasil soils have a surface layer less than 20 inches thick. The Axtell, Edge, Lufkin, and Tabor soils have a clayey subsoil. Padina soils have a sandy surface layer more than 40 inches thick and are in slightly higher landscape positions. Personville soils are underlain by limestone. Rader and Robco soils have gray mottles within 30 inches of the surface and are in lower, concave positions. Silawa soils have a thin, loamy surface layer and are in slightly higher positions. The Styx soils have gray mottles in the lower part of the subsoil and are in lower positions. Uhland and Whitesboro soils are on flood plains. Also included in this unit are small eroded areas of Silstid soils, and areas of closely similar soils that are moderately well drained. Included soils make up less than 15 percent of this map unit.

This Silstid soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The low to moderate available water capacity and low natural fertility are the most limiting features. Fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This Silstid soil is moderately suited to rangeland because of the moderate available water capacity and low natural fertility. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The low natural fertility and moderate available water capacity are the limiting features. Soil blowing is also a problem if this soil is cropped. Leaving crop residue on or near the surface reduces wind erosion, maintains organic matter, conserves moisture, and maintains fertility. Crops respond well to fertilization.

This map unit is moderately suited to rangeland wildlife habitat.

This soil is well suited to most urban uses and moderately suited to recreational uses. The limiting features are sidewall sloughing, the sandy surface layer, seepage, and soil blowing. Good design and proper installation can reduce the effects of these limitations.

This Silstid soil is in capability subclass IIIs and in the Sandy range site.

SsD—Silstid loamy fine sand, 3 to 8 percent slopes

This very deep, gently sloping and moderately sloping soil is on side slopes on uplands. Slopes are slightly convex. Areas are irregular in shape and range from about 10 to 200 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 8 inches, pale brown loamy fine sand

Subsurface layer:
8 to 24 inches, very pale brown loamy fine sand

Subsoil:
24 to 40 inches, yellowish brown sandy clay loam that has red mottles
40 to 52 inches, brownish yellow sandy clay loam that has red and light gray mottles
52 to 80 inches, mottled light brown, pinkish gray, red, and brownish yellow sandy clay loam

Important soil properties—

Permeability: rapid in the surface and subsurface and moderate in the subsoil
Available water capacity: low to moderate
Drainage: well drained
Runoff: low
Water erosion hazard: moderate
Shrink-swell potential: low
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Edge, Gasil, Padina, Robco, and Silawa soils. The Edge soils have a clayey subsoil. The Gasil soils have a surface layer less than 20 inches thick and are in slightly lower landscape positions. Padina soils have a sandy surface layer more than 40 inches thick. Robco soils have gray mottles above 30 inches and are in concave positions. Silawa soils have a surface layer less than 20 inches thick.

Included soils make up less than 15 percent of this map unit.

This Silstid soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The most limiting features are low natural fertility and low to moderate available water capacity. Fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is moderately suited to rangeland because of low natural fertility and low to moderate available water capacity. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The low natural fertility, erosion hazard, and low to moderate available water capacity are limiting features. Soil blowing is also a problem if this soil is cropped. Leaving crop residue on or near the surface reduces both wind and water erosion, maintains organic matter, conserves moisture, and maintains fertility. Crops respond well to fertilization.

This soil is moderately suited to rangeland wildlife habitat.

This soil is well suited to most urban uses and poorly suited to recreational uses. The limiting features are the sandy surface layer, sidewall sloughing, seepage, slope, and soil blowing. Good design and proper installation can reduce the effects of these limitations.

This Silstid soil is in capability subclass IIIe and in the Sandy range site.

StA—Styx loamy fine sand, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on high stream terraces. Slopes are mainly smooth or slightly convex. Areas are irregular in shape and range from about 15 to 500 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 15 inches, dark grayish brown loamy fine sand

Subsurface layer:
15 to 27 inches, pale brown loamy fine sand

Subsoil:
27 to 46 inches, yellowish brown sandy clay loam that has red, pale brown, and strong brown mottles
46 to 65 inches, light yellowish brown sandy clay loam that has red, yellowish red, and brownish yellow mottles
65 to 80 inches, light gray sandy clay loam that has yellow mottles

Important soil properties—

Permeability: rapid in the surface and subsurface and moderate in the subsoil
Available water capacity: moderate
Drainage: well drained
Runoff: negligible
Water erosion hazard: slight
Shrink-swell potential: low
Water table: perched at a depth of 3.5 to 4.5 feet during periods of prolonged rainfall
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Groesbeck, Lavender, Padina, Personville, Rader, and Silawa. The Groesbeck and Lavender soils have bedrock at 20 to 40 inches. Padina soils have a sandy surface layer 40 to 60 inches thick and are in slightly higher landscape positions. Personville soils have bedrock at 40 to 60 inches. Rader soils have gray mottles because of wetness and are in slightly lower positions. Silawa soils are redder in the subsoil. Included soils make up less than 15 percent of this map unit.

This Styx soil is used mainly as pasture or rangeland.

This soil is moderately suited to pasture and hayland grasses. The moderate available water capacity and low natural fertility are the most limiting features. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and lovegrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is moderately suited to rangeland because of moderate available water capacity and low natural fertility. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The low natural fertility and moderate available water capacity are the limiting features. Soil blowing is also a problem if this soil is cropped. Leaving crop residue on or near the surface reduces both wind and water erosion, maintains organic matter, conserves moisture, and maintains fertility. Crops respond well to fertilization.

This soil is well suited to rangeland wildlife habitat and moderately suited to openland wildlife habitat.

This soil is well suited to most urban uses and moderately suited to recreational uses. The limiting features are wetness, seepage, sidewall sloughing, sandy surface layer, and soil blowing. Good design and proper installation can reduce the effects of these limitations.

This Styx soil is in capability subclass IIIs and in the Sandy range site.

TaA—Tabor fine sandy loam, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on stream terraces and terrace remnants on uplands. Slopes are generally plane or slightly concave. Soil areas are irregular in shape and range from about 50 to 800 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 12 inches, dark brown fine sandy loam

Subsoil:
12 to 17 inches, yellowish brown clay that has yellowish brown and red mottles
17 to 28 inches, light olive brown clay that has red mottles
28 to 42 inches, light yellowish brown clay
42 to 55 inches, light yellowish brown clay that has strong brown and light olive brown mottles
55 to 65 inches, light yellowish brown clay loam that has strong brown and light olive brown mottles

Underlying material:
65 to 80 inches, light yellowish brown clay loam that has light olive brown mottles and light gray shale fragments

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: medium
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Crockett, Edge, Gasil, Rader, and Lufkin soils. Axtell soils are redder in the upper part of the subsoil. Crockett soils are less acid in the subsoil. Gasil soils have a loamy subsoil and are in slightly higher landscape positions. Edge soils are redder in the upper part of the subsoil and are in slightly higher positions. Lufkin soils are gray throughout and are in lower positions. Rader soils have a loamy subsoil. Included soils make up less than 15 percent of this map unit.

This Tabor soil is used mainly as pasture or rangeland. A few small areas are in cropland.

This soil is moderately suited to pasture and hayland grasses. The most limiting feature is the dense, clayey subsoil that restricts the growth of roots and movement of air and water. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass, lovegrass, and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring. Lime may be needed to decrease soil acidity.

This soil is well suited to rangeland. The climax vegetation is medium and tall grasses in an oak savannah. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The very slow permeability, clayey subsoil, and erosion hazard are the limiting features. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is well suited to openland and rangeland wildlife habitat.

This soil is moderately suited to urban and recreational uses. The most limiting features are the shrink-swell potential, low strength, very slow permeability, and corrosivity to uncoated steel and concrete. Good design and proper installation can reduce the effects of these limitations.

This Tabor soil is in capability subclass IIIe and in the Sandy Loam range site.

Tc—Tinn clay, occasionally flooded

This very deep, nearly level soil is on flood plains of rivers and their larger tributaries. Slopes are less than 1 percent. Undisturbed areas have gilgai microrelief. Soil areas range from about 40 to 300 acres. Some areas of this soil are flooded as often as one or two times in a 5 year period and remain flooded for 1 to 3 days. Other areas are flooded less often, depending on the degree of protection from levees and small flood prevention reservoirs.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 12 inches, very dark gray clay

Subsoil:
12 to 42 inches, very dark gray clay
42 to 80 inches, dark grayish brown clay

Important soil properties—

Permeability: very slow, however water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Kaufman and Whitesboro soils. Kaufman soils are non-calcareous. Whitesboro soils are loamy and on natural levees along stream channels. Also included are small, frequently flooded areas of Tinn soils that are in slightly lower landscape positions. Areas of soils similar to Tinn soils that are underlain by gravel and sand below 40 inches and that are more poorly drained are included. Included soils make up less than 15 percent of this map unit.

This Tinn soil is used mainly as pasture or cropland.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring

This soil is moderately suited to crops such as cotton, corn, oats, wheat, and grain sorghum. The flood hazard is the major limiting feature. Leaving crop residue on or near the surface aids in water infiltration and maintains organic matter. Nitrogen and phosphorous fertilizer applications increase yields.

This map unit is well suited to native grass production. The climax vegetation is medium and tall grasses with an overstory of scattered oak, elm, hackberry, and willow trees adjacent to drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is moderately suited to openland wildlife habitat and well suited to woodland wildlife habitat.

This soil is not suited to most urban and recreational uses. The major limitation is the flooding hazard. Other limitations include very slow permeability, clay texture, low strength, and very high shrink-swell potential. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

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

To—Tinn clay, frequently flooded

This very deep, nearly level soil is on flood plains of rivers and their larger tributaries. Slopes are less than 1 percent. Undisturbed areas have gilgai microrelief. Soil areas are elongated and range from 50 to several thousand acres. Some areas cover the entire flood plain and range in width from about 1,000 feet to 1 mile. This soil is flooded once or twice during most years and remains flooded for 2 to 7 days after heavy rains. Flooding is most likely to occur during November through February.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 18 inches, black clay

Subsoil:
18 to 54 inches, black clay
54 to 72 inches, very dark gray clay
72 to 80 inches, very dark grayish brown clay

Important soil properties—

Permeability: very slow; however, water moves very rapidly down cracks when the soil is dry
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: slight
Shrink-swell potential: very high
Water table: none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Kaufman and Whitesboro soils. The Kaufman soils are noncalcareous. Whitesboro soils are loamy and are in slightly higher landscape positions. Also included are small areas of Tinn soils in slightly higher positions that are occasionally flooded and soils that are poorly drained. Included soils make up less than 15 percent of this map unit.

This Tinn soil is used mainly as pasture and is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring

This soil is well suited to native grass production. The climax vegetation is medium and tall grasses with an overstory of scattered elm, hackberry, oak, and willow trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This soil is not suited to cropland because of the flooding hazard.

This map unit is moderately suited to openland and woodland wildlife habitat.

This soil is not suited to most urban and recreational uses. The major limitation is the flooding hazard. Other limitations include very slow permeability, clay texture, low strength, and very high shrink-swell potential. Trench sidewalls become very unstable in this soil under certain conditions. Trenches excavated to a depth of 5 feet or more should be shored or the sidewall graded to an angle that ensures safe working conditions.

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

Uh—Uhland fine sandy loam, frequently flooded

This very deep, nearly level soil is on flood plains of streams that drain areas of sandy soils. Areas of Uhland soil are irregular in shape and range from 20 to 200 acres. Slopes are 0 to 1 percent. This soil is inundated one or more times in most years by floods of shallow depth and short duration.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 7 inches, dark brown fine sandy loam

Subsoil:
7 to 30 inches, very pale brown fine sandy loam that has strong brown and light brownish gray mottles
30 to 48 inches, light brownish gray fine sandy loam that has strong brown mottles
48 to 60 inches, light gray fine sandy loam that has reddish yellow mottles
60 to 80 inches, light gray fine sandy loam that has brownish yellow mottles

Important soil properties—

Permeability: moderately slow
Available water capacity: moderate
Drainage: moderately well drained
Runoff: negligible
Water erosion hazard: slight
Shrink-swell potential: low
Water table: perched at a depth of 2 to 3.5 feet for about 30 to 60 days, mostly during spring
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Oletha, Nahatche, Silstid, and Whitesboro soils. The Oletha soils have a clayey surface layer and are in lower landscape positions. Nahatche soils are wetter and in lower positions. Silstid soils are sandy and in upland positions. Whitesboro soils have a darker surface layer and are in slightly lower positions. Also included are soils similar to Uhland soils that are sandy throughout. Included soils make up less than 15 percent of this map unit.

This Uhland soil is used mainly as rangeland.

This soil is well suited to rangeland. The climax vegetation is medium and tall grasses with an overstory of scattered oak, willow, and elm trees. Controlled grazing and brush control are needed for maximum production.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and bahiagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This map unit is moderately suited to openland, wetland, and rangeland wildlife habitat.

This soil is not suited to cropland because of the hazard of flooding and wetness.

This soil is not suited to urban and recreational uses. The major limitation is the flooding hazard. Other limitations include wetness, moderately slow permeability, and corrosivity to uncoated steel.

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

Wa—Whitesboro loam, occasionally flooded

This very deep, nearly level soil is on broad flood plains of the Navasota River and its tributaries. It is partially protected from flooding by levees or flood prevention reservoirs. Soil areas are long and narrow or oblong in shape and range from 20 to several hundred acres. Slopes are 0 to 1 percent. This soil is inundated about once every 2 to 10 years by floods of shallow depth and short duration.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 26 inches, very dark grayish brown loam

Subsoil:
26 to 36 inches, dark grayish brown clay loam that has dark brown mottles
36 to 55 inches, grayish brown clay loam that has yellowish brown mottles

Underlying material:
55 to 80 inches, yellowish brown clay loam

Important soil properties—

Permeability: moderate

Available water capacity: high
Drainage: moderately well drained
Runoff: negligible
Water erosion hazard: slight
Shrink-swell potential: moderate
Water table: none within a depth of 6 feet; however, the soil may be saturated to a depth of 2 to 3 feet for short periods after flooding or heavy rains, mostly during winter and spring months
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Crockett, Edge, Kaufman, Nahatche, Oletha, Tinn and Uhland soils. The Axtell, Crockett, and Edge soils have a clayey subsoil and are on uplands. The Kaufman and Tinn soils are clayey throughout. Nahatche soils are grayer throughout, and they are on alluvial fans next to uplands and on natural levees next to stream channels. Oletha soils are in old sloughs and other depressional areas and have a clayey subsoil. Uhland soils have a lighter colored surface layer and are in higher landscape positions. Included soils make up less than 15 percent of this map unit.

This Whitesboro soil is used mainly as pasture and is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is well suited to rangeland. The climax vegetation is medium and tall grasses with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This Whitesboro soil is well suited to crops such as cotton, corn, grain sorghum, and small grains. In some years, excess wetness may interfere with tillage operations or planting. Leaving crop residue on or near the surface improves soil tilth, maintains organic matter content, and aids in water infiltration. A complete fertilizer increases yields. Native and improved varieties of pecans are also produced on this soil.

This soil is well suited to openland wildlife habitat and moderately suited to rangeland wildlife habitat.

This map unit is not suited to most urban uses and moderately suited to recreational uses. The most limiting feature is the hazard of flooding. Good design and proper installation can reduce the effects of this limitation for some uses.

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

Wf—Whitesboro loam, frequently flooded

This very deep, nearly level soil is on broad flood plains of the Navasota River and its tributaries. Areas of this soil generally include the entire width of the flood plain and range from 100 to several hundred acres. Slopes are 0 to 1 percent. This soil is inundated one or more times most years by floods of shallow depth and short duration.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 26 inches, very dark grayish brown loam

Subsoil:
26 to 51 inches, dark grayish brown clay loam
51 to 58 inches, mottled grayish brown, yellowish brown, reddish yellow, and yellowish red sandy clay loam

Underlying material:
58 to 80 inches, yellowish brown sandy clay loam

Important soil properties—

Permeability: moderate
Available water capacity: high
Drainage: moderately well drained
Runoff: negligible
Water erosion hazard: slight
Shrink-swell potential: moderate
Water table: none within a depth of 6 feet; however, the soil may be saturated to a depth of 2 or 3 feet for short periods after flooding or heavy rains, mostly during winter and spring months
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Axtell, Crockett, Edge, Kaufman, Nahatche, Oletha, Tinn, and Uhland soils. The Axtell, Crockett and Edge soils have a clayey subsoil and are on uplands. The Kaufman and Tinn soils are clayey throughout. Nahatche soils are grayer throughout, and they are on alluvial fans next to uplands and on natural levees next to stream channels. Oletha soils are in old sloughs and other depressional areas and have a clayey subsoil. Uhland soils have a lighter colored surface layer and are in higher landscape positions. Included soils make up less than 15 percent of this map unit.

This Whitesboro soil is used mainly as pasture.

This soil is well suited to pasture and hayland grasses. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal and common bermudagrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is well suited to rangeland. The climax vegetation is medium and tall grasses with an overstory of scattered oak and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This Whitesboro soil is not suited to cropland because of the flooding hazard.

This soil is moderately suited to rangeland wildlife habitat.

This map unit is not suited to most urban and recreational uses. The major limitation is the flood hazard. Wetness is an additional limiting feature.

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

WnA—Wilson clay loam, 0 to 2 percent slopes

This very deep, nearly level and very gently sloping soil is on ancient stream terraces. Slopes are plane or slightly concave. Soil areas are irregular in shape and range from 20 to 1,000 acres.

The typical sequence, depth, and composition of the layers of this soil are—

Surface layer:
0 to 7 inches, very dark gray clay loam

Subsoil:
7 to 22 inches, black clay that has dark grayish brown mottles
22 to 34 inches, dark gray clay that has light brownish gray and grayish brown mottles
34 to 43 inches, gray clay that has yellowish brown and light brownish gray mottles
43 to 60 inches, light gray clay that has yellowish brown mottles
60 to 80 inches, light brownish gray clay that has yellowish brown and brownish yellow mottles

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: low
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: none within a depth of 6 feet; however, soil is saturated in the surface layer for short periods in most years
Bedrock: none within a depth of 6 feet

Included with this soil in mapping are small areas of Branyon, Bremond, Burleson, Crockett, Houston Black, Leson, Mabank, and Whitesboro soils. Branyon, Burleson, Houston Black, and Leson soils are clayey throughout. Crockett and Bremond soils have a subsoil that is brown, and they are in slightly higher positions. Mabank soils have an abrupt texture change between the surface layer and the subsoil. Whitesboro soils are loamy and on flood plains. Also included are small areas of soils similar to Wilson soils that have a higher calcium carbonate content, and others that have a gravelly surface layer. Included soils make up less than 15 percent of this map unit.

This Wilson soil is used mainly as cropland (fig. 14). A few small areas are in rangeland.

This soil is moderately suited to crops such as cotton, corn, grain sorghum, and small grains. The moderate erosion hazard and the dense, clayey subsoil are the limiting features. Leaving crop residue on or near the surface helps control erosion, aids in water infiltration, maintains fertility, improves tilth, prevents compaction, and maintains organic matter. Terracing, contour farming, grassed waterways, and conservation tillage help reduce soil erosion. Crops respond well to fertilization.

This soil is moderately suited to rangeland. The climax vegetation is a mixture of medium and tall native grasses, forbs, and shrubs with an overstory of scattered oak, mesquite, and hackberry trees along drainageways. Controlled grazing and brush control are needed for maximum production.

This map unit is moderately suited to openland and rangeland wildlife habitat.

This soil is moderately suited to pasture and hayland grasses. The dense, clayey subsoil is the limiting feature. A complete fertilizer and controlled grazing are needed for improved yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers and singletary peas. This adds nitrogen to the soil and provides early grazing in the spring.

This soil is poorly suited to most urban and recreational uses. The shrinking and swelling with changes in moisture, very slow permeability, and low strength are the limiting features. Good design and proper installation can reduce the effects of these limitations.

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

WxA—Wilson-Bremond complex, 0 to 2 percent slopes

These very deep, nearly level and very gently sloping soils are on broad uplands and ancient stream terraces. Soil areas are rounded or long and narrow and range from 20 to 500 acres. These soils are in a regular and repeating pattern of low mounds and shallow depressions. Bremond

Figure 14.—Wilson clay loam, 0 to 2 percent slopes, is suited to crop production. This field is planted in corn.

soils are on convex mounds that are about 6 to 20 inches higher than the Wilson soils. The mounds are 20 to 100 feet across and are about 250 to 500 feet apart. In some areas, Bremond soils are on small, low ridges that meander through the low areas. The size of the mounds and the pattern of occurrence vary within soil areas and from one soil area to another.

This complex is about 50 percent Wilson soils, 30 percent Bremond soils and 20 percent other soils. These soils are too intricately mixed or too small to be mapped separately at the selected scale.

The typical sequence, depth, and composition of the layers of the Wilson soil are—

Surface layer:
0 to 8 inches, very dark gray clay loam

Subsoil:
8 to 25 inches, very dark gray clay
25 to 45 inches, dark gray clay that has yellowish brown mottles
45 to 62 inches, grayish brown clay that has yellowish brown mottles
62 to 80 inches, light brownish gray clay that has yellowish brown mottles

The typical sequence, depth, and composition of the layers of the Bremond soil are—

Surface layer:
0 to 6 inches, dark brown fine sandy loam

Subsoil:
6 to 14 inches, dark brown clay that has red and very pale brown mottles
14 to 25 inches, mottled red, strong brown, and pale brown clay
25 to 46 inches, pale brown clay that has red, strong brown, and light brownish gray mottles

46 to 62 inches, light yellowish brown clay that has reddish yellow, light brownish gray, and pale brown mottles
62 to 80 inches, brownish yellow clay loam, with reddish yellow, light brownish gray, strong brown, and pale brown mottles

Important soil properties—

Permeability: very slow
Available water capacity: high
Drainage: moderately well drained
Runoff: very low
Water erosion hazard: moderate
Shrink-swell potential: high
Water table: Wilson—none within a depth of 6 feet; however, soil is saturated in the surface layer for short periods in most years; Bremond—none within a depth of 6 feet
Bedrock: none within a depth of 6 feet

Included in mapping of this complex are small areas of Axtell, Burleson, Crockett, and Rader soils. Axtell soils are more acid and in higher landscape positions. Burleson soils are clayey throughout. Crockett soils are in slightly higher positions and are not as gray as the Wilson soils. Rader soils are loamy throughout. Also included are small areas of gravelly soils. Included soils make up less than 15 percent of this map unit.

These soils are used as cropland or pasture. They are moderately suited to crops such as cotton, corn, grain sorghum, and wheat. The most limiting features are the hazard of erosion and the dense, clayey subsoil. Leaving crop residue on or near the surface helps control erosion, maintains organic matter content, aids in increasing water infiltration, improves tilth, and helps prevent compaction. Conservation tillage helps reduce soil erosion. The addition of lime and a complete fertilizer increases yields on these soils.

These soils are moderately suited to pasture and hayland grasses. The dense, clayey subsoil is the most limiting feature of these soils. A complete fertilizer and controlled grazing help improve yields of adapted grasses such as coastal bermudagrass and kleingrass. Some pastures are overseeded with legumes such as clovers or singletary peas. This adds nitrogen to the soil and provides grazing in the early spring

The soils in this map unit are moderately suited to rangeland. The dense, clayey subsoil is the most limiting feature. The climax vegetation is medium and tall grasses with an overstory of scattered mesquite, oak, and hackberry trees along fence rows and drainageways. Controlled grazing and brush control are needed for maximum production.

These soils are moderately suited to openland, wetland, and rangeland wildlife habitat.

These soils are poorly suited to urban and recreational uses. The limiting features are shrinking and swelling with changes in moisture, very slow permeability, low strength, and corrosivity to uncoated steel. The effects of these limitations can be reduced by good design and proper installation.

The Wilson soil and the Bremond soil are in capability subclass IIIe and are in the Claypan Prairie range site.

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.

The soils on about 118,000 acres in Limestone County, or nearly 20 percent, meet the requirements for prime farmland. These soils are scattered throughout the county, but most are in General Soil Map Units 2 and 3, which are described under the heading "General Soil Map Units."

A recent trend in land use in some parts of the survey area has been the loss of prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

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:

BnA	Branyon clay, 0 to 2 percent slopes
BuA	Burleson clay, 0 to 2 percent slopes
GfB	Gasil loamy fine sand, 1 to 5 percent slopes
GsA	Groesbeck loamy fine sand, 0 to 2 percent slopes
GsC	Groesbeck loamy fine sand, 2 to 5 percent slopes
HeB	Heiden clay, 1 to 3 percent slopes
HoB	Houston Black clay, 1 to 3 percent slopes
Kc	Kaufman clay, occasionally flooded
LsB	Leson clay, 1 to 3 percent slopes
PeB	Personville loamy fine sand, 1 to 5 percent slopes
RaA	Rader fine sandy loam, 0 to 2 percent slopes
SaB	Silawa fine sandy loam, 1 to 3 percent slopes
Tc	Tinn clay, occasionally flooded
Wa	Whitesboro 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, suitabilities, 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

Mark R. Freeman, resource conservationist, Natural Resources Conservation Service, assisted with the preparation of this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified. The system of land capability classification used by the Natural Resources Conservation Service is explained in this section. The estimated yields of the main crops and hay and pasture plants are listed for each soil in table 5.

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 Texas Agricultural Extension Service.

Cropland

In 1990 about 127,000 acres, or 21 percent of the survey area, was used for crops. Of this total, 34,520 acres was used for row crops and 92,480 acres for close-growing crops.

Field crops suited to the soils and climate of Limestone County include grain sorghum, corn, and cotton. Wheat, oats, and forage sorghum are the close-growing crops that are commonly grown.

Soil erosion is the major problem on nearly all of the cropland where slopes are more than 2 percent. Loss of the surface layer through erosion is damaging. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Second, soil erosion on farm land results in sediment entering streams and affecting water quality. Controlling erosion protects topsoil and helps to maintain good water quality for municipal use, for recreation, and for fish and wildlife.

Management of crop residue helps control erosion. A good litter of residue left on the surface of the soil protects against pounding raindrops, reduces crusting, decreases runoff, and reduces evaporation of soil moisture. In addition, it adds organic matter to the soil, improves tilth, and reduces the effects of compaction by farm machinery. Using proper tillage equipment keeps crop residue on the surface. Conservation tillage reduces erosion on sloping soils and can be adapted to most of the soils that are presently being cropped.

Contour farming and terraces are erosion-control practices that are commonly used within the survey area. These practices are best adapted to soils that have smooth, uniform slopes. They are most practical on deep and moderately deep, clayey and loamy soils that have slopes of more than 1 percent.

Pasture and Hayland

About 103,700 acres, or 17 percent of Limestone County, was used for permanent pasture in 1990. Forage in excess of grazing needs is harvested for hay in pastures suitable for this purpose. Pasture and hayland are important in Limestone County because raising livestock is the major farm enterprise (fig. 15). For the past several years, land has been converted from other uses to pasture and hayland. Pasture and hayland are mainly planted to introduced grasses that respond effectively to good management. These include common bermudagrass, coastal bermudagrass, kleingrass, and bahiagrass.

Good management practices for pasture include fertilization, rotational grazing to maintain proper grazing height, and weed and brush management. Good management practices for hay include fertilization and cutting forage at the correct height and at the proper stage of growth.

Well managed pasture requires adequate fencing to allow the rotation of grazing and the efficient harvest of forage. Proper use of forage ensures that plants retain vigor.

Horticultural Production

Robert Wright, Limestone County extension agent, helped prepare this section.

Fruit and vegetable production have been increasing in Limestone County since 1986 (fig. 16). Commercial vegetable production almost doubled between 1985 and 1989. During this time, the number of trees in commercial peach production has increased about 20 percent. Commercial pecan production has declined, but the number of trees in home orchards has increased. Pecan trees are also increasingly being planted in home landscapes for the shade and beauty they provide.

To achieve the desired production of vegetable, nut, and fruit crops, the normal problems caused by insects, diseases, and weather must be overcome. Selection of a proper site is also necessary. The soils in Limestone County vary, and some are more suited to horticultural

Figure 15.—Hay is an important cash crop and provides supplemental feed for cattle. This hay field is on Groesbeck loamy fine sand, 0 to 2 percent slopes.

Figure 16.—Fruit production in Limestone County is on the increase. This peach orchard is on Edge fine sandy loam, 1 to 5 percent slopes.

crops than others. Vegetables, pecans, and fruit crops all need well drained soils. Pecan trees can be planted and can thrive on soils throughout the county, but they do best on the well drained alluvial soils along creeks and rivers. Most of the commercial vegetable and fruit production is in the southeastern part of the county where the more suitable sandy soils are located.

Other important factors to consider for growing horticultural crops include soil fertility and soil reaction (pH). Both can be determined with a soil analysis. Soil fertility and pH can be changed, if necessary, by proper application of fertilizer and other chemical elements. Generally, the soil pH is the cause of most of the problems in the county related to growing horticultural crops. Although many soils have a pH of about 7.0 (neutral), the sandy soils tend to have a pH below 7.0 (acid). Some are very acidic and must be limed to increase the pH and maintain vegetative growth.

Proper internal drainage of the soil is important for fruit tree production. A fruit orchard site should have a soil with a loamy sand or sandy loam surface layer 20 inches or more thick. Even more important is the subsoil, which needs to be permeable to allow for proper drainage and aeration. Periods of prolonged wet weather in poorly drained soils may cause fungus infections and drown roots.

Both fruit and pecan production are long-term ventures requiring thorough planning and careful site selection. Horticultural production in Limestone County will continue to increase and will play an important part in the county's agricultural income in the future. Success will be achieved only through proper planning and management of these enterprises.

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 Texas Agricultural 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 *(16)*.Crops that require special management are excluded. 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.

The capability classification of each map unit is given in the section “Detailed Soil Map Units” and in table 5.

Rangeland

Homer Sanchez, range conservationist, Natural Resources Conservation Service, assisted with the preparation of this section.

Rangeland is land on which the native vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. In areas that have similar climate and topography, 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 soils, vegetation, and water. Rangeland receives no regular or frequent cultural treatment such as fertilizer or tillage.

There are two major kinds of rangeland in the county corresponding to the two Major Land Resource Areas. The Texas Blackland Prairie, which comprises the northern and western parts of the county, was originally a tall grass prairie. Grasses such as big bluestem, indiangrass, little bluestem, switchgrass, Virginia wildrye, and eastern

Figure 17.—Many fields of highly erodible soils that were formally used for crop production have been converted to rangeland such as this area of Crockett loam, 1 to 3 percent slopes.

gamagrass were dominant. Trees were only along drainageways or in widely scattered motts. The Texas Claypan Area, which comprises about one-third of the county in the southeastern part, was an oak savannah. It consisted of an open stand of mostly post oak and blackjack oak with an understory of mainly indiangrass, little bluestem, big bluestem, switchgrass, beaked panicum, native legumes, and forbs.

Natural wildfires controlled the spread of trees and shrubs and helped to maintain the ecological balance of native vegetation.

About 325,800 acres, or 55 percent of Limestone County, is used as rangeland. Only a few small areas of this rangeland are composed entirely of original native vegetation. The original vegetation was altered when wildfires were supressed, domestic livestock were brought in, and land was placed into cultivation or used as pasture. Many areas of cropland, much of it highly erodible, have been allowed to return to native vegetation (fig. 17). Because of past management, most of these areas have been invaded by woody plants and weeds. The amount of forage produced is generally less than half of the original potential. Most of the rangeland is in poor to fair condition with some of the dominant grasses being Texas wintergrass, meadow dropseed, threeawns, and little bluestem. Some introduced species such as King Ranch bluestem have invaded or survived prior management.

Range vegetation cannot meet the year-round needs of most livestock operations. Small-grain pasture and protein concentrates are commonly used to supplement winter forage.

Range Sites and Range Condition

Soils vary in their capability to produce grasses and other plants suitable for grazing. Soils that produce about the same kinds and amounts of forage are grouped into a range site.

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. This natural plant community is also referred to as the climax plant community or climax vegetation because it is the product of all the environmental factors responsible for its development.

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

Range sites are subject to many influences that modify or even temporarily destroy vegetation. Examples are drought, overgrazing, wild fires, and short-term tillage. If these conditions are not too severe, the plant community will recover and return to climax. However, severe deterioration of the range site may permanently alter the potential of the site.

Grazing can change the quality and quantity of forage on a range site by changing the composition of the plant community.

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

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

Invaders are plants that are normally not included in the climax plant community because they cannot compete with the climax vegetation for moisture, nutrients, and light. They invade the site and grow along with increasers only after the climax vegetation has been reduced by continual heavy grazing. Most invader species have little grazing value.

Range management requires a knowledge of the kinds of soil and of the climax or potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the climax plant community on a particular range site. The more closely the existing community resembles the climax community, the better the range condition. Range condition is an ecological rating only. It does not have a specific meaning about the present plant community in a given use.

Four range condition classes are used to show the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. A range site is in excellent condition if 76 to 100 percent of the present plant community is the same as the climax vegetation; 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 will be eliminated. Under these conditions, the vegetation must be reestablished before management can be effective. The condition of the range can be improved by brush control, range seeding, fencing, water development, or other mechanical treatments to revitalize stands of native plants. Thereafter, deferred grazing, proper grazing use, and a planned grazing system can help to maintain or improve the range.

The objective in range management is to control grazing so the plants growing on a site remain or improve to about the same in kind and amount as the climax plant community for that site. Such management generally results in the optimum production of vegetation; reduction of undesirable brush species; water conservation; and erosion control. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Good production of livestock and forage on rangeland is obtained primarily by managing the time of grazing and limiting the amount of forage removed. The green parts of plants manufacture food for growth and store part of it for use in regrowth and seed production. Management practices that permit this process to take place are discussed below.

Proper Grazing Use. The objective of this practice is to graze at an intensity that will maintain enough cover to protect the soil and maintain or improve the quantity of desirable vegetation.

Deferred Grazing. This is the deferment or restriction of grazing until the better forage plants have completed most of their seasonal growth or have made seed. It helps keep the desirable plants healthy and vigorous and permits plants that have been depleted to recover. Deferred grazing helps to improve plant cover and reduce soil erosion.

Fencing. This practice excludes livestock from areas that should be protected from grazing, confines livestock to an area, subdivides grazing land to permit use of planned grazing systems, and protects new seedlings or plantings from grazing.

Prescribed Burning. Livestock operators and wildlife managers use this practice to periodically remove or reduce a dense cover of mature vegetation. When done properly and at the right time, this practice will stimulate new, succulent growth; help to restore climax plant species; and reduce infestations of noxious weeds and brush. However, desirable plants can be severely damaged or killed if the soil surface is too dry, allowing the fire to reach the plant crowns and roots. Burning is not recommended more often than once every three years, since doing so may harm perennial grass vegetation. Prescribed burning is an effective management tool that can be substituted for chemical or mechanical treatments in many plant communities.

Planned Grazing Systems. The objective of this practice is to rotate the grazing of livestock through two or more pastures in a planned sequence for a specified period of time. A planned grazing system may be relatively simple in design using two pastures, or may be more complex and management intensive, using one or two herds and many pastures. To be successful, it must be tailored to conditions existing in each ranch unit and meet the needs of the plants and animals as well as the rancher.

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 indicated for each soil map unit listed in table 6. The relationship between soils and vegetation was established 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.

The soils of Limestone County have been grouped into 11 range sites. The soils in each range site have similar properties important to growing native grasses. They have the potential for producing about the same kind and amount of vegetation.

Blackland Prairie range sites include Blackland, Clay Loam, Clayey Bottomland, Claypan Prairie, Eroded Blackland, and Shallow Clay. Claypan Savannah range sites include Claypan Savannah, Deep Sand, Loamy Bottomland, Sandy, and Sandy Loam. The following paragraphs describe these range sites.

Blackland Range Site. The Branyon, Burleson, Heiden, Houston Black, and Leson soils in map units BnA, BuA, FhC2, HeB, HoB, and LsB are in this range site. These soils have relatively high natural fertility. The climax plant community is a tall grass prairie with a few large live oaks, elm, and hackberry trees along drainageways and in motts. The composition by weight is about 85 percent grasses, 5 percent woody plants, and 10 percent forbs.

Little bluestem, indiangrass, and big bluestem produce about 75 percent of the forage. Other grasses such as switchgrass, sideoats grama, Texas wintergrass, Texas cupgrass, tall dropseed, Florida paspalum, eastern gamagrass, and Virginia wildrye make up the other 10 percent. Woody plants are live oak, elm, hackberry, bumelia, and coralberry. Many palatable forbs and legumes are native to the site.

Overgrazing by cattle will eventually eliminate tall grasses like big bluestem, indiangrass, switchgrass, and eastern gamagrass. These are replaced by silver bluestem, Texas wintergrass, tall dropseed, and other mid grasses. With continued grazing, buffalograss, Texas grama, tumblegrass, annual weeds, and annual grasses will dominate the site, and noxious brush species like mesquite, winged elm, honey locust, and osageorange will invade.

Clay Loam Range Site. The Lamar soil in map unit LaE2 is in this range site. The climax plant community is a true tall grass prairie that is highly productive. The composition by weight is about 85 percent grasses, 5 percent woody plants, and 10 percent forbs.

Indiangrass, big bluestem, switchgrass, Virginia and Canada wildrye, and Florida paspalum make up about 70 percent. Sideoats grama, silver bluestem, low panicums, and Texas wintergrass make up 10 percent. Short grasses make up 5 percent. Woody plants include hackberry, elm, pecan, and oak. The primary forbs are Maximilian sunflower, Engelmanndaisy, penstemon, bundleflower, and many other legumes.

Tall grasses such as big bluestem, little bluestem, indiangrass, switchgrass, and Florida paspalum decrease in abundance under continuous, heavy grazing. They are replaced initially by sideoats grama, silver bluestem, low panicums, Texas wintergrass, and tall dropseed. As overgrazing continues, plants such as threeawns, hairy grama, red lovegrass, Texas grama, buffalograss, tumblegrass, western ragweed, broomweed, prairie coneflower, and woody plants such as mesquite, baccharis, yaupon, and hawthorn dominate the site.

Clayey Bottomland Range Site. The Kaufman, Oletha, and Tinn soils in map units Kc, Kd, Ot, Tc, and To are in this range site. The climax plant community is a tall grass savannah. Oak, elm, hackberry, cottonwood, ash, black willow, pecan, and other large trees form about 30 percent canopy cover. The canopy is generally more dense near streams or drainageways. Cool-season grasses and sedges grow under the canopy, and warm-season grasses and forbs dominate the open areas. The composition by weight is about 70 percent grasses, 25 percent woody plants, and 5 percent forbs.

Sedges, Virginia wildrye, Canada wildrye, and rustyseed paspalum produce 35 percent of the composition by weight. Beaked panicum, switchgrass, indiangrass, vine-mesquite, and Florida paspalum produce 25 percent. Buffalograss, long leaf uniola, knotroot bristlegrass, and other grasses produce 10 percent. 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 then dominate the understory and better quality forage is greatly reduced.

Claypan Prairie Range Site. The Bremond, Crockett, Mabank, Normangee and Wilson soils in map units CrA, CrB, CrC2, MaA, NoB, NrD2, WnA, and WxA are in this range site. In climax condition, this is a true tall grass prairie site with oak, elm, and hackberry trees along drainageways or in motts. The composition by weight is about 85 percent grasses, 5 percent woody plants, and 10 percent forbs.

Little bluestem and indiangrass make up about 65 percent of the forage. Switchgrass, big bluestem, Virginia wildrye, Canada wildrye, Florida paspalum, sideoats grama, meadow dropseed, Texas wintergrass, and vine-mesquite comprise 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. Many forbs, such as Maximilian sunflower, Engelmanndaisy, halfshrub sundrop, western indigo, and prairie clover make up 10 percent.

Tall grasses such as big bluestem, little bluestem, indiangrass, and switchgrass decrease in abundance under continuous, heavy grazing. Meadow dropseed, silver bluestem, sideoats grama, and Texas wintergrass increase. If overgrazing continues, mesquite and pricklypear invade the site and plants such as buffalograss, Texas wintergrass, Texas grama, windmillgrass, and weedy forbs will dominate the understory.

Claypan Savannah Range Site. The Axtell, Edge, and Lufkin soils in map units AxA, AxB, EgB, EgD, EgC2, EhC3, LuA, and LxA are in this range site. The climax plant community is a post oak, blackjack oak savannah with trees shading about 15 to 20 percent of the ground. The composition by weight is about 80 percent grasses, 15 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.

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. Post oak, elm, yaupon, hackberry, and other woody plants may increase to form a dense canopy that inhibits grass and forb production.

Deep Sand Range Site. The Padina soil in map units PaC and PaE is in this range site. The climax plant community is a post oak, blackjack oak savannah with a 20 to 25 percent canopy. The understory consists of mid to tall grasses. The composition by weight is about 80 percent grasses, 15 percent woody plants, and 5 percent forbs.

Little bluestem makes up about 50 percent of the composition and indiangrass makes up about 10 percent. Other grasses are purpletop, switchgrass, sand lovegrass, low panicums, purple lovegrass, sand dropseed, brownseed paspalum, and splitbeard bluestem. Woody plants such as blackjack oak and post oak make up 10 percent of the composition. Woody plants in the understory include shrubs such as yaupon, hawthorn, and American beautyberry. Forbs include legumes such as lespedeza, tickclover, and partridge pea.

Overgrazing and other adverse conditions cause a decrease in little bluestem, sand lovegrass, indiangrass, and purpletop and an increase in low panicums, low paspalums, purple lovegrass, and woolysheath threeawn. Woody plants such as oak and yaupon increase to form a dense canopy. Plants that invade the site include red lovegrass, tumble lovegrass, crabgrass, red sprangletop, sandbur, brackenfern, pricklypear, and queen’s delight. If overgrazing continues, production will drop to a very low level and poor quality forage will dominate.

Eroded Blackland Range Site. The Ellis and Ferris soils in map units EsC2, EsE2, FeD2, and FhC2 are in this range site. The climax plant community is a tall grass prairie. All forage grasses that make up the climax vegetation have been removed by cultivation and the productive capacity has been permanently reduced by erosion. However, these soils will still support the same grass species as the Blackland range site. To reestablish the original composition of climax vegetation will require a minimum of about 40 years. Composition by weight of the climax plant community is about 85 percent grasses, 5 percent woody plants, and 10 percent forbs.

Little bluestem, indiangrass, and big bluestem make up 70 percent of the climax vegetation. In addition, Virginia wildrye, Canada wildrye, switchgrass, Florida paspalum, sideoats grama, tall dropseed, silver bluestem, Texas wintergrass, and vine-mesquite make up 15 percent. Forbs, such as Maximilian sunflower, Engelmanndaisy, and bundleflower, make up 10 percent.

Most of this site is in some intermediate stage of secondary plant succession. Silver bluestem, tall dropseed, Texas wintergrass, sideoats grama, and buffalograss are dominant in most areas, and they respond as increasers. If overgrazed, buffalograss or Texas wintergrass, or both, will dominate the site.

Loamy Bottomland Range Site. The Nahatche, Uhland, and Whitesboro soils in map units Na, Uh, Wa, and Wf are in this range site. The climax plant community is a tall grass savannah with trees shading about 30 percent of the ground. The overstory consists of oak, pecan, hackberry, elm, cottonwood, hickory, and ash. The understory consists of hawthorns, greenbriar, honeysuckle, grape, and peppervines. Cool-season grasses and sedges dominate the shaded areas, while warm-season grasses dominate the open areas. The composition by weight is about 75 percent grasses, 20 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 40 percent of the plant community. Redtop panicum, gaping panicum, low panicums, uniolas, buffalograss, knotroot bristlegrass, Texas wintergrass, and other grasses make up 10 percent. The forbs are tickclover, lespedeza, snoutbean, partridge pea, and gayfeather.

The forage on this site is preferred by livestock. Overgrazing and fire suppression reduce the amount of warm-season grasses and forbs and increase the tree and brush canopy. Forage production decreases as shade-tolerant grasses and forbs become dominant.

Sandy Range Site. The Robco, Silstid, and Styx soils in map units RoA, SsB, SsD, and StA are in this range site. The climax plant community is an open savannah of post oak and blackjack oak, which shades about 20 to 25 percent of the ground. The open areas are predominantly tall grasses. The composition by weight is about 80 percent grasses, 15 percent woody plants, and 5 percent forbs.

About 55 percent of the composition is little bluestem, with indiangrass making up 10 percent. Switchgrass, beaked panicum, sand lovegrass, purpletop, and brownseed paspalum total 10 percent. Other grasses such as fringeleaf paspalum, purple lovegrass, tall dropseed, splitbeard bluestem, and low panicums make up 5 percent. Post oak and blackjack oak make up about 10 percent. Woody plants in the understory are hawthorn, American beautyberry, greenbriar, yaupon, and berry vines. The forbs are lespedeza, tickclover, sensitive briar, snoutbean, tephrosia, partridge pea, and western ragweed.

With continuous overgrazing and the suppression of natural fires, the taller grasses decrease in abundance and the woody plants increase. Little bluestem, indiangrass, and switchgrass are replaced by brownseed paspalum, tall dropseed, fall witchgrass, and others. If overgrazing continues, these are replaced by red lovegrass, yankeeweed, bullnettle, snakecotton, and croton. Other invading plants are broomsedge bluestem, smutgrass, sandbur, pricklypear, queen’s delight, beebalm, pricklypoppy, baccharis, and waxmyrtle. Woody species eventually form dense thickets in some areas.

Sandy Loam Range Site. The Gasil, Groesbeck, Lavender, Personville, Rader, Silawa, and Tabor soils in map units GfB, GsA, GsC, LrB, LxA, PeB, RaA, SaB, SaD, and TaA are in this range site. The climax plant community is a post oak and blackjack oak savannah with a 20 to 25 percent canopy. The total composition by weight is about 80 percent grasses, 15 percent woody plants, and 5 percent forbs.

Little bluestem is the dominant grass and makes up about 50 percent of the climax vegetation. Indiangrass makes up about 10 percent. Eastern gamagrass, switchgrass, big bluestem, beaked panicum, and longleaf uniola make up 10 percent of the total composition, and many other grasses make up another 10 percent. Post oak and blackjack oak make up about 10 percent and other woody plants that include elm, yaupon, greenbriar, American beautyberry, and berry vines make up 5 percent. The forbs include Engelmanndaisy, gayfeather, sensitive briar, and native legumes.

Tall grasses such as little bluestem, indiangrass, big bluestem, and eastern gamagrass decrease in abundance as overgrazing and fire suppression take place. Plants such as brownseed paspalum replace the tall grasses. Further deterioration of this site is caused by an increase in thickets of oak trees and shrubs, carpetgrass, annual grasses, and forbs.

Shallow Clay Range Site. The Oglesby soil in map unit OgB is in this range site. The plant community is an open grassland of mid and tall grasses with scattered motts of oak trees.

About 30 percent of the composition by weight is little bluestem, with sideoats grama making up another 25 percent. Plains lovegrass, Texas cupgrass, vine-mesquite, and cane or silver bluestem make up about 15 percent.

As overgrazing and fire suppression take place, woody plants dominate the site. Mid and tall grasses are replaced by short grasses such as curly mesquite, buffalograss, fall witchgrass, threeawns, red grama, and Texas grama. Annual forbs and grasses also increase.

Recreation

Limestone County's location, climate, topography, highway systems, and natural resources help provide many opportunities for outdoor recreational activities. Winters are relatively mild and only occasionally, after the passing of severe cold fronts, are outside activities restricted. Much of the county has soils, existing vegetative patterns, and topographic conditions suitable for recreational activities. Rolling terrain and a variety of vegetative patterns provide esthetic appeal and enhance the recreational experience.

Lake Limestone, Lake Mexia, and Fort Parker State Park Lake, provide more than 11,000 surface acres of water. These areas are used for picnicking, camping, swimming, fishing, boating, and water skiing. The presence of small game animals such as mourning dove, bobwhite quail, and fox squirrel, various waterfowl, and white-tailed deer offers an opportunity for hunting in many parts of the county.

The soils of the survey area are rated in table 7 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 7, 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 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

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

Matthew R. Judy, biologist, Natural Resources Conservation Service, helped prepare this section.

Wildlife in the county is increasing because of better habitat management and renewed interest in some game species. For instance, the population of white-tailed deer has more than doubled within the last 10 years. According to the Texas Parks and Wildlife Department, the current deer population is about 1 deer for every 11 acres of habitat. Most of the deer herd is concentrated in 152,000 acres of post oak savannah in the southeastern part of the county.

Native wild turkey were reintroduced in the post oak savannah area in the winter of 1989 by the Texas Parks and Wildlife Department. The objective is to restore wild turkey throughout its native range.

Additional game species found within the county include mourning dove, bobwhite quail, fox squirrel, and various waterfowl.

Other wildlife species common to the area include armadillo, cottontail rabbit, jackrabbit, raccoon, opossum, bats, striped skunk, and spotted skunk. There are many species of rodents, the largest of which are nutria and beaver. Predators include the coyote, red and gray fox, and bobcat. Many songbirds, hawks, owls, wading birds, reptiles, and amphibians are also native to the county. Many of these nongame species benefit when landowners manage for game animals.

Limestone County has many soils suitable for impounding water. Numerous ponds and lakes have been built to provide livestock water, help prevent soil erosion, or provide flood control. Many have been stocked with largemouth bass, bluegill, and channel catfish to provide fishing as a secondary use. Other fish species found in streams and in unmanaged ponds and lakes include green sunfish, bullhead catfish, white crappie, and gar.

Three large lakes in Limestone County provide habitat for fish and other aquatic wildlife. Lake Mexia, Fort Parker State Park Lake, and Lake Limestone were all formed by the construction of dams on the Navasota River.

Lake Mexia is located in northeast Limestone County. It was built in 1961 to provide a municipal water supply to Mexia and the Mexia State School. The lake is relatively shallow, and silt deposition has increased turbidity to the point that the quality of fishery habitat has declined throughout much of the reservoir.

Fort Parker State Park Lake was constructed in 1935 by the Civilian Conservation Corp. It is estimated that 60 percent of the lake is less than 4 feet deep, which severely impacts the fishery resource.

Lake Limestone was impounded in 1978 and is the largest lake in Limestone County. It is in the southeastern corner of the county with small portions in Robertson and Leon Counties. The primary function of this reservoir is to provide a source of cooling water for a coal-fired power generating plant. The lake is moderately clear and contains adequate structure to provide good fishery habitat.

The primary sport fishes in these lakes are largemouth bass, white crappie, channel catfish, flathead catfish, and white bass. Other fishes present are gizzard shad, bluegill, threadfin shad, redear sunfish, smallmouth buffalo, freshwater drum, carp, black and yellow bullhead, and spotted gar.

Wetlands in the county consist of seasonally ponded depressions in the flood plain of the Navasota River. These areas are mostly small and scattered but provide wintering habitat for various waterfowl species including wood ducks, mallard, teal, widgeon, gadwall, pintail, and shoveler.

Open bodies of water such as farm ponds, lakes, and rivers make up the remaining wetlands in the county, providing resting and feeding areas for waterfowl during migratory periods.

Bald eagles sometimes nest in late winter through early summer along the Navasota River and around the larger lakes. Other protected birds that may migrate through the county are the American peregrine falcon, the arctic peregrine falcon, the interior least tern, the piping plover, and the whooping crane.

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 8, 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 anagement 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, wheat, oats, 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 fescue, lovegrass, kleingrass, clover, and vetch.

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, goldenrod, beggarweed, sunflower, and partridge pea.

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 yaupon, greenbriar, sumac, and coral berry.

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, meadowlark, field sparrow, cottontail, coyote, and fox.

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

Surface Mine Reclamation

Norman Bade, resource conservationist, Natural Resources Conservation Service, helped prepare this section.

Lignite deposits underlie many of the soils in the southern part of Limestone County. Some of this land has been leased for future mining. Strip mining these near-surface lignite deposits will result in large areas of disturbed lands. This process includes clearing existing vegetation, removing all overburden, mining the lignite, and replacing the overburden.

Land reclamation includes soil reconstruction and revegetation. After the lignite is mined and the overburden is replaced, the spoil is graded to its planned contour and revegetated to the planned land use. Following reconstruction, land can be used as cropland, pasture, rangeland, wildlife habitat, recreational areas, woodland, orchard, or residential or industrial development. The selected land use determines the reclamation procedures that will be used, including the kinds of plants that will be established.

Successful reclamation of strip-mined soils depends on an understanding of the chemical, physical, and biological properties of soils. The soil properties generally are altered as the soil is disturbed. This can affect the alternative land use and productivity.

The objectives of reclamation are to restore the soil to a condition capable of its intended use, to prevent permanent damage, and to control erosion and sedimentation.

The method of soil reconstruction is important to the success of reclamation efforts. Methods used in the removal of overburden and reconstruction of the soil should provide for the placement of soil material on the surface that is the best for plant growth and productivity. Surface mining and reconstruction alter many of the soil properties and cause an initial increase in erosion potential, a decrease in fertility, and a strong tendency to crust. Reclamation problems caused by geologic materials containing acid-forming pyrites can be avoided by ensuring these materials are not mixed into the rooting zone. Testing of chemical properties of the reconstructed soil is needed to make certain these materials are not present.

Because of the disturbance of the soils following mining and reconstruction, the reclamation process generally requires a larger application of soil amendments, more plant materials, and more intensive management.

The revegetation of mined lands requires a good seedbed, adequate amounts of fertilizer, and selection of plant species that control erosion and provide for the land’s intended use. Plants commonly used for cover and forage include coastal bermudagrass, common bermudagrass, selection 75 kleingrass, Pensacola bahiagrass, and King Ranch bluestem. Other important species include Haskell sideoats grama, T-587 old world bluestem, Alamo switchgrass, and Lometa indiangrass.

The addition of legumes, such as Yuchii arrowleaf clover, crimson clover, subterranean clover, and hairy vetch, increases forage capabilities and provides needed nitrogen for other species. Other forbs and legumes, such as Sabine Illinois bundleflower, singletary pea, Engelmanndaisy, and Aztec Maximilian sunflower, provide forage diversity and improve wildlife habitat. The addition of trees, shrubs, and vines also aids in enhancing wildlife habitat.

Current Texas regulations require that all lignite mine sites be reclaimed according to a prepared and approved reclamation plan, which includes the vegetation of the area. After vegetation has been established, it must be maintained for a designated period. National and state regulations should be considered in the planning, site selection, design, and application of any reclamation procedures.

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 9 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 10 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 10 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 10 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 10 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 11 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 11, 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 12 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 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.

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.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 18.

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 13 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 *(4)* and the system adopted by the American Association of State Highway and Transportation Officials *(3)*.

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. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 18.

Rock fragments 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 14 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, 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 fib ric 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 14, 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 15 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, 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 or 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.

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 15 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 15 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 15.

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.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

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.

Physical and Chemical Analyses of Selected Soils

The results of physical analysis of several typical pedons in the survey area are given in table 16 and the results of chemical analysis in table 17. The data are for soils sampled at carefully selected sites. Unless otherwise indicated, the pedons are typical of the series. They are described in the section “Soil Series and Their Morphology.” Soil samples were analyzed by the Soil Characterization Laboratory, Texas Agricultural Experiment Station, College Station, Texas.

Most determinations, except those for grain-size analysis and bulk density, were made on soil material smaller than 2 millimeters in diameter. Measurements reported as percent or quantity of unit weight were calculated on an ovendry basis. The methods used in obtaining the data are indicated in the list that follows. The codes in parentheses refer to published methods *(18)*.

Sand—(0.05-2.0 mm fraction) weight percentages of material less than 2 mm (3A1).

Silt—(0.002-0.05 mm fraction) pipette extraction, weight percentages of all material less than 2 mm (3A1).

Clay—(fraction less than 0.002 mm) pipette extraction, weight percentages of material less than 2 mm (3A1).

Water retained—pressure extraction, percentage of ovendry weight of less than 2 mm material; 1/3 bar (4B1).

Bulk density—of less than 2 mm material, saran-coated clods field moist (4A1a), 1/3 bar (4A1d), ovendry (4A1h).

Linear extensibility—change in clod dimension based on whole soil (4D).

Organic carbon—wet combustion. Walkley-Black modified acid-dichromate, ferric sulfate titration (6A1c)

Extractable cations—ammonium acetate pH 7.0, atomic absorption; calcium (6N2e), magnesium (6O2d), sodium (6P2b), potassium (6Q2b).

Cation-exchange capacity—sodium acetate, pH 8.2 (5A2a).

Base saturation—sodium acetate, pH 8.2.

Reaction (pH)—1:1 water dilution (8C1f).

Exchangeable sodium percentage (5D).

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 Soil Mechanics Laboratory, Natural Resources Conservation Service, Fort Worth, Texas.

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); and Plasticity index—T 90 (AASHTO), D 4318 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(17, 19)*. 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 Ustalf (*Ust*, meaning burnt or dry, 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 Haplustalfs (*Hapl*, meaning minimal horizonation, plus *ustalf*, the suborder of the Alfisols that has an ustic 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 Haplustalfs.

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, mixed, thermic Typic Haplustalfs.

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.

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” *(20)*. Many of the technical terms used in the descriptions are defined in “Soil Taxonomy” *(17)* and in “Keys to Soil Taxonomy” *(19)*. 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.”

Axtell Series

The Axtell series consists of very deep, moderately well drained, very slowly permeable soils on stream terraces. These soils formed in alkaline clayey alluvium. Slopes range from 0 to 3 percent. Soils of the Axtell series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Axtell fine sandy loam, 0 to 1 percent slopes; from the intersection of U.S. Highway 84 and Texas Highway 14 in Mexia, 8.0 miles west on Highway 84, 3.0 miles north on Farm Road 2310, 2.0 miles west on county road, 0.8 mile north on county road, and 100 feet east, in rangeland:

A—0 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; hard, friable; common fine and medium roots, few coarse roots; about 2 percent fine and coarse siliceous pebbles; strongly acid; clear smooth boundary.

Bt1—9 to 18 inches; reddish brown (2.5YR 4/4) clay, reddish brown (2.5YR 5/4) dry; many medium prominent dark yellowish brown (10YR 4/4) and common medium distinct red (2.5YR 5/8) mottles; moderate medium subangular blocky structure; very hard, firm; about 2 percent fine and medium roots; thin patchy clay films on faces of peds; few fine and coarse siliceous pebbles; common streaks of dark grayish brown coatings on peds along cracks; very strongly acid; clear wavy boundary.

Bt2—18 to 32 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; few medium prominent red (2.5YR 4/8) mottles; moderate medium subangular blocky structure; very hard, firm; few fine and medium roots; thin patchy clay films on faces of peds; few pressure faces; about 2 percent fine and coarse siliceous pebbles; few dark streaks in cracks; strongly acid; clear smooth boundary.

Btk1—32 to 43 inches; light yellowish brown (2.5Y 6/4) clay, pale yellow (2.5Y 7/4) dry; moderate coarse angular blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; few fine pressure faces; few fine and medium calcium carbonate concretions and masses; 5 percent fine and coarse siliceous pebbles; few brown organic root stains; slightly effervescent; moderately alkaline; gradual wavy boundary.

Btk2—43 to 60 inches; light yellowish brown (2.5Y 6/4) clay, pale yellow (2.5Y 7/4) dry; few fine prominent brownish yellow (10YR 6/8) mottles; moderate coarse angular blocky structure; extremely hard, very firm; few fine roots; thin patchy clay films on faces of peds; few pressure faces; common fine black concretions; common fine and medium calcium carbonate concretions and masses; few patches of neutral salts; 5 percent siliceous pebbles; few brown organic root stains; strongly effervescent; moderately alkaline; gradual wavy boundary.

Btk3—60 to 80 inches; light yellowish brown (2.5Y 6/4) clay loam, pale yellow (2.5Y 7/4) dry; moderate medium and coarse angular blocky structure; very hard, firm; few fine roots; thin patchy clay films on faces of peds; common fine and medium calcium carbonate concretions and masses; few fine black concretions; strongly effervescent; moderately alkaline.

Solum thickness ranges from 60 to more than 80 inches. The boundary between the A and Bt horizon is abrupt over subsoil crests and clear over subsoil troughs. Depth to carbonates ranges from 30 to 60 inches in most pedons. Base saturation in the upper part of the Bt horizon ranges from 55 to 75 percent.

The A horizon has a hue of 10YR, value of 4 to 6, and chroma of 2 or 3. The E horizon, where present, is about 1 unit of value higher than the A horizon. Some pedons contain as much as 5 percent, by volume, gravel on the surface and in the A horizon. The combined thickness of the A and E horizons ranges from 5 to 12 inches. Reaction ranges from strongly acid to slightly acid.

The Bt1 horizon has a hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 8. Mottles in shades of red, brown, gray, or yellow are in most pedons or the matrix is mottled with these colors. Reaction is very strongly acid or strongly acid.

The Bt2 horizon has a hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 8. Mottles in shades of red, brown, gray, or yellow are in most pedons or the matrix is mottled with these colors. Reaction ranges from strongly acid to slightly acid.

The Btk and BC horizons, where present, have a hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2 to 4. Mottles in shades of red, brown, gray, or yellow are in most pedons or the matrix is mottled with these colors. The texture is sandy clay loam, clay loam, or clay. The reaction ranges from neutral to moderately alkaline. Calcium carbonate concretions or masses range from none to few in the BC horizon and few to common in the Btk horizon.

Branyon Series

The Branyon series consists of very deep, moderately well drained, very slowly permeable soils on ancient stream terraces. These soils formed in calcareous clayey sediments. Slopes range from 0 to 2 percent. Soils of the Branyon series are fine, montmorillonitic, thermic Udic Haplusterts.

Typical pedon of Branyon clay, 0 to 2 percent slopes; from the intersection of Texas Highway 171 and Farm Road 73 in Coolidge, 7.5 miles west on Farm Road 73, 2.3 miles northwest on Farm Road 341, and 150 feet west, in cropland:

Ap—0 to 6 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate fine granular structure; extremely hard, very firm, very sticky and very plastic; few fine and medium roots; few pressure faces; few fine and medium calcium carbonate concretions; about 2 percent rounded siliceous pebbles; strongly effervescent; moderately alkaline; abrupt wavy boundary.

Bss—6 to 14 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few pressure faces; common coarse intersecting slickensides; few fine and medium calcium carbonate concretions; few fine black concretions; about 2 percent siliceous pebbles;

strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss1—14 to 48 inches; dark gray (10YR 4/1) clay, gray (10YR 5/1) dry; moderate coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; common intersecting slickensides; few streaks of very dark gray (10YR 3/1) material in cracks; common fine and medium calcium carbonate concretions; few masses of calcium carbonate; few fine black concretions; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss2—48 to 62 inches; gray (10YR 5/1) clay, light gray (10YR 6/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; common intersecting slickensides; common streaks of very dark gray (10YR 3/1) material in cracks; common fine and medium calcium carbonate concretions; few masses of calcium carbonate; few fine black concretions; about 2 percent cobbles and siliceous pebbles; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bk—62 to 80 inches; light brownish gray (10YR 6/2) clay, light gray (10YR 7/2) dry; few medium faint yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium calcium carbonate concretions; common masses of calcium carbonate; few fine and medium black concretions; about 2 percent cobbles and siliceous pebbles; strongly effervescent; moderately alkaline.

The solum thickness ranges from 60 to more than 80 inches. About 2 to 10 percent of the surface is covered by siliceous pebbles and up to 10 percent by volume are in the A horizon. Depth to intersecting slickensides ranges from 6 to 23 inches. There are few black concretions and few to common concretions of calcium carbonate below the surface layer.

The Ap and A horizons have a hue of 10YR, value of 3 to 5, and chroma of 1. Reaction ranges from neutral to moderately alkaline.

The Bss and Bkss horizons have a hue of 10YR or 2.5Y, value of 3 to 7, and chroma of 1 or 2. Where present, mottles in shades of brown, gray, or yellow range from few to common. Reaction ranges from slightly alkaline to moderately alkaline.

The Bk horizon has a hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 1 or 2. Where present, mottles in shades of yellow, brown, and olive range from few to common.

Bremond Series

The Bremond series consists of very deep, moderately well drained, very slowly permeable soils on terraces. These soils formed in alkaline clayey sediments. Slopes range from 0 to 2 percent. Soils of the Bremond series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Bremond fine sandy loam, in an area of Wilson-Bremond complex, 0 to 2 percent slopes; from the intersection of U.S. Highway 84 and State Highway 14 in Mexia; 18.4 miles west on U.S. Highway 84, 3.5 miles southeast on Farm Road 339, 1.1 miles northeast on county road, 0.2 mile northwest on county road, and 45 feet west, in cropland:

Ap—0 to 6 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; hard, friable; common fine and medium roots; about 2 percent siliceous pebbles; strongly acid; abrupt smooth boundary.

Bt1—6 to 14 inches; dark brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; many medium prominent red (2.5YR 4/8) and few medium distinct very pale brown (10YR 7/3) mottles; moderate fine and medium subangular blocky structure; very hard, firm; common fine and few medium roots; few clay films on faces of peds and along root channels; few fine black concretions; about 2 percent siliceous pebbles; common streaks of dark brown material in cracks; slightly acid; gradual wavy boundary.

Bt2—14 to 25 inches; mottled red (2.5YR 4/6), strong brown (7.5YR 5/6), and pale brown (10YR 6/3) clay; moderate fine and medium subangular blocky structure; very hard, very firm; few fine roots; few clay films on faces of peds; few small slickensides; few fine black concretions; about 2 percent siliceous pebbles; few grainy gray coatings on peds along cracks; neutral; gradual wavy boundary.

Bt3—25 to 46 inches; pale brown (10YR 6/3) clay, very pale brown (10YR 7/3) dry; common medium prominent red (2.5YR 4/8), common fine prominent strong brown (7.5YR 5/8), and few fine faint light brownish gray mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few clay films on faces of peds; few small slickensides; few fine black concretions; about 2 percent siliceous pebbles increasing in quantity with depth; few gray coatings on peds along cracks; neutral; gradual wavy boundary.

Btk1—46 to 62 inches; light yellowish brown (10YR 6/4) clay, very pale brown (10YR 7/4) dry; common fine prominent reddish yellow (7.5YR 6/8), common fine and medium distinct light brownish gray (10YR 6/2), and few fine faint pale brown mottles; moderate fine subangular blocky structure; very hard, very firm; few fine roots; few fine clay films on faces of peds; few fine black concretions; common medium and coarse calcium carbonate concretions and masses; 5 percent siliceous pebbles; few dark organic stains; strongly effervescent; moderately alkaline; gradual wavy boundary.

Btk2—62 to 69 inches; brownish yellow (10YR 6/6) clay loam, yellow (10YR 7/6) dry; few fine prominent reddish yellow (7.5YR 6/8) and many medium prominent light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; very hard, firm; few fine roots; few fine clay films on faces of peds; few fine black concretions; common fine and medium calcium carbonate concretions and masses; about 2 percent siliceous pebbles; few dark organic stains; some intermixing of sandier material; strongly effervescent; moderately alkaline; gradual wavy boundary.

Btk3—69 to 80 inches; brownish yellow (10YR 6/6) clay loam, yellow (10YR 7/6) dry; few fine prominent strong brown (7.5YR 5/6) and many coarse prominent light brownish gray (10YR 6/2) and pale brown (10YR 6/3) mottles; weak fine subangular blocky structure; very hard, firm; few clay films on faces of peds; few fine black concretions; common fine, medium, and coarse calcium carbonate concretions and masses; about 2 percent siliceous pebbles; few dark organic stains; strongly effervescent; moderately alkaline.

Solum thickness ranges from 60 to more than 80 inches. Depth to secondary carbonates ranges from 40 to 70 inches; however, some pedons do not have visible carbonates. The solum commonly contains 2 to 5 percent by volume siliceous pebbles.

The A horizon has a hue of 10YR, value of 3 to 6, and chroma of 2 to 4. The boundary between the A and the Bt is commonly abrupt and wavy over subsoil crests and clear in subsoil troughs. The reaction ranges from strongly acid to neutral.

The Bt1 horizon has a hue of 5YR to 10YR, value of 4 or 5, and chroma of 3 or 4. It has few to many mottles in shades of red, brown, or olive. Texture is clay or clay loam. Slickensides range from few to common. Reaction ranges from moderately acid to neutral.

The Bt2 and Bt3 horizon have colors in shades of yellow or brown and mottles in shades of red, yellow, brown, or gray. Some horizons are mottled in these colors. The texture is clay loam or clay. Slickensides range from few to common. Reaction ranges from slightly acid to moderately alkaline. Some pedons have few to common calcium carbonate concretions in the lower Bt horizon.

The Btk horizon has matrix colors in shades of brown, yellow, olive, or gray, or it is mottled with these colors. The texture is sandy clay loam, clay loam, or clay. The reaction ranges from neutral to moderately alkaline. Calcium carbonate concretions and masses range from few to many.

Burleson Series

The Burleson series consists of very deep, moderately well drained, very slowly permeable soils on ancient stream terraces. These soils formed in alkaline clayey sediments. Slopes range from 0 to 2 percent. Soils of the Burleson series are fine, montmorillonitic, thermic Udic Haplusterts.

Typical pedon of Burleson clay, 0 to 2 percent slopes; from the intersection of State Highway 14 and State Highway 164 in Groesbeck, 15.9 miles west on State Highway 164, 1.2 miles northeast on county road, 74 feet north, in cropland:

Ap—0 to 6 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; few pressure faces; few fine brown concretions; about 2 percent siliceous pebbles; surface crust about 1/4 inch thick; neutral; gradual wavy boundary.

A—6 to 18 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few slickensides in lower part; few fine and medium calcium carbonate concretions; about 2 percent siliceous pebbles, few streaks of dark gray material on peds along cracks; neutral; gradual wavy boundary.

Bss1—18 to 29 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; common intersecting slickensides; few fine and medium calcium carbonate concretions; about 2 percent siliceous pebbles; few streaks of dark gray material in filled cracks; neutral; gradual wavy boundary.

Bss2—29 to 42 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; weak coarse prismatic structure parting to weak coarse angular blocky; extremely hard, very firm, very sticky and very plastic; few fine roots; common intersecting slickensides; few fine brown concretions; few fine and medium calcium carbonate concretions; few masses of calcium carbonate; about 2 percent siliceous pebbles; few streaks of black material in filled cracks; moderately alkaline; gradual wavy boundary.

Bw—42 to 80 inches; grayish brown (2.5Y 5/2) clay, light brownish gray (2.5Y 6/2) dry; few fine faint light yellowish brown and few fine prominent yellowish brown (10YR 5/4) mottles; weak coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few slickensides; few fine brown concretions; few fine calcium carbonate concretions; few neutral salt crystals; about 2 percent siliceous pebbles; few streaks of very dark gray material on peds along cracks; moderately alkaline.

The solum thickness is 60 inches or more. Depth to intersecting slickensides ranges from 15 to 24 inches. Siliceous pebbles and cobbles range from 0 to 10 percent by volume. Black or brown concretions range from none to few throughout the solum.

The Ap and A horizons have a hue of 10YR, value of 2 to 5, and chroma of 1. Concretions and masses of calcium carbonate are present in some pedons in the lower part of the A horizon. Reaction ranges from moderately acid to moderately alkaline.

The Bss horizon has a hue of 10YR or 2.5Y, value of 2 to 5, and chroma of 1 or 2. Some pedons have few mottles in shades of gray and brown.

The Bw horizon has a hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 1 or 2. Some pedons have few to common mottles in shades of brown, gray, yellow, or olive.

Crockett Series

The Crockett series consists of very deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in alkaline shales and clays (fig. 18). Slopes range from 0 to 5 percent. 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 State Highway 164 and State Highway 14 in Groesbeck, 0.2 mile east on State Highway 164, 4.2 miles southwest on county road, and 70 feet north, in pasture:

A—0 to 5 inches, dark grayish brown (10YR 4/2) loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very hard, friable; common fine and medium roots; few wormcasts; about 2 percent pebbles; neutral; abrupt wavy boundary.

Bt1—5 to 16 inches; mottled reddish brown (5YR 4/4), yellowish brown (10YR 5/4), and light olive brown (2.5Y 5/4) clay; few medium distinct dark grayish brown (10YR 4/2) mottles; moderate fine subangular blocky structure; extremely hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few very dark gray organic stains; few cracks filled with loamy A horizon material; neutral; gradual wavy boundary.

Bt2—16 to 35 inches; dark grayish brown (2.5Y 4/2) clay, grayish brown (2.5Y 5/2) dry; common medium prominent reddish brown (5YR 4/4) and yellowish brown (10YR 5/4) and common medium distinct light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; extremely hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few pressure faces; few fine black concretions; few white streaks on faces of peds; few reddish brown stains on faces of peds along cracks; moderately alkaline; gradual wavy boundary.

Bt3—35 to 47 inches; mottled strong brown (7.5YR 4/6), olive brown (2.5Y 4/4), light olive brown (2.5Y 5/6), and olive yellow (2.5Y 6/6) clay; moderate coarse angular blocky structure; extremely hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few fine calcium carbonate concretions in lower part; few fine black concretions; few cracks with dark grayish brown material; moderately alkaline; gradual wavy boundary.

BC—47 to 54 inches, mottled olive brown (2.5Y 4/4), olive gray (5Y 5/2), and light gray (5Y 7/2) clay; many medium distinct brownish yellow (10YR 6/8) mottles; weak coarse angular blocky structure; extremely hard, very firm; few thin patchy clay films on faces of peds; few fine black concretions; few fine masses of calcium carbonate on faces of peds; few shale fragments; moderately alkaline; gradual wavy boundary.

Ck1—54 to 65 inches; mottled olive gray (5Y 5/2) and light olive brown (2.5Y 5/6) clay loam; many medium distinct brownish yellow (10YR 6/8) mottles; massive; very hard, very firm; few fine masses and few coarse concretions of calcium carbonate; about 10 percent interbedded weakly consolidated shale in thin layers and about 2 percent light olive brown (2.5Y 6/4) brittle shale fragments; few gypsum crystals; strongly effervescent; moderately alkaline; gradual wavy boundary.

Ck2—65 to 80 inches; olive gray (5Y 5/2) clay loam, light olive gray (5Y 6/2) dry; common medium prominent brownish yellow (10YR 6/8) mottles; massive; very hard, very firm; few fine masses and concretions of calcium carbonate; about 12 percent interbedded weakly consolidated shale in thin layers and about 2 percent light olive brown (2.5Y 6/4) brittle weathered shale fragments; few gypsum crystals; strongly effervescent; moderately alkaline.

Solum thickness ranges from 42 to 60 inches. Some pedons have up to 10 percent by volume siliceous pebbles.

The A horizon has a hue of 10YR, value of 3 to 6, and chroma of 2 to 4. The boundary between the A and the Bt horizons is abrupt and wavy over subsoil crests and clear in subsoil troughs. Thickness averages less than 9 inches, but is as much as 15 inches over subsoil troughs. Reaction ranges from moderately acid to slightly alkaline.

The Bt1 horizon has hue of 5YR to 2.5Y, value of 4 to 6, and chroma of 3 to 6. Mottles in shades of red, olive, yellow, brown, and gray range from few to many. Texture is clay or clay loam. Reaction ranges from moderately acid to neutral.

The Bt2 and Bt3 horizons have colors in shades of brown or yellow with mottles in shades of red, brown, yellow, or gray. Some horizons are mottled in these colors. Some pedons have up to 5 percent by volume calcium carbonate concretions. Reaction ranges from slightly acid to moderately alkaline.

The BC, Ck, or C horizons, where present, have matrix colors in shades of brown, yellow, gray, or olive, or they are mottled with these colors. The texture of the BC horizon is clay loam or clay. The texture of the Ck or C horizon is loam, sandy clay loam, or clay loam. Calcium carbonate concretions and masses range from none to many. The reaction ranges from slightly acid to moderately alkaline.

Edge Series

The Edge series consists of very deep, well drained, very slowly permeable soils on uplands. These soils formed in mostly loamy and sandy materials derived mainly from the Calvert Bluff and Hooper members of the Wilcox Formation. Slopes range from 1 to 12 percent. Soils of the Edge series are fine, mixed, thermic Udic Paleustalfs.

Typical pedon of Edge fine sandy loam, 1 to 5 percent slopes; from the intersection of Farm Road 2749 and Highway 7 about 6 miles east of Kosse, 5.4 miles north on Farm Road 2749, and 10 feet east, in rangeland:

A—0 to 9 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, friable; common fine and medium roots; strongly acid; abrupt smooth boundary.

Bt1—9 to 17 inches; red (2.5YR 4/6) clay, red (2.5YR 5/6) dry; moderate fine and medium subangular blocky structure; very hard, very firm; few fine and coarse roots; common thin clay films on faces of peds and along root channels; very strongly acid; clear wavy boundary.

Bt2—17 to 26 inches; red (2.5YR 4/8) clay, red (2.5YR 5/8) dry; moderate fine and medium subangular blocky structure; very hard, very firm; few fine, medium, and coarse roots; common thin clay films on faces of peds; few dark brown coatings along root channels; very strongly acid; clear wavy boundary.

Bt3—26 to 38 inches; red (2.5YR 4/8) clay loam, red (2.5YR 5/8) dry; few fine distinct reddish yellow (5YR 6/6) mottles; weak fine and medium subangular blocky structure; hard, firm; few fine and medium roots; few thin clay films on faces of peds; very strongly acid; gradual wavy boundary.

BC—38 to 51 inches; strong brown (7.5YR 5/8) sandy clay loam, reddish yellow (7.5YR 6/8) dry; common fine distinct red (2.5YR 4/8) mottles; weak fine subangular blocky structure; hard, firm; few fine roots; 5 percent grayish brown (10YR 5/2) fragments of shale intermixed with thin strata of mudstone and sandstone; very strongly acid; gradual wavy boundary.

C—51 to 80 inches; yellowish red (5YR 5/8) weakly consolidated mudstone that has a sandy clay loam texture; reddish yellow (5YR 6/8) dry; few fine prominent red (2.5YR 4/6), few fine distinct strong brown (7.5YR 5/8), and few fine prominent light brownish gray (10YR 6/2) mottles; massive; very hard, firm; few fine roots; 7 percent grayish brown (10YR 5/2) fragments of shale; 6 percent thin strata and fragments of indurated sandstone; strongly acid.

Solum thickness ranges from 43 to 60 inches. Some pedons have up to 10 percent by volume ironstone gravel.

The A horizon has a hue of 10YR, value of 4 to 6, and chroma of 2 or 3. The E horizon, where present, is 1 or 2 units of value lighter than the A horizon. Reaction ranges from very strongly acid to neutral.

The Bt horizon has a hue of 2.5YR or 5YR, value of 3 to 5, and chroma of 4 to 8. Some pedons have mottles of these colors or mottles of pale brown or strong brown or the matrix is mottled with these colors. Texture is sandy clay, clay loam, or clay. Base saturation ranges from about 45 to 85 percent but is 75 percent or more in some part. The coefficient of linear extensibility ranges from about 0.06 to 0.09 in the upper part. Reaction is very strongly acid to slightly acid.

The BC horizon has hue of 2.5YR to 10YR, value of 3 to 7, and chroma of 2 to 8. Some pedons have few to common mottles in shades of red, brown, or gray. The matrix is mottled in these colors in some pedons. Texture is sandy clay loam, clay loam, or clay. Reaction ranges from very strongly acid to slightly alkaline.

The C horizon is weakly consolidated mudstone or sandstone. Colors are in shades of brown, red, or gray. Some pedons have few to common mottles in these colors. Most pedons have thin strata of interbedded sandy material. Fragments of shale and sandstone range from 5 to 12 percent by volume in some pedons. The texture is fine sandy loam, sandy clay loam, or sandy loam. The reaction is strongly acid to moderately alkaline.

Ellis Series

The Ellis series consists of very deep, well drained, very slowly permeable soils on erosional uplands. These soils formed in weakly consolidated shales. Slopes range from 3 to 15 percent. Soils of the Ellis series are fine, montmorillonitic, thermic Udertic Ustochrepts.

Typical pedon of Ellis clay, 5 to 15 percent slopes, eroded; from the intersection of U.S. Highway 84 and State

Highway 14 in Mexia, 4.0 miles north on State Highway 14, 0.4 mile east on county road, and 100 feet south, in pasture:

A—0 to 6 inches; olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry; moderate fine and medium subangular blocky structure; very hard, firm, sticky and plastic; common fine and medium roots; common fine and medium calcium carbonate concretions; moderately alkaline; clear smooth boundary.

Bw1—6 to 24 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few fine roots; few pressure faces and small slickensides; few fine and medium calcium carbonate concretions and masses; few dark grayish brown streaks on faces of peds along cracks; moderately alkaline; clear smooth boundary.

Bw2—24 to 37 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; common medium prominent yellowish brown (10YR 5/8) mottles; moderate medium subangular blocky structure; very hard, very firm, sticky and plastic; few fine roots; common pressure faces and small slickensides; few masses of calcium carbonate; about 2 percent pebbles; dark grayish brown streaks on faces of peds along cracks; moderately alkaline; clear smooth boundary.

C—37 to 80 inches; grayish brown (10YR 5/2) weakly consolidated shale that has clay texture, light brownish gray (10YR 6/2) dry; massive; very hard, very firm, sticky and plastic; few masses and seams of calcium carbonate; moderately alkaline.

Solum thickness ranges from 28 to 40 inches. Some pedons have up to 2 percent by volume siliceous pebbles throughout the solum. These soils have dry-weather cracks that close when the soil becomes moist. Few to common pressure faces and small slickensides are below the A horizon.

The A horizon has a hue of 10YR or 2.5Y, value of 4 to 5, and chroma of 2 to 4. Reaction ranges from slightly acid to moderately alkaline.

The Bw horizon has a hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 2 to 4. Reaction ranges from slightly acid to moderately alkaline. Some pedons have few to common calcium carbonate concretions and masses.

The BC horizon, where present, has hue of 10YR to 5Y, value of 4 to 7, and chroma of 2 to 6. In some pedons, mottles of these colors range from few to many or the matrix is a mixture of these colors. Most pedons have few concretions and masses of calcium carbonate and up to 5 percent by volume unweathered shale fragments.

The C horizon has colors in shades of gray, brown, yellow, or olive. Most pedons have few concretions and masses of calcium carbonate.

Ferris Series

The Ferris series consists of very deep, well drained, very slowly permeable soils on uplands. These soils formed in weakly consolidated calcareous clays and shales. Slopes range from 2 to 15 percent. Soils of the Ferris series are fine, montmorillonitic, thermic Chromic Udic Haplusterts.

Typical pedon of Ferris clay, 5 to 15 percent slopes, eroded; from the intersection of U.S. Highway 84 and Farm Road 73 near Prairie Hill, 3.7 miles west on Highway 84, 2.5 miles south, 0.2 mile west, and 1.9 miles south on county road, and 30 feet north, in cropland:

Ap—0 to 4 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; moderate fine subangular blocky structure; very hard, very firm, very sticky and very plastic; common fine roots; few pressure faces; few fine calcium carbonate concretions; about 2 percent pebbles; strongly effervescent; moderately alkaline; clear wavy boundary.

Bss1—4 to 30 inches; olive (5Y 5/3) clay, pale olive (5Y 6/3) dry; weak fine medium subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots, common intersecting slickensides; few pressure faces; few fine calcium carbonate concretions; few dark grayish brown streaks; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss2—30 to 45 inches; olive (5Y 5/4) clay, pale olive (5Y 6/4) dry; common medium prominent light olive brown (2.5Y 5/6) mottles; weak medium angular blocky structure; very hard, very firm, very sticky and very plastic; few fine roots; common intersecting slickensides; few fine calcium carbonate concretions and masses; few fine black concretions; about 2 percent dark gray shale fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

Ck1—45 to 65 inches; mottled light olive brown (2.5Y 5/6), grayish brown (2.5Y 5/2), light brownish gray (2.5Y 6/2), and olive (5Y 5/4) clay; common medium distinct yellowish brown (10YR 5/8) mottles; massive; very hard, very firm, very sticky and very plastic; common fine and medium calcium carbonate concretions; about 5 percent fragments of weakly consolidated weathered shale; strongly effervescent; moderately alkaline; gradual wavy boundary.

Ck2—65 to 80 inches; light olive brown (2.5Y 5/6) clay, olive yellow (2.5Y 6/6) dry; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; very hard, very firm, very sticky and very plastic; common fine and medium calcium carbonate concretions; about 10 percent fragments of weakly consolidated weathered shale; strongly effervescent; moderately alkaline.

Solum thickness ranges from 33 to about 54 inches. Calcium carbonate concretions range from few to common throughout most pedons.

The A horizon has a hue of 2.5Y or 5Y, value of 3 to 6, and chroma of 2 to 4. Where values are 3, the horizon is less than 10 inches thick.

The Bss horizon and Bw horizon, where present, have a hue of 2.5Y or 5Y, value of 4 to 7, and chroma of 2 to 6. Most pedons have few to common mottles in shades of yellow, brown, gray, or olive. Stains of very dark grayish brown or dark grayish brown range from few to many in the Bss1 horizon, and from none to few in the Bw horizon.

The Ck horizon is mottled in shades of brown, gray, yellow, or olive in most pedons.

Gasil Series

The Gasil series consists of very deep, well drained, moderately permeable soils on uplands. These soils formed from deeply weathered loamy sediments and sandstone (fig. 19). Slopes range from 1 to 5 percent. Soils of the Gasil series are fine-loamy, siliceous, thermic Ultic Paleustalfs.

Typical pedon of Gasil loamy fine sand, 1 to 5 percent slopes; from the intersection of Farm Road 3371 and Farm Road 937 about 10 miles southeast of Groesbeck, 2.4 miles northwest on Farm Road 937, and 600 feet west and south on field road, in rangeland:

A—0 to 16 inches; brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; hard, friable; many fine and medium roots; slightly acid; clear smooth boundary.

Bt1—16 to 36 inches; yellowish brown (10YR 5/8) sandy clay loam, brownish yellow (10YR 6/8) dry; few medium distinct reddish yellow (7.5YR 6/8) mottles; weak medium subangular blocky structure; very hard, firm; few fine and medium roots; few clay films on faces of peds; few very pale brown coatings of sand; strongly acid; gradual smooth boundary.

Bt2—36 to 46 inches; yellowish brown (10YR 5/8) sandy clay loam, brownish yellow (10YR 6/8) dry; few medium prominent red (2.5YR 5/8) mottles; weak medium subangular blocky structure; very hard, firm; few fine and medium roots; few patchy clay films on faces of peds; few thin very pale brown coatings of sand; strongly acid; gradual smooth boundary.

Bt3—46 to 60 inches; mottled light gray (10YR 7/2), brownish yellow (10YR 6/8), and red (2.5YR 4/8) sandy clay loam; weak medium subangular blocky structure; very hard, firm; few medium roots; few patchy clay films on faces of peds; about 2 percent ironstone fragments; few light gray coatings of sand; strongly acid; gradual smooth boundary.

BCt—60 to 80 inches; mottled white (10YR 8/2), brownish yellow (10YR 6/8), and red (2.5YR 4/8) sandy clay loam; weak fine subangular blocky structure; very hard, firm; few fine roots; few patchy clay films on faces of peds; about 2 percent ironstone fragments; about 2 percent gray shale fragments; strongly acid.

Solum thickness ranges from 60 to more than 80 inches. Some horizons have up to 2 percent by volume ironstone pebbles.

The A horizon has a hue of 10YR, value of 4 to 6, and chroma of 3 to 6. The E horizon, where present, is 1 or 2 units of value higher than the A horizon. The reaction ranges from slightly acid to slightly alkaline. The combined thickness of the A and E horizons ranges from 12 to 19 inches.

The Bt and BCt horizons have a hue of 7.5YR or 10YR, value of 5 to 8, and chroma of 4 to 8. Mottles in shades of red, yellow, and brown range from few to many. Some pedons have grayish mottles below 30 inches. Texture is sandy clay loam, or fine sandy loam. Base saturation ranges from 40 to 70 percent. Reaction is strongly acid to slightly acid.

Groesbeck Series

The Groesbeck series consists of moderately deep, moderately well drained, moderately permeable soils on uplands. These soils formed in loamy sediments over limestone. Slopes range from 0 to 5 percent. Soils of the Groesbeck series are fine-loamy, siliceous, thermic Udic Argiustolls.

Typical pedon of Groesbeck loamy fine sand, 0 to 2 percent slopes; from the intersection of Farm Road 1245 and Farm Road 1633 in Thelma about 7 miles northwest of Groesbeck, 1.0 mile northwest on Farm Road 1245, 1.8 miles north and 0.8 mile northeast on county road, and 1600 feet south, in native pasture:

A—0 to 15 inches; very dark grayish brown (10YR 3/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; slightly hard, very friable; common fine and medium roots; few fine pores; slightly acid; clear smooth boundary.

Bt—15 to 29 inches; light olive brown (2.5Y 5/4) sandy clay loam, yellowish brown (2.5Y 6/4) dry; few medium prominent brownish yellow (10YR 6/8) and strong brown (7.5YR 5/8) mottles; weak fine and medium subangular blocky structure; hard, firm; few fine and medium roots; few thin discontinuous clay films along root channels; few fine black concretions; about 2 percent fine siliceous pebbles; neutral; clear smooth boundary.

Bk—29 to 32 inches; light brownish yellow (2.5Y 6/4) sandy clay loam, light brownish gray (2.5Y 6/2) dry; common medium prominent brownish yellow (10YR 6/8) mottles; moderate medium subangular blocky structure; hard, firm; few fine and medium roots; few fine and medium black concretions; common fine and medium calcium carbonate concretions; few coarse limestone fragments; about 2 percent fine siliceous pebbles; strongly effervescent; slightly alkaline; abrupt wavy boundary.

2R—32 inches; hard limestone bedrock.

Thickness of the solum and depth to hard limestone range from 20 to 40 inches. Some pedons have up to 5 percent by volume siliceous pebbles in some horizons.

The A horizon has a hue of 10YR, value of 2 to 5, and chroma of 2 or 3. Reaction is slightly acid or neutral.

The Bt horizon has hue of 10YR to 5Y, value of 4 to 7, and chroma of 2 to 8. Mottles in shades of red, brown, gray, or yellow range from few to common. Grayish mottles are considered to be lithochromic. Texture is fine sandy loam or sandy clay loam. Reaction ranges from slightly acid to slightly alkaline. Some pedons have few calcium carbonate concretions.

The Bk horizon has hue of 10YR to 5Y, value of 5 to 7, and chroma of 2 to 6. Mottles in shades of brown or yellow range from few to common in some pedons. Texture is fine sandy loam, loam, or sandy clay loam. Reaction is slightly alkaline or moderately alkaline.

The 2R layer is hard limestone bedrock that is tightly fractured. Fossils range from none to common. Hardness is more than 3 on Mohs scale.

Heiden Series

The Heiden series consists of very deep, well drained, very slowly permeable soils on erosional uplands. These soils formed in weakly consolidated calcareous clays and marls. Slopes range from 1 to 5 percent. Soils of the Heiden series are fine, montmorillonitic, thermic Udic Haplusterts.

Typical pedon of Heiden clay, 1 to 3 percent slopes; from the intersection of U.S. Highway 84 and State Highway 14 in Mexia, 17.0 miles west on U.S. Highway 84 to intersection with Farm Road 73 and a county road near Prairie Hill, 2.2 miles southwest on county road, and 99 feet south, in cropland:

Ap—0 to 7 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; weak fine subangular blocky structure; very hard, very firm, very sticky and very plastic; few fine and medium roots; few fine calcium carbonate concretions; few fine fragments of snail shells; slightly effervescent; moderately alkaline; abrupt wavy boundary.

A—7 to 18 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; moderate fine subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium roots; few fine intersecting slickensides; few fine and medium calcium carbonate concretions; few fine brown concretions; about 2 percent fine fragments of snail shells; few very dark gray streaks on peds along cracks; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss1—18 to 38 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; moderate fine subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium roots; common fine intersecting slickensides; few fine and medium calcium carbonate concretions; few fine brown concretions; about 2 percent small snail shell fragments; few very dark gray streaks on peds along cracks; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss2—38 to 46 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and plastic; few fine roots; common medium intersecting slickensides; few fine brown concretions; few fine and medium calcium carbonate concretions; few masses of calcium carbonate; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss—46 to 56 inches; olive gray (5Y 4/2) clay, olive (5Y 5/3) dry; few fine prominent brownish yellow (10YR 6/6) mottles; weak coarse angular blocky structure; extremely hard, very firm, very sticky and plastic; few fine roots; common intersecting slickensides; few fine brown concretions; few fine and medium calcium carbonate concretions; common masses of calcium carbonate on faces of peds; few streaks of very dark grayish brown A horizon material; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bk—56 to 65 inches; olive (5Y 5/4) clay, pale olive (5Y 6/4) dry; few medium prominent strong brown (7.5YR 5/6) and brownish yellow (10YR 6/6) mottles; weak coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium calcium carbonate concretions; common masses of calcium carbonate; few dark gray streaks along cracks; strongly effervescent; moderately alkaline; gradual wavy boundary.

C—65 to 80 inches; pale olive (5Y 6/4) clay, pale yellow

(5Y 7/4) dry; few medium prominent dark grayish brown (10YR 4/2) mottles; massive; very hard, very firm, very sticky and very plastic; few fine and medium calcium carbonate concretions; few masses of calcium carbonate; few dark gray streaks along cracks; 5 percent gray shale fragments; strongly effervescent; moderately alkaline.

The combined thickness of the A and B horizons ranges from 51 to 65 inches.

The A horizon has a hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2.

The Bss horizon has a hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4. Most pedons have few to common mottles in shades of brown and yellow. Calcium carbonate concretions range from few to common in the lower part. Some pedons have few calcium carbonate concretions in the upper part.

The Bk and Bkss horizons have hue of 10YR to 5Y, value of 4 to 6, and chroma of 2 to 4. Some pedons have few to common mottles in shades of brown and yellow. Calcium carbonate concretions and soft masses range from common to many.

The C horizon has colors in shades of brown, yellow, and olive. Mottles in shades of brown and yellow range from few to common.

Houston Black Series

The Houston Black series consists of very deep, moderately well drained, very slowly permeable soils on uplands. These soils formed from weakly consolidated calcareous clays and marls (fig. 20). Slopes range from 1 to 3 percent. Soils of the Houston Black series are fine, montmorillonitic, thermic Udic Haplusterts.

Typical pedon of Houston Black clay, 1 to 3 percent slopes; from the intersection of U.S. Highway 84 and State Highway 14 in Mexia, 18.4 miles west on U.S. Highway 84, 4.1 miles southeast on Farm Road 339, 400 feet southwest on Farm Road 342, and 100 feet north, in cropland:

Ap—0 to 6 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; extremely hard, very firm, very sticky and very plastic; common fine roots; few fine calcium carbonate concretions; slightly effervescent; moderately alkaline; clear wavy boundary.

A—6 to 21 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few pressure faces; few intersecting slickensides in the lower part; few fine black concretions; few fine calcium carbonate concretions; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss1—21 to 45 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; common intersecting slickensides; few black concretions; few fine and medium calcium carbonate concretions; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bss2—45 to 56 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; few medium prominent yellowish brown (10YR 5/8) mottles; moderate coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few pressure faces; common intersecting slickensides; few dark gray streaks along cracks; few fine black concretions; common fine and medium calcium carbonate concretions; strongly effervescent; moderate alkaline; gradual wavy boundary.

Bk—56 to 80 inches; grayish brown (10YR 5/2) clay, light brownish gray (10YR 6/2) dry; common fine prominent brownish yellow (10YR 6/8) mottles; weak medium and coarse angular blocky structure; very hard, very firm, very sticky and very plastic; common dark gray streaks on faces of peds; few very dark gray streaks along cracks; few fine and medium black concretions; common fine calcium carbonate concretions and masses; 5 percent gray shale fragments; strongly effervescent; moderately alkaline.

Solum thickness is more than 80 inches. Depth to intersecting slickensides ranges from 16 to 24 inches.

The A horizon has a hue of 10YR, value of 2 to 4, and chroma of 1. Some pedons have as much as 10 percent by volume of siliceous pebbles and cobbles.

The Bss horizon has a hue of 10YR, value of 2 to 4, and chroma of 1; or color is neutral with value of 2 to 4. Some pedons have few yellowish brown mottles in the lower part.

The Bk horizon has a hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. Mottles in shades of gray, brown, yellow, or olive range from common to many. Calcium carbonate concretions and soft masses range from common to many.

Kaufman Series

The Kaufman series consists of very deep, moderately well drained, very slowly permeable soils on the flood plains of the Navasota River and its larger tributaries. These soils formed in alkaline clayey alluvium. Slopes are less than 1 percent. Soils of the Kaufman series are very-fine, montmorillonitic, thermic Typic Hapluderts.

Typical pedon of Kaufman clay, frequently flooded; from the intersection of State Highway 164 and State Highway 14 in Groesbeck, 1.4 miles north on State Highway 14, 1.5 miles northeast on county road, 1700 feet east in pasture to flood plain, 500 feet northeast along fence, 100 feet south along tree line, and 70 feet east, in field:

A1—0 to 6 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; extremely hard, very firm, very sticky and very plastic; common fine and medium roots; few pressure faces; few dark yellowish brown (10YR 4/4) root stains on faces of peds; few wormcasts; neutral; clear wavy boundary.

A2—6 to 17 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine and medium roots; few pressure faces; few intersecting slickensides; moderately alkaline; gradual wavy boundary.

Bss1—17 to 40 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; few fine faint very dark grayish brown mottles; moderate medium subangular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few pressure faces; common intersecting slickensides; moderately alkaline; gradual wavy boundary.

Bss2—40 to 63 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few fine roots; few pressure faces; common intersecting slickensides; few fine calcium carbonate concretions; moderately alkaline; gradual wavy boundary.

Bss3—63 to 80 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few pressure faces; common intersecting slickensides; few fine and medium calcium carbonate concretions; moderately alkaline.

The solum thickness ranges from 60 to about 90 inches. The soil is moderately acid to moderately alkaline throughout. Clay content of the control section exceeds 60 percent. Depth to intersecting slickensides ranges from 10 to 24 inches. Some pedons have few calcium carbonate and black concretions.

The A horizon has a hue of 10YR, value of 2, and chroma of 1 or less. Some pedons have few very dark grayish brown mottles in the lower part.

The Bss horizon has a hue of 10YR, value of 2 or 3, and chroma of 1; or color is neutral with value of 2 or 3. Some pedons have chroma of 2 in the lower part. Mottles in shades of brown are in the upper part.

Lamar Series

The Lamar series consists of very deep, well drained, moderately permeable soils on erosional uplands. These soils formed from calcareous loamy sediments. Slopes range from 5 to 15 percent. Soils of the Lamar series are fine-silty, mixed, thermic Udic Ustochrepts.

Typical pedon of Lamar clay loam, 5 to 15 percent slopes, eroded; from the intersection of U.S. Highway 84 and State Highway 14 in Mexia, 4 miles north on Highway 14, 0.5 mile east on county road, and 50 feet north, in pasture:

A—0 to 3 inches; olive brown (2.5Y 4/4) clay loam, light olive brown (2.5Y 5/4) dry; weak medium subangular blocky structure; hard, firm; many fine and medium roots; few fine and medium calcium carbonate concretions; neutral; clear smooth boundary.

Bw—3 to 18 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine prominent yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; hard, firm; common fine roots; few fine and medium calcium carbonate concretions and masses; neutral; clear smooth boundary.

Bk—18 to 27 inches; light olive brown (2.5Y 5/6) clay loam, olive yellow (2.5Y 6/6) dry; weak fine subangular blocky structure; hard, firm; few fine roots; few fine and medium calcium carbonate concretions; common masses of calcium carbonate on faces of peds; 5 percent grayish brown shale fragments in lower part; strongly effervescent; moderately alkaline; clear smooth boundary.

C1—27 to 42 inches; mottled grayish brown (10YR 5/2) and brownish yellow (10YR 6/8) clay loam; massive; hard, firm; few fine and medium calcium carbonate concretions in upper part; moderately alkaline; clear smooth boundary.

C2—42 to 80 inches; grayish brown (10YR 5/2) clay loam, light brownish gray (10YR 6/2) dry; few coarse prominent yellowish brown (10YR 5/8) mottles; massive; hard, firm; 5 percent gray shale fragments; moderately alkaline.

Solum thickness ranges from 25 to 48 inches. Reaction ranges from neutral to moderately alkaline. Calcium carbonate masses and concretions range from 0 to 15 percent by volume.

The A horizon has a hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4.

The Bw and Bk horizons have a hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 2 to 6. Some pedons have few to common mottles in shades of brown. Texture is clay loam or silty clay loam.

The C horizon has colors in shades of brown, yellow, and olive. Some pedons are mottled with these colors. Texture is loam, clay loam, or silty clay loam, or is stratified with these textures.

Lavender Series

The Lavender series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in a thin layer of sandy and loamy Tertiary-age sediments that were deposited over limestone. Slopes range from 1 to 5 percent. Soils of the Lavender Series are fine-loamy, siliceous, thermic Udic Haplustalfs.

Typical pedon of Lavender loamy fine sand in an area of Lavender-Rock outcrop complex, 1 to 5 percent slopes; from the intersection of Farm Road 1633 and Farm Road 2705 about 7.0 miles southwest of Mexia, 1.4 miles west on Farm Road 1633, 2.3 miles south on county road, and 32 feet east, in pasture:

A—0 to 7 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, very friable; few fine and medium roots; about 2 percent fine siliceous pebbles; slightly acid; clear smooth boundary.

Bt1—7 to 13 inches; yellowish red (5YR 5/6) loamy fine sand, reddish yellow (5YR 6/6) dry; moderate medium subangular blocky structure; hard, friable; few fine roots; few fine pores; few thin discontinuous clay films on faces of peds; few medium black concretions; about 2 percent fine and medium siliceous pebbles; neutral; clear smooth boundary.

Bt2—13 to 22 inches; strong brown (7.5YR 4/6) sandy clay loam; strong brown (7.5YR 5/6) dry; few medium distinct brown (7.5YR 5/4) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; very hard, firm; few fine roots; few fine pores; few thin discontinuous clay films on faces of peds; common fine black concretions; about 2 percent fine and medium siliceous pebbles; few dark brown (7.5YR 4/2) organic stains along root channels; slightly acid; gradual smooth boundary.

Bt3—22 to 31 inches; dark brown (7.5YR 4/4) sandy clay loam, brown (7.5YR 5/4) dry; few medium distinct strong brown (7.5YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; very hard, firm; few fine roots; few fine pores; few thin discontinuous clay films on faces of peds; common fine black concretions; about 2 percent fine and medium siliceous pebbles; few dark brown (7.5YR 4/2) organic stains along root channels; moderately acid; abrupt irregular boundary.

2R—31 inches; hard limestone bedrock.

Solum thickness and depth to bedrock range from 20 to 40 inches. The lower boundary of the solum rests abruptly on limestone or may grade into bedded limestone. The clay content of the control section ranges from 18 to 30 percent. The argillic horizon has a base saturation that ranges from 75 to 87 percent. Most pedons contain up to 5 percent by volume siliceous pebbles.

The A horizon has a hue of 10YR or 7.5YR, value of 4 to 7, and chroma of 2 to 4. The E horizon, where present, is 1 or 2 units of value higher than the A horizon. The combined thickness of the A and E horizons ranges from 7 to 17 inches. Texture of the E horizon is loamy fine sand or fine sandy loam. Reaction ranges from moderately acid to neutral.

The Bt horizon has a hue of 2.5YR to 7.5YR, value of 4 to 7, and chroma of 4 to 8. Most pedons have few to common mottles of these colors. Texture is loamy fine sand, fine sandy loam, or sandy clay loam. Reaction ranges from moderately acid through slightly alkaline.

The 2R layer is white, hard limestone bedrock that is tightly fractured. Fossils range from none to common. Hardness is more than 3 on Mohs scale.

Leson Series

The Leson series consists of very deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in alkaline shales and clays. Slopes range from 1 to 3 percent. Soils of the Leson series are fine, montmorillonitic, thermic Udic Haplusterts.

Typical pedon of Leson clay, 1 to 3 percent slopes; from the intersection of Farm Road 73 and State Highway 171 in Coolidge, about 3.4 miles southwest on Farm Road 73, 0.2 mile northwest on Farm Road 936, and 100 feet east, in cropland:

Ap—0 to 6 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate fine angular blocky structure; extremely hard, firm, very sticky and very plastic; few fine roots; few pressure faces; about 2 percent fine and medium siliceous pebbles; neutral; clear wavy boundary.

Bss—6 to 33 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate medium angular blocky structure; extremely hard, very firm, very sticky and very plastic; few medium roots; common intersecting slickensides below 16 inches; few medium siliceous pebbles; about 2 percent cobbles; moderately alkaline; gradual wavy boundary.

Bkss1—33 to 47 inches; very dark grayish brown (10YR

3/2) clay, dark grayish brown (10YR 4/2) dry; moderate coarse angular blocky structure; extremely hard, very firm, very sticky and very plastic; few medium roots; common intersecting slickensides; common pressure faces; common fine and medium calcium carbonate concretions and few masses; few medium pebbles; about 2 percent cobbles; few fine black streaks along cracks; strongly effervescent; moderately alkaline; gradual wavy boundary.

Bkss2—47 to 57 inches; dark grayish brown (10YR 4/2) clay, grayish brown (10YR 5/2) dry; moderate fine angular blocky structure; extremely hard, very firm, very sticky and very plastic; few medium roots; common intersecting slickensides; few pressure faces; common fine and medium calcium carbonate concretions; few masses of calcium carbonate; common fine black streaks along cracks; strongly effervescent; moderately alkaline; gradual wavy boundary.

Ck1—57 to 63 inches; grayish brown (10YR 5/2) clay, light brownish gray (10YR 6/2) dry; massive; extremely hard, very firm, very sticky and very plastic; common fine and medium calcium carbonate concretions and masses; 3 percent shale fragments; strongly effervescent; moderately alkaline; gradual wavy boundary.

Ck2—63 to 80 inches; mottled light olive brown (2.5Y 5/4) and yellowish brown (10YR 5/6) weakly consolidated shale that has clay texture; common medium prominent grayish brown (10YR 5/2) mottles; massive; extremely hard, very firm, very sticky and very plastic; few medium roots; many masses of calcium carbonate; few fine black concretions; 5 percent grayish brown (10YR 5/2) shale fragments; strongly effervescent; moderately alkaline.

Solum thickness ranges from 55 to more than 65 inches. Pebbles range from 1 to 5 percent by volume throughout the solum.

The Ap or A horizon has a hue of 10YR, value of 2 to 4, and chroma of 1. Reaction ranges from slightly acid to moderately alkaline.

The Bss and Bkss horizons have a hue of 10YR, value of 2 to 6, and chroma of 1 or 2. Mottles in shades of gray, brown, or yellow range from none to common. Streaks of black and very dark gray material in filled cracks range from few to common. Most pedons have few to common gypsum crystals, calcium carbonate concretions and masses, and black concretions. Reaction is slightly acid to moderately alkaline in the Bss horizon and neutral to moderately alkaline in the Bkss horizon.

The C or Ck horizons have colors in shades of brown or gray. Mottles in shades of brown, yellow, or gray are few to many or the soil is mottled in these colors. Most pedons have up to 5 percent by volume calcium carbonate concretions and shale fragments. Reaction is slightly alkaline or moderately alkaline.

Lufkin Series

The Lufkin series consists of very deep, moderately well drained, very slowly permeable soils on high stream terraces or remnants of terraces in upland positions. These soils formed in slightly acid to alkaline clayey sediments. Slopes range from 0 to 1 percent. Soils of the Lufkin series are fine, montmorillonitic, thermic Oxyaquic Vertic Paleustalfs.

Typical pedon of Lufkin fine sandy loam in an area of Lufkin-Rader complex, 0 to 1 percent slopes; from the intersection of Texas Highway 164 and Farm Road 1953 about 7 miles southeast of Groesbeck, 0.8 mile west on Texas Highway 164, and about 100 feet south, in rangeland:

A—0 to 7 inches; grayish brown (10YR 5/2) fine sandy loam, light brownish gray (10YR 7/2) dry; weak fine subangular blocky structure; hard, friable; many fine and medium roots; few fine pores; common brown organic stains on faces of peds; about 2 percent siliceous pebbles; moderately acid; abrupt wavy boundary.

Btg1—7 to 29 inches; dark gray (10YR 4/1) clay loam, gray (10YR 5/1) dry; few fine faint dark grayish brown mottles; moderate medium subangular blocky structure; very hard, firm; few fine and medium roots; thin discontinuous clay films on faces of peds; few pressure faces; few fine black concretions; about 2 percent pebbles; clean sand grains on peds along cracks; very strongly acid; gradual smooth boundary.

Btg2—29 to 41 inches; dark gray (10YR 4/1) clay loam, gray (10YR 5/1) dry; common fine faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; thin patchy clay films on faces of peds; few pressure faces; few pockets of sandy material in cracks; moderately acid; gradual smooth boundary.

Btg3—41 to 60 inches; grayish brown (10YR 5/2) clay loam, light brownish gray (10YR 6/2) dry; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; thin patchy clay films on faces of peds; few fine black concretions; few fine and medium calcium carbonate concretions; few cracks with darker loamy material; neutral; gradual smooth boundary.

BC—60 to 80 inches; light brownish gray (10YR 6/2) clay loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; very hard, firm; few fine roots; few fine black concretions; few fine calcium carbonate concretions; few cracks with darker loamy material; neutral.

Solum thickness ranges from 60 to more than 80 inches.

Some pedons contain 1 to 3 percent by volume pebbles in the upper part.

The A horizon has a hue of 10YR, value of 3 to 5, and chroma of 1 to 3. The E horizon, where present, is one unit of value higher than the A horizon in most pedons. The combined thickness of the A and E horizons ranges from 6 to 11 inches, and averages less than 10 inches in more than 50 percent of the pedons. Reaction ranges from strongly acid to slightly acid.

The Btg horizon has a hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 1 or 2. Most pedons have few to common mottles in shades of brown. Texture is clay loam or clay. Reaction ranges from very strongly acid to slightly acid in the upper part and moderately acid to slightly alkaline in the lower part. Some pedons have few calcium carbonate or black concretions.

The BC horizon is present in most pedons below 40 inches. It has a hue of 10YR, value of 5 to 7, and chroma of 1 or 2. Mottles in shades of brown or yellow range from common to many. Texture is clay loam or sandy clay loam. Some pedons have few black concretions. Reaction ranges from slightly acid to moderately alkaline.

Mabank Series

The Mabank series consists of very deep, moderately well drained, very slowly permeable soils on stream terraces and remnants of terraces in upland positions. These soils formed in alkaline clays. Slopes range from 0 to 2 percent. Soils of the Mabank series are fine, montmorillonitic, thermic Oxyaquic Vertic Paleustalfs.

Typical pedon of Mabank fine sandy loam, 0 to 2 percent slopes; from the intersection of Farm Roads 73 and 1951 in Coolidge, 3.6 miles southwest on Farm Road 73, 6.2 miles northwest on Farm Road 936, 3 miles southwest on county road, 0.5 mile south on county road, and 100 feet east, in pasture:

A—0 to 6 inches; dark grayish brown (10YR 4/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very hard, friable; common fine roots; common worm casts; few cracks on surface; moderately acid; abrupt wavy boundary.

Btg1—6 to 25 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; very hard, firm; common fine roots; few thin discontinuous clay films on faces of peds; few fine pressure faces; slightly alkaline; gradual wavy boundary.

Btg2—25 to 37 inches; dark gray (10YR 4/1) clay, gray (10YR 5/1) dry; moderate medium subangular blocky structure; hard, firm; common fine roots; few thin patchy clay films on faces of peds; few dark brown organic stains on faces of peds; few streaks of very dark gray material along cracks; moderately alkaline; clear wavy boundary.

Btg3—37 to 51 inches; gray (10YR 5/1) clay loam, light gray (10YR 6/1) dry; weak fine subangular blocky structure; hard, firm; few fine roots; few thin patchy clay films on faces of peds; few pressure faces; few fine and medium calcium carbonate concretions; moderately alkaline; clear wavy boundary.

Btg4—51 to 60 inches; gray (10YR 5/1) clay loam, light gray (10YR 6/1) dry; few fine prominent light olive brown (2.5Y 5/6) and few fine faint light gray mottles; weak fine subangular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few pressure faces; few fine and medium calcium carbonate concretions; few fine black concretions; moderately alkaline; clear wavy boundary.

Btg5—60 to 80 inches; grayish brown (10YR 5/2) clay loam, light brownish gray (10YR 6/2) dry; common medium prominent light olive brown (2.5Y 5/6) and common medium faint light brownish gray (10YR 6/2) mottles; weak fine subangular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few fine pressure faces; few fine and medium calcium carbonate concretions; few fine black concretions; moderately alkaline.

Solum thickness ranges from 60 to more than 80 inches. Up to 2 percent by volume siliceous pebbles are present throughout the solum of some pedons. When the soil is dry, cracks at least 0.4 inch wide extend from the top of the Btg horizon to a depth of 24 inches or more.

The A horizon has a hue of 10YR, value of 3 to 6, and chroma of 1 or 2. It is hard or very hard and massive when dry but has weak structure when moist. Reaction is moderately acid to neutral.

The Btg1 horizon has a hue of 10YR, value of 2 to 4, and chroma of 1. Reaction ranges from moderately acid to moderately alkaline. Black concretions range from none to few.

The lower Btg horizons have a hue of 10YR, value of 4 to 6, and chroma of 1 or 2. Some pedons have few to common mottles in shades of brown, yellow or gray. Reaction ranges from moderately acid to moderately alkaline. Some pedons have few calcium carbonate and black concretions.

The BC horizon, where present, has a hue of 10YR or 2.5Y, value of 5 to 7, and chroma of 2. Some pedons have few to common mottles in shades of gray, yellow, and brown. Reaction ranges from moderately acid to moderately alkaline. Some pedons have few calcium carbonate and black concretions.

Figure 18.—Profile of a Crockett loam. This very slowly permeable soil has scattered, white calcium carbonate concretions in the lower part of the clay subsoil.

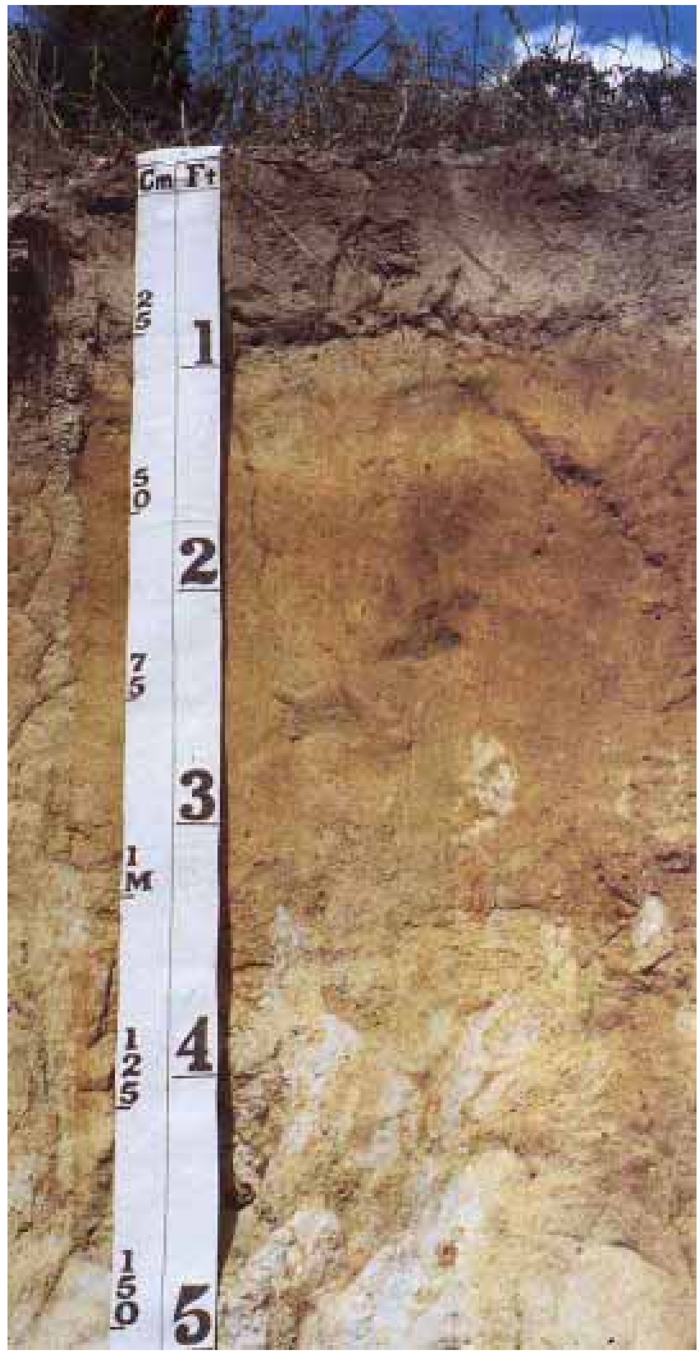

Figure 19.—Profile of a Gasil loamy fine sand. The subsoil is yellowish brown sandy clay loam.

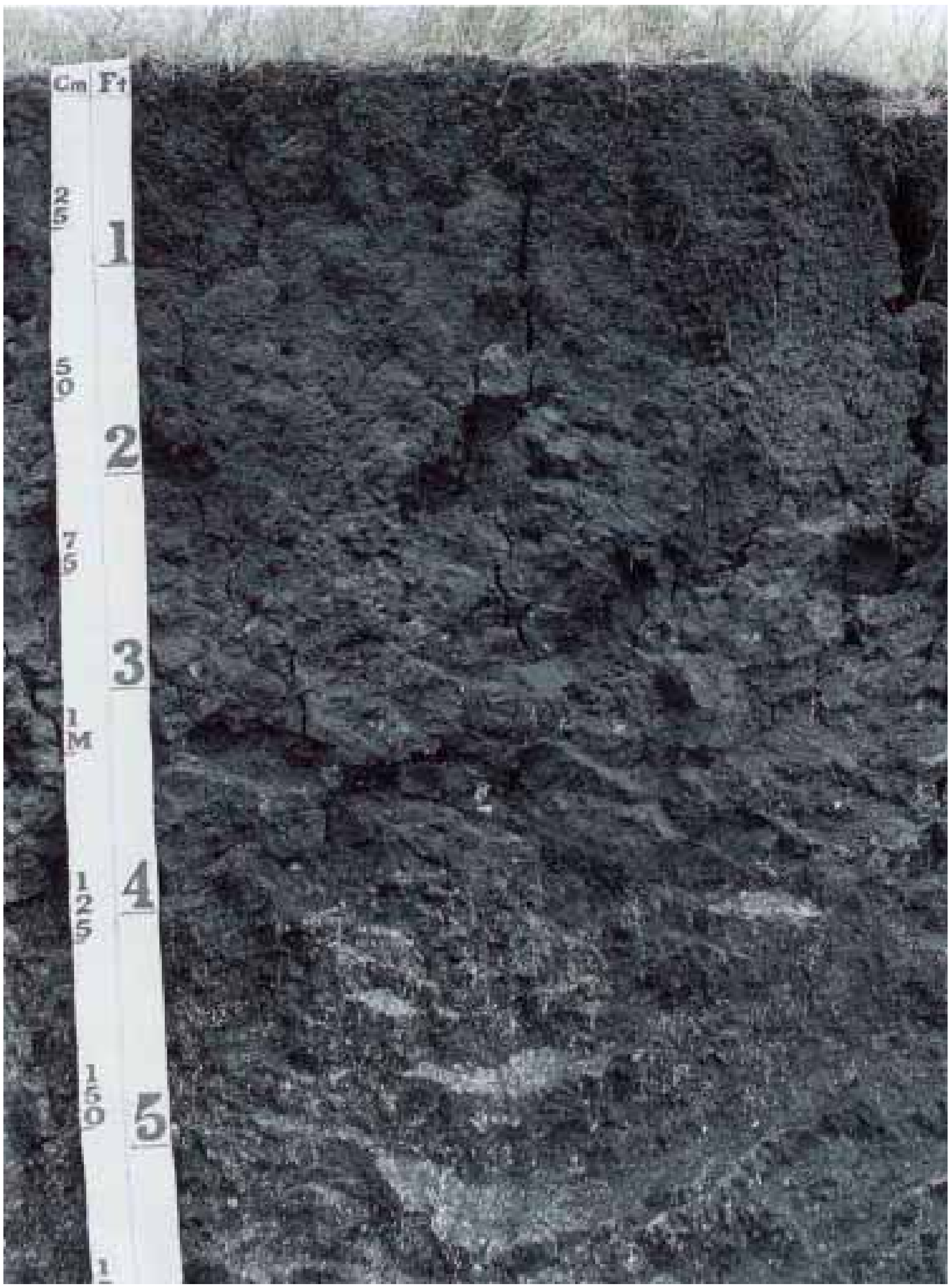

Figure 20.—Profile of Houston Black clay. The smooth shiny surface of slickensides, most evident in the lower part, illustrates the effects of shrink-swell properties.

Figure 21.—Profile of a Personville loamy fine sand. This well drained soil has a loamy subsoil that rests abruptly on limestone bedrock.

Figure 22.—Profile of a Silstid loamy fine sand. The light color of the subsurface layer is the result of leaching of clay, organic matter, and nutrients.

Figure 23.—Profile of a Tinn clay. This very deep clay soil formed from alluvial parent materials eroded from the Blackland Prairie.

Nahatche Series

The Nahatche series consists of very deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in loamy alluvium. Slopes are less than 1 percent. 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 164 and Farm Road 39 in Personville about 11 miles east of Groesbeck, 6.6 miles northwest on Farm Road 39 to Fallon Community, 2.7 miles north and east on county road, and 200 feet east, in pasture:

A—0 to 15 inches; dark grayish brown (10YR 4/2) loam, grayish brown (10YR 5/2) dry; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; hard, friable; common fine and medium roots; few fine black concretions; few wormcasts; many dark brown stains along root channels; slightly alkaline; clear smooth boundary.

Cg1—15 to 45 inches; grayish brown (10YR 5/2) loam, light brownish gray (10YR 6/2) dry; common fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; hard, friable; few fine roots; common seams and strata of brown sandy loam material; few dark brown organic stains; neutral; clear smooth boundary.

Cg2—45 to 60 inches; light brownish gray (10YR 6/2) loam, light gray (10YR 7/2) dry; few fine prominent yellowish brown (10YR 5/4) mottles; weak medium subangular blocky structure; hard, friable; few seams and strata of brown sandy loam material; slightly alkaline; clear smooth boundary.

Cg3—60 to 80 inches; light brownish gray (10YR 6/2) silt loam, light gray (10YR 7/2) dry; weak medium subangular blocky structure; hard, friable; few seams and strata of brown sandy loam material; slightly alkaline.

Clay content of the 10- to 40-inch control section ranges from 18 to 30 percent. Reaction ranges from strongly acid to slightly alkaline. Thin strata of a more sandy material are common in most pedons.

The A horizon has hue of 7.5YR to 10YR, value of 4 to 5, and chroma of 2 or 3. Mottles in shades of brown or gray range from few to many.

The Cg horizon has a hue of 7.5YR or 10YR, value 4 to 6, and chroma of 2 or 3. Mottles in shades of gray, yellow, and brown range from few to many, or the matrix is mottled in these colors. The Cg horizon has strata with textures of loam, sandy clay loam, silt loam, silty clay loam, and clay loam. Some pedons have few iron manganese concretions.

Normangee Series

The Normangee series consists of very deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in alkaline clays and shales. Slopes range from 1 to 8 percent. Soils of the Normangee series are fine, montmorillonitic, thermic Udertic Haplustalfs.

Typical pedon of Normangee clay loam, 1 to 3 percent slopes; from the intersection of Texas Highway 84 and Farm Road 2838 about 3.5 miles west of Mexia, 0.1 mile northwest on Farm Road 2838, 1.1 miles north on county road, and 50 feet southeast, in cropland:

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; hard, firm; common fine and medium roots; neutral; clear wavy boundary.

Bt1—6 to 16 inches; dark brown (10YR 4/3) clay, brown (10YR 5/3) dry; few fine distinct strong brown (7.5YR 4/6) and few fine prominent yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine and medium roots; few thin discontinuous clay films on faces of peds; few dark streaks on peds along cracks; neutral; gradual smooth boundary.

Bt2—16 to 30 inches; olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry; few fine prominent strong brown (7.5YR 5/6) and few fine faint light olive brown mottles; moderate medium subangular blocky structure; very hard, very firm; few fine and medium roots; few thin discontinuous clay films on faces of peds; few fine black concretions; few dark streaks on peds along cracks; neutral; gradual smooth boundary.

Bt3—30 to 38 inches; olive brown (2.5Y 4/4) clay, light olive brown (2.5Y 5/4) dry; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few thin discontinuous clay films on faces of peds; few fine and medium calcium carbonate concretions; few fine black concretions; few dark streaks on peds along cracks; few pebbles; moderately alkaline; gradual smooth boundary.

BC—38 to 51 inches; light olive brown (2.5Y 5/4) clay loam, light yellowish brown (2.5Y 6/4) dry; few fine and medium prominent brownish yellow (10YR 6/8) mottles; moderate fine and medium subangular blocky structure; very hard, very firm; few fine roots; few fine calcium carbonate concretions and masses; few streaks of neutral salts; few dark streaks on peds along cracks; about 2 percent grayish brown shale fragments; moderately alkaline; gradual smooth boundary.

C—51 to 80 inches; light yellowish brown (2.5Y 6/4) clay loam, pale yellow (2.5Y 7/4) dry; few medium and coarse distinct brownish yellow (10YR 6/8) and few fine distinct olive yellow (2.5Y 6/8) mottles; massive; very hard, very firm; 5 percent gray shale fragments; few fine calcium carbonate concretions; slightly alkaline.

The solum thickness ranges from 40 to 60 inches. The soil has cracks 0.5 inch wide to a depth of more than 25 inches when dry. Depth to secondary carbonates is greater than 30 inches.

The A horizon has a hue of 10YR, value of 4 to 6, and chroma of 2 to 4. The texture is clay loam or gravelly clay loam. Reaction is moderately acid to neutral.

The upper part of the Bt horizon has hue of 5YR to 10YR, value of 4 to 5,and chroma of 3 to 4. Mottles in shades of red and brown range from few to common. Some pedons have few iron manganese concretions and few calcium carbonate concretions. The texture is clay or clay loam. Reaction is moderately acid to moderately alkaline.

The lower part of the Bt horizon and the BC horizon have a hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 2 to 6. They have various amounts and sizes of mottles in shades of yellow, red, or brown. The texture is clay or clay loam. Some pedons have few calcium carbonate concretions. Reaction ranges from slightly acid to moderately alkaline.

The C horizon has colors in shades of gray, brown, and yellow. Texture is clay or clay loam. The reaction ranges from slightly acid to moderately alkaline. Some pedons have few calcium carbonate concretions.

Oglesby Series

The Oglesby series consists of shallow, well drained, slowly permeable soils on uplands. These soils formed in interbedded limestone and marl over limestone bedrock. Slopes are 1 to 3 percent. Soils of the Oglesby series are clayey, montmorillonitic, thermic, Lithic Haplustolls.

Typical pedon of Oglesby clay, 1 to 3 percent slopes; from the intersection of Farm Road 1633 and Farm Road 1245 about 5.3 miles northwest of Groesbeck, 2.4 miles south on Farm Road 1245, 1000 feet southwest on field road, and 2000 feet south, in pasture:

A1—0 to 9 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; common fine roots; about 2 percent small limestone fragments, slightly alkaline; clear smooth boundary.

A2—9 to 18 inches; very dark grayish brown (10YR 3/2) clay, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; hard, firm, sticky and plastic; few fine roots; few pressure faces; about 2 percent limestone fragments; about 2 percent pebbles; slightly alkaline; clear wavy boundary.

R—18 inches; white, hard limestone bedrock.

The solum thickness and depth to bedrock range from 11 to 18 inches. Fragments of limestone can make up as much as 10 percent of the mass, by volume. Colors have a hue of 10YR, value of 2 to 4, and chroma of 1 or 2. The reaction is neutral or slightly alkaline.

Oletha series

The Oletha series consists of very deep, moderately well drained, very slowly permeable soils on flood plains. The soils formed in clayey and loamy sediments. Slopes range from 0 to 1 percent. Soils of the Oletha series are fine-loamy, siliceous, nonacid, thermic Aquic Ustochrepts.

Typical pedon of Oletha silty clay, frequently flooded; from the intersection of Farm Road 1246 and Farm Road 937 in Oletha which is about 12 miles south of Groesbeck, 0.9 mile south on Farm Road 937, 4.6 miles west-southwest on county road, 0.5 mile northwest on field road, and 271 feet northeast, in rangeland:

A—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; common fine and medium roots; common fine pores; moderately acid; clear smooth boundary.

Bw1—6 to 10 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; few medium distinct dark yellowish brown (10YR 4/4) and brown (7.5YR 4/4) mottles; moderate medium angular blocky structure; very hard, very firm; common fine and medium roots; few fine pores; few clean sand grains on ped faces; very strongly acid; abrupt smooth boundary.

Bw2—10 to 16 inches; dark grayish brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) dry; common fine prominent brown (7.5YR 4/4) mottles; weak coarse angular blocky structure; extremely hard, very firm; few fine roots; many fine and very fine pores; few fine and medium iron-manganese concretions; few clean sand grains on ped faces; strongly acid; abrupt smooth boundary.

Ab—16 to 25 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; few fine faint dark grayish brown and dark yellowish brown mottles; moderate coarse prismatic structure parting to moderate coarse angular blocky; very hard, very firm; few fine roots; few fine pores; few fine iron-manganese concretions; very dark gray (10YR 3/1) organic stains on ped faces; few krotovina streaks; neutral; gradual smooth boundary.

Byb—25 to 33 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; many fine and medium prominent light yellowish brown (10YR 6/4) and few fine prominent yellowish red (5YR 5/6) mottles; moderate coarse prismatic structure parting to moderate medium angular blocky; very hard, firm; few fine roots; few fine and medium pores; thin continuous clay films; few fine iron-manganese concretions; few very dark gray (10YR 3/1) organic coatings on the exterior of peds; common threads of gypsum on faces of peds; neutral; gradual smooth boundary.

Bgb—33 to 44 inches; grayish brown (10YR 5/2) loam, light brownish gray (10YR 6/2) dry; many fine and medium prominent brownish yellow (10YR 6/8) and common fine prominent reddish yellow (7.5YR 6/6) mottles; weak medium prismatic structure parting to weak medium angular blocky; hard, firm; few fine roots; common fine pores; few fine and medium calcium carbonate masses and concretions; few fine and medium iron-manganese concretions; few coarse patchy brown (10YR 5/3) clay films; slightly alkaline; gradual smooth boundary.

BCgb—44 to 59 inches; grayish brown (10YR 5/2) fine sandy loam, light brownish gray (10YR 6/2) dry; common fine and medium prominent strong brown (7.5YR 4/6) mottles; weak coarse angular blocky structure; friable; few fine roots; common fine pores; few fine iron-manganese concretions; few thin continuous brown (10YR 5/3) clay films on faces of peds; neutral; gradual smooth boundary.

BCb1—59 to 72 inches; mottled brownish yellow (10YR 6/8) and light brownish gray (10YR 6/2) sandy clay loam; few fine prominent red (2.5YR 4/8) mottles; weak coarse angular blocky structure; friable; few fine roots; common fine pores; neutral; gradual smooth boundary.

BCb2—72 to 80 inches; mottled brownish yellow (10YR 6/8) and light brownish gray (10YR 6/2) fine sandy loam; few fine prominent red (2.5YR 4/8) mottles; weak coarse angular blocky structure; friable; very few fine roots; few fine pores; neutral.

Solum thickness ranges from 60 to more than 80 inches. Clay content of the control section ranges from 24 to 35 percent. Most pedons have thin, discontinuous loamy or sandy strata throughout. Few dark gray and brown organic stains are in most pedons. Calcium carbonate and iron-manganese concretions range from none to few.

The A horizon has a hue of 10YR, value of 3 or 4, and chroma of 1 or 2. Few mottles in shades of brown or yellow are in some pedons. Reaction ranges from strongly acid to neutral.

The Bw horizon, where present, has a hue of 10YR, value of 4 or 6, and chroma of 1 or 2. Mottles range from few to many in shades of yellow or brown. Texture is silt loam, loam, or clay loam. Reaction ranges from very strongly acid to strongly acid.

The Ab horizon, where present, has a hue of 10YR, value of 3 or 4, and chroma of 1 or 2. Few mottles in shades of brown are in some pedons. Texture is clay loam or sandy clay loam. Reaction ranges from neutral to moderately alkaline.

The Byb and Bgb horizons, where present, have a hue of 10YR, value of 4 to 6, and chroma of 1 or 2. Mottles in shades of brown and gray range from none to few. Texture is clay loam, sandy clay loam, or loam. Reaction ranges from neutral to moderately alkaline.

The BC horizon has a hue of 10YR, value of 4 to 6, and chroma of 1 or 2. Few mottles in shades of brown and gray are in some pedons. Texture is fine sandy loam or sandy clay loam. Reaction ranges from slightly acid to slightly alkaline.

Padina Series

The Padina series consists of very deep, well drained soils that are rapidly permeable in the surface layer and moderately permeable in the subsoil. These soils formed in thick sandy materials and are on uplands and high stream terraces. Slopes range from 1 to 12 percent. Soils of the Padina series are loamy, siliceous, thermic Grossarenic Paleustalfs.

Typical pedon of Padina loamy fine sand, 1 to 5 percent slopes; from the intersection of Farm Road 937 and Farm Road 1246 in Oletha about 12 miles south of Groesbeck, 1.5 miles west on Farm Road 1246, 3.2 miles northwest on county road, and 60 feet southwest of road, in wooded area:

A—0 to 4 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak fine granular structure; soft, friable; many fine and medium roots; common fine pores; moderately acid; clear smooth boundary.

E—4 to 47 inches; pale brown (10YR 6/3) loamy fine sand, very pale brown (10YR 7/3) dry; single grain; loose; few fine and medium roots; moderately acid; clear wavy boundary.

Bt1—47 to 54 inches; yellowish brown (10YR 5/6) fine sandy loam, brownish yellow (10YR 6/6) dry; common medium prominent yellowish red (5YR 5/6) mottles;

weak medium subangular blocky structure; hard, friable; few fine roots; thin discontinuous clay films on faces of peds; few streaks of pale brown sand; strongly acid; clear smooth boundary.

Bt2—54 to 63 inches; brownish yellow (10YR 6/6) sandy clay loam, yellow (10YR 7/6) dry; many medium prominent dark red (2.5YR 3/6) and common coarse prominent light gray (10YR 7/2) mottles; weak coarse subangular blocky structure; hard, friable; few fine roots; thin patchy clay films on faces of peds; about 2 percent brown pebbles and about 2 percent fine ironstone fragments; few streaks of light gray sand; strongly acid; clear smooth boundary.

Bt3—63 to 80 inches; light gray (10YR 7/2) sandy clay loam, white (10YR 8/2) dry; many medium prominent dark red (2.5YR 3/6) and common coarse distinct brownish yellow (10YR 6/6) mottles; weak coarse angular blocky structure; hard, firm; few fine and coarse roots; thin patchy clay films on faces of peds; few ironstone fragments; common streaks of white sand; very strongly acid.

Solum thickness ranges from 65 to more than 80 inches.

The A horizon has a hue of 10YR, value of 4 to 6, and chroma of 2 to 4. The E horizon is one or two units of value higher than the A horizon. Reaction ranges from moderately acid to neutral. The combined thickness of the A and E horizons ranges from 40 to 72 inches.

The Bt1 horizon has hue of 5YR to 10YR, value of 4 to 7, and chroma of 2 to 8. Few mottles in shades of red, gray, or brown are in some pedons.

The lower part of the Bt horizon has the same range in colors as the upper part. In some pedons the matrix is mottled in these colors. Texture is sandy clay loam or fine sandy loam with 18 to 35 percent clay. Reaction ranges from strongly acid to slightly acid.

Personville Series

The Personville series consists of deep, moderately well drained, moderately permeable soils on uplands or old stream terraces (fig. 21). These soils formed in loamy sediments underlain by limestone. Slopes range from 1 to 5 percent. Soils of the Personville series are fine-loamy, siliceous, thermic Udic Haplustalfs.

Typical pedon of the Personville loamy fine sand, 1 to 5 percent slopes; from the intersection of Farm Road 1245 and Farm Road 1633 in the Thelma Community about 7.0 miles northwest of Groesbeck, 1.0 mile northwest on Farm Road 1245, 1.8 miles north and 0.8 mile northeast on county road, 150 feet south on field road, and 50 feet west, in cropland:

Ap—0 to 6 inches; dark yellowish brown (10YR 3/4) loamy fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; few fine siliceous pebbles; about 2 percent fine ironstone pebbles; neutral; clear smooth boundary.

A—6 to 18 inches; dark yellowish brown (10YR 3/4) loamy fine sand, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, very friable; few fine and medium roots; about 2 percent fine siliceous pebbles and about 2 percent fine ironstone pebbles; neutral; clear smooth boundary.

Bt1—18 to 28 inches; dark brown (10YR 4/3) sandy clay loam, dark yellowish brown (10YR 4/4) dry; common fine prominent yellowish red (5YR 5/8) mottles; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm; few fine and medium roots; common fine pores; common thin patchy clay films on faces of peds; about 2 percent fine siliceous pebbles; slightly acid; clear smooth boundary.

Bt2—28 to 37 inches; yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; common fine prominent strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm; few fine and medium roots; many fine pores; common thin patchy yellowish brown (10YR 5/4) clay films on faces of peds; few medium black concretions; about 2 percent fine siliceous pebbles; slightly acid; gradual smooth boundary.

Bt3—37 to 47 inches; brownish yellow (10YR 6/8) fine sandy loam, yellow (10YR 7/8) dry; many medium distinct strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm; few fine and medium roots; common fine pores; few thin patchy yellowish brown (10YR 5/4) clay films on faces of peds; few medium black concretions; about 2 percent fine siliceous pebbles; neutral; abrupt smooth boundary.

2R—47 inches; hard limestone bedrock.

The solum thickness and depth to bedrock range from 40 to 60 inches. The lower boundary of the solum may rest abruptly on limestone bedrock or grade into bedded limestone. The clay content ranges from 18 to 35 percent. Some pedons have up to 5 percent by volume siliceous and ironstone pebbles in some horizon.

The A horizon has a hue of 10YR, value of 3 to 7, and chroma of 2 to 4. Reaction is slightly acid or neutral. The E horizon, where present, is one or two units of value higher than the A horizon.

The Bt horizon has a hue of 10YR, value of 4 to 7, and chroma of 3 to 8. Few to many mottles in shades of red, yellow, or brown are in some pedons. Texture is fine sandy loam or sandy clay loam. Up to 5 percent by volume fragments of limestone are immediately above the bedrock. Reaction ranges from strongly acid to neutral.

The 2R horizon is white, hard limestone bedrock that is tightly fractured. Fossils range from few to common. Hardness is more than 3 on Mohs scale.

Rader Series

The Rader series consists of very deep, moderately well drained, very slowly permeable soils on stream terraces. These soils formed in acid, loamy and clayey, ancient alluvium. Slopes range from 0 to 2 percent. Soils of the Rader series are fine-loamy, mixed, thermic Aquic Paleustalfs.

Typical pedon of Rader fine sandy loam, 0 to 2 percent slopes; from the intersection of U.S. Highway 84 and Farm Road 73 in Prairie Hill which is 18.8 miles west of Mexia, 4.5 miles east on Farm Road 73, 2.0 miles north on Farm Road 341, 0.1 mile east on county road, 1.6 miles north on county road, and 50 feet east, in pasture:

A—0 to 12 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable; common fine roots; about 2 percent siliceous pebbles; slightly acid; clear smooth boundary.

E—12 to 19 inches; brown (10YR 5/3) fine sandy loam, pale brown (10YR 6/3) dry; weak fine subangular blocky structure; slightly hard, friable; few fine and medium roots; slightly acid; clear wavy boundary.

Bt/E—19 to 25 inches; strong brown (7.5YR 5/8) sandy clay loam, reddish yellow (7.5YR 6/8) dry; the majority of peds are coated with light brownish gray (10YR 6/2) and light gray (10YR 7/2) fine sandy loam which comprises 20 percent of the layer; few fine distinct yellowish red (5YR 5/8) and few fine prominent red (2.5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few thin patchy clay films on faces of peds; few fine black concretions; strongly acid; gradual wavy boundary.

Bt1—25 to 41 inches; light brownish gray (10YR 6/2) clay loam, light gray (10YR 7/2) dry; few fine faint grayish brown and few fine prominent yellowish red (5YR 5/8) and red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few fine black concretions; about 2 percent pebbles; very strongly acid; gradual smooth boundary.

Bt2—41 to 63 inches; light brownish gray (10YR 6/2) clay loam, light gray (10YR 7/2) dry; few fine prominent strong brown (7.5YR 5/8) and yellowish red (5YR 5/8), and common fine and medium prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few fine black concretions; very strongly acid; gradual smooth boundary.

Bt3—63 to 80 inches; light gray (10YR 7/2) sandy clay loam, light gray (10YR 7/2) dry; few medium prominent reddish yellow (7.5YR 6/8) and common medium and coarse prominent yellowish red (5YR 5/8) mottles; weak medium subangular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few fine black concretions; few streaks of neutral salts; slightly alkaline.

Solum thickness is 60 to more than 80 inches.

The A horizon has a hue of 10YR, value of 4 to 6, and chroma of 2 to 4. The E horizon is one or two units of value higher than the A horizon. Reaction ranges from very strongly acid to slightly acid. Combined thickness of the A and E horizons ranges from 13 to 19 inches.

The Bt component of the Bt/E horizon has a hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 4 to 8. Few to common mottles in shades of red and gray are in some pedons. Texture is sandy clay loam or clay loam. The E component, in the form of coatings and pockets, makes up 15 to 30 percent by volume. Texture and colors are the same as those of the E horizon. Reaction is very strongly acid or strongly acid.

The Bt horizon has a hue of 7.5 YR or 10YR, value of 5 to 7, and chroma of 2 to 4. Mottles in shades of red, brown, yellow, and gray range from few to many or the matrix is mottled in these colors. Texture is sandy clay loam, clay loam, sandy clay, or clay. Reaction is very strongly acid or strongly acid in the upper part, and strongly acid to moderately alkaline in the lower part.

Robco Series

The Robco series consists of very deep, moderately well drained soils that are rapidly permeable in the surface layer and slowly permeable in the subsoil. These soils formed in sandy sediments and are on foot slopes and at the head of drainageways on uplands. Slopes range from 0 to 2 percent. Soils of the Robco series are loamy, siliceous, thermic, Aquic Arenic Paleustalfs.

Typical pedon of Robco loamy fine sand, 0 to 2 percent slopes; from the intersection of Texas Highway 164 and Farm Road 937 in Groesbeck, 4.7 miles southeast on Farm Road 937 to the Box Church community, 0.7 mile southwest on county road, 0.5 mile south on county road, and 200 feet west, in pasture:

A—0 to 16 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, friable; common fine and medium roots; common fine pores; few strong brown root stains; about 2 percent pebbles; slightly acid; clear smooth boundary.

E—16 to 25 inches; pale brown (10YR 6/3) loamy fine sand, very pale brown (10YR 7/3) dry; single grain; loose; few fine roots; few fine pebbles; about 2 percent ironstone fragments; moderately acid; clear wavy boundary.

Bt/E—25 to 27 inches; yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; common medium distinct light brownish gray (10YR 6/2) and few medium prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; the majority of peds are coated with pale brown (10YR 6/3) and very pale brown (10YR 7/3) loamy fine sand that comprises 20 percent of the layer; hard, friable; few fine roots; thin patchy clay films on faces of peds; few fine and medium black concretions; about 2 percent ironstone fragments; moderately acid; clear smooth boundary.

Bt1—27 to 44 inches; coarsely mottled red (2.5YR 4/6), brownish yellow (10YR 6/6), and light gray (10YR 7/2) sandy clay loam; moderate medium subangular blocky structure; hard, firm; few fine roots; thin continuous clay films along root channels; few fine and coarse black concretions; few fine and medium brown concretions; very strongly acid; clear smooth boundary.

Bt2—44 to 60 inches; yellowish brown (10YR 5/8) clay loam, brownish yellow (10YR 6/8) dry; few medium and coarse prominent light brownish gray (10YR 6/2) and red (2.5YR 4/8) mottles; moderate medium subangular blocky structure; very hard, firm; few fine roots; thin patchy clay films on faces of peds; few fine black concretions; few fine brown concretions; moderately acid; clear smooth boundary.

Bt3—60 to 80 inches; yellowish brown (10YR 5/6) clay, brownish yellow (10YR 6/6) dry; few fine prominent red (2.5YR 4/8) mottles; moderate fine subangular blocky structure; very hard, firm; thin patchy clay films on faces of peds; few fine black concretions; moderately acid.

Thickness of the solum ranges from 60 to more than 80 inches.

The A horizon has a hue of 10YR, value of 4 to 7, and chroma of 3 or 4. The E horizon is one or two units of value higher than the A horizon. Few to common strong brown mottles are in some pedons. The combined thickness of the A and E horizons ranges from 24 to 32 inches. Reaction is strongly acid to slightly acid.

The Bt component of the Bt/E horizon has a hue of 10YR, value of 4 to 7, and chroma of 4 to 6. Mottles in shades of brown, red, or yellow range from few to many. The E material consists of coatings and pockets.

The Bt horizon has hue of 7.5YR to 10YR, value of 5 to 7, and chroma of 2 to 8. Mottles in shades of red, yellow, and brown range from common to many. Reaction ranges from very strongly acid to moderately acid. Texture is sandy clay loam or clay loam in the upper part and clay loam, sandy clay, and clay in the lower part.

The BC horizon, where present, has colors in shades of gray, yellow, red, or brown with few to many mottles. Reaction ranges from very strongly acid to neutral.

Silawa Series

The Silawa series consists of very deep, well drained, moderately permeable soils on high stream terraces. These soils formed in sandy and loamy sediments. Slopes are 1 to 12 percent. Soils of the Silawa series are fine-loamy, siliceous, thermic, Ultic Haplustalfs.

Typical pedon of Silawa fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 14 and Texas Highway 7 in Kosse, 1.5 miles east on Texas Highway 7, 200 feet north on county road, and 20 feet west, in cropland:

Ap—0 to 7 inches; brown (7.5YR 5/4) fine sandy loam, light brown (7.5YR 6/4) dry; weak fine granular structure; slightly hard, very friable; common fine and medium roots; about 2 percent siliceous pebbles; moderately acid; clear smooth boundary.

Bt1—7 to 24 inches; red (2.5YR 4/6) clay loam, red (2.5YR 5/6) dry; few fine faint yellowish brown mottles; weak medium subangular blocky structure; very hard, firm; few fine roots; thin patchy clay films on faces of peds; about 2 percent siliceous pebbles; moderately acid; clear smooth boundary.

Bt2—24 to 44 inches; red (2.5YR 5/8) sandy clay loam, light red (2.5YR 6/8) dry; weak coarse subangular blocky structure; very hard, firm; few fine roots; thin patchy clay films along old root channels; about 2 percent siliceous pebbles; strongly acid; gradual smooth boundary.

BC—44 to 58 inches; reddish yellow (7.5YR 6/6) fine sandy loam, reddish yellow (7.5YR 7/6) dry; weak fine subangular blocky structure; hard, friable; few fine roots, few fine pores; about 2 percent fine siliceous pebbles; strongly acid; gradual smooth boundary.

C—58 to 80 inches; brownish yellow (10YR 6/6) loamy fine sand, yellow (10YR 7/6) dry; massive; slightly hard, friable; few fine roots; few fine pores; strongly acid.

Solum thickness ranges from 40 to about 60 inches. Base saturation ranges from 38 to 70 percent in the Bt horizon.

Up to 5 percent by volume siliceous pebbles are in some horizons of some pedons.

The A or Ap horizon has a hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 3 or 4. An E horizon is present in some pedons, and is one or two units of value higher than the A horizon. Reaction ranges from strongly acid to slightly acid. The combined thickness of the A and E horizons ranges from 4 to 19 inches.

The Bt horizon has hue of 2.5YR to 7.5YR, value of 4 to 6, and chroma of 6 or 8. Few mottles in shades of red or brown are in some pedons. Texture is sandy clay loam or clay loam. Reaction ranges from very strongly acid to moderately acid.

The BC horizon has a hue of 2.5YR to 10YR, value of 4 to 6, and chroma of 4 to 8. Some pedons are mottled in these colors. Texture is sandy clay loam or fine sandy loam. Reaction ranges from very strongly acid to moderately acid.

The C horizon has colors in shades of brown, yellow, and red. It has strata of loamy sand, loamy fine sand, or fine sandy loam. Reaction ranges from very strongly acid to slightly acid.

Silstid Series

The Silstid series consists of very deep, well drained soils that are rapidly permeable in the surface layer and moderately permeable in the subsoil. These soils formed in sandy and loamy sediments and are on uplands (fig. 22). Slopes range from 1 to 8 percent. Soils of the Silstid series are loamy, siliceous, thermic, Arenic Paleustalfs.

Typical pedon of Silstid loamy fine sand, 1 to 3 percent slopes; from the intersection of Farm Road 937 and Farm Road 1246 in Oletha about 14 miles southeast of Groesbeck, 1.5 miles west on Farm Road 1246, 3.5 miles north and west on county road, and 100 feet south, in wooded area:

A—0 to 5 inches; dark brown (10YR 4/3) loamy fine sand, brown (10YR 5/3) dry; single grain; loose; common medium and coarse roots; few fine pores; moderately acid; clear smooth boundary.

E—5 to 27 inches; brown (10YR 5/3) loamy fine sand, pale brown (10YR 6/3) dry; single grain; loose; few fine, medium, and coarse roots; few fine pores; moderately acid; clear smooth boundary.

Bt1—27 to 43 inches; yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; weak medium subangular blocky structure; hard, firm; few fine and medium roots; few fine pores; thin patchy clay films on faces of peds and along root channels; strongly acid; gradual smooth boundary.

Bt2—43 to 60 inches; yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; few medium distinct strong brown (7.5YR 5/6) and few medium prominent red (2.5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few fine pores; few thin patchy clay films on faces of peds; few fine black concretions; few lenses of pale brown (10YR 6/3) clean sand grains; strongly acid; gradual smooth boundary.

BCt—60 to 80 inches; mottled yellowish brown (10YR 5/8) and reddish yellow (7.5YR 6/6) sandy clay loam; weak fine subangular blocky structure; hard, friable; few medium roots; few fine pores; few thin clay coatings on sand grains; common lenses of very pale brown (10YR 7/3) clean sand grains; strongly acid.

Solum thickness is 60 to more than 80 inches. The combined thickness of the A and E horizons is 20 to 40 inches.

The A horizon has a hue of 10YR, value of 4 to 7, and chroma of 3 or 4. The E horizon is one or two units of value higher than the A horizon. Reaction ranges from moderately acid to neutral.

The Bt and BC horizons have a hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 6 to 8. Few to many mottles in shades of red, brown, gray, and yellow are in some pedons. Some lower horizons are mottled in these colors. Reaction ranges from strongly acid to slightly acid.

Styx Series

The Styx series consists of very deep, well drained soils that are rapidly permeable in the surface layer and moderately permeable in the subsoil. These soils formed in sandy and loamy sediments and are on high stream terraces. Slopes are 0 to 2 percent. Soils of the Styx series are loamy, siliceous, thermic, Arenic Paleustalfs.

Typical pedon of Styx loamy fine sand, 0 to 2 percent slopes; from the intersection of Farm Road 2705 and Farm Road 1633 about 4.5 miles southwest of Mexia, 1.6 miles southeast on Farm Road 1633, 1.7 miles northwest on county road, and 38 feet west, in pasture:

A—0 to 15 inches; dark grayish brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; loose, very friable; many fine and medium roots; slightly acid; clear smooth boundary.

E—15 to 27 inches; pale brown (10YR 6/3) loamy fine sand, very pale brown (10YR 7/3) dry; weak fine subangular blocky structure; loose, very friable; common fine roots; slightly acid; clear smooth boundary.

Bt1—27 to 37 inches; yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—37 to 46 inches; yellowish brown (10YR 5/6) sandy clay loam, brownish yellow (10YR 6/6) dry; common medium prominent red (2.5YR 4/6) and few medium distinct pale brown (10YR 6/3) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt3—46 to 65 inches; light yellowish brown (10YR 6/4) sandy clay loam, light yellowish brown (10YR 6/4) dry; common medium prominent yellowish red (5YR 5/8), few fine distinct brownish yellow (10YR 6/8), and few medium prominent red (2.5YR 4/8) mottles; weak fine and medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films on faces of peds; very strongly acid; gradual smooth boundary.

BCt—65 to 80 inches; light gray (10YR 7/2) sandy clay loam, very pale brown (10YR 7/3) dry; common medium distinct yellow (10YR 7/8) mottles; weak fine subangular blocky structure; slightly hard, friable; few fine roots; few patchy clay films on faces of peds; 10 percent light gray uncoated sand grains; very strongly acid.

Solum thickness is 60 to more than 80 inches. Black concretions range from none to few throughout.

The A horizon has a hue of 10YR, value of 4 to 7, and chroma of 2 to 4. The E horizon is one or two units of value higher than the A horizon. Reaction ranges from strongly acid to neutral. Combined thickness of the A and E horizons ranges from 22 to 32 inches.

The Bt horizon has a hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 6 or 8. The upper part is mottled in these colors in some pedons. The lower part of the Bt horizon has few to common mottles in shades of red and gray in some pedons or the matrix is mottled in these colors. Texture is sandy clay loam or clay loam. Reaction ranges from very strongly acid to slightly acid.

The BC horizon has hues of 5YR to 10YR, value of 4 to 7, and chroma of 2 to 8. Texture is sandy clay loam or clay loam. Some pedons have up to 10 percent by volume uncoated sand grains. Reaction ranges from very strongly acid to slightly acid.

Tabor Series

The Tabor series consists of very deep, moderately well drained, very slowly permeable soils on high stream terraces and on remnants of terraces on broad upland divides. These soils formed in clayey and loamy sediments. Slopes range from 0 to 2 percent. Soils of the Tabor series are fine, montmorillonitic, thermic, Udertic Paleustalfs.

Typical pedon of Tabor fine sandy loam, 0 to 2 percent slopes; from the intersection of Texas Highway 171 and Farm Road 638 in Tehuacana, 2.3 miles north on Farm Road 638, 3.8 miles east on Farm Road 27, 1.4 miles south on county road, and 50 feet west, in pasture:

A—0 to 12 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; slightly hard, friable; common fine and medium roots; slightly acid; abrupt wavy boundary.

Bt1—12 to 17 inches; yellowish brown (10YR 5/4) clay, light yellowish brown (10YR 6/4) dry; few medium prominent red (2.5YR 5/8) and few medium faint yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few thin clay films on faces of peds; few brown streaks on peds along cracks; strongly acid; clear wavy boundary.

Bt2—17 to 28 inches; light olive brown (2.5Y 5/4) clay, light yellowish brown (2.5Y 6/4) dry; few medium prominent red (2.5YR 5/8) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; few medium slickensides; few fine and medium black concretions; slightly acid; clear wavy boundary.

Bt3—28 to 42 inches; light yellowish brown (2.5Y 6/4) clay, pale yellow (2.5Y 7/4) dry; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few thin clay films on faces of peds; few pressure faces; few fine and medium black concretions; neutral; gradual wavy boundary.

Bt4—42 to 55 inches; light yellowish brown (2.5Y 6/4) clay, pale yellow (2.5Y 7/4) dry; common medium prominent strong brown (7.5YR 5/8) and common fine distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few thin clay films on faces of peds; few fine and medium black concretions; few medium calcium carbonate concretions; few fine streaks of barite; about 2 percent light brownish gray shale fragments; slightly alkaline; gradual wavy boundary.

BCt—55 to 65 inches; light yellowish brown (2.5Y 6/4) clay loam, pale yellow (2.5Y 7/4) dry; common fine and medium prominent strong brown (7.5YR 5/8) and common fine and medium distinct light olive brown (2.5Y 5/6) mottles; weak medium subangular blocky structure; hard, firm; few thin clay films on faces of peds; common fine and medium black concretions; few seams of sandier material; about 2 percent light brownish gray shale fragments; slightly alkaline; gradual wavy boundary.

C—65 to 80 inches; light yellowish brown (2.5Y 6/4) clay loam, pale yellow (2.5Y 7/4) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; hard, firm; few fine black concretions; few seams of sandier material; about 2 percent light gray shale fragments; slightly alkaline.

Solum thickness ranges from 60 to 70 inches. Some pedons have up to 5 percent by volume siliceous pebbles in some horizons.

The A horizon has a hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. The E horizon, where present, is one or two units of value or chroma higher than the A horizon. The combined thickness of the A and E horizons ranges from 11 to 18 inches. Reaction ranges from strongly acid to slightly acid.

The Bt horizon has a hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 3 to 6. Some pedons have few to many mottles in shades of brown, gray, yellow, and red. The matrix of some pedons are mottled in these colors. Texture is clay or clay loam. Reaction ranges from very strongly acid to strongly acid in the upper part and from strongly acid to neutral in the lower part. Some pedons have few black concretions and soft masses.

The BC horizon is present in most pedons and has the colors of the Bt horizon. Texture is clay loam or clay. Reaction ranges from neutral to slightly alkaline. Some pedons have few to common black concretions, soft masses of ferrous manganese, and concretions and soft masses of calcium carbonate. Fragments of unweathered shale range from few to common in some pedons.

The C horizon has colors in shades of gray or brown and has mottles in shades of red, yellow, brown, olive, and white. Texture is sandy clay, clay, or clay loam with some pedons having interbedded shale. Few calcium carbonate concretions and gypsum crystals are in some pedons.

Tinn Series

The Tinn series consists of very deep, moderately well drained, very slowly permeable soils on flood plains of streams that drain the Blackland Prairie. These soils formed in calcareous clayey alluvium (fig. 23). Slopes are dominantly less than 1 percent. Soils of the Tinn series are fine, montmorillonitic, thermic, Typic Hapluderts.

Typical pedon of Tinn clay, frequently flooded; from the intersection of Farm Road 171 and Farm Road 73 in Coolidge, 2.8 miles northeast on Farm Road 73, 0.6 mile north on county road, and 400 feet east, in cropland:

Ap—0 to 6 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate very fine and fine angular blocky; very hard, very firm; few fine roots; few fine and medium pores; slightly effervescent; moderately alkaline; abrupt smooth boundary.

A—6 to 18 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate very fine and fine angular blocky; very hard, very firm; few fine roots; few fine and medium pores; common fine pressure faces; few fine slickensides; about 2 percent fine siliceous pebbles and about 2 percent fine ironstone fragments; few wormcasts; few medium grayish brown (2.5Y 5/2) streaks along root channels; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bss1—18 to 28 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; few fine roots; few fine and medium pores; common fine pressure faces; common fine grooved slickensides; about 2 percent fine siliceous pebbles and about 2 percent fine ironstone fragments; few wormcasts; few medium grayish brown (2.5Y 5/2) streaks along root channels; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bss2—28 to 54 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; moderate coarse angular blocky structure parting to moderate fine angular blocky; very hard, very firm; few fine roots; few fine and medium pores; many prominent grooved slickensides that range from 5 to 10 centimeters across, most slickensides are oriented at about 45 degrees; few fine black concretions; few medium calcium carbonate concretions that are pitted; about 2 percent fine siliceous pebbles; about 2 percent shell fragments; few wormcasts; few coarse very dark gray (10YR 3/1) masses; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bss3—54 to 72 inches; very dark gray (10YR 3/1) clay, dark gray (10YR 4/1) dry; moderate coarse angular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; few fine roots; few fine and medium pores; common prominent grooved slickensides up to one meter across that are oriented at 45 to 60 degrees; few fine and medium calcium carbonate concretions that are pitted; few wormcasts; slightly effervescent; moderately alkaline; gradual wavy boundary.

Bk—72 to 80 inches; very dark grayish brown (2.5Y 3/2) clay, dark grayish brown (2.5Y 4/2) dry; moderate coarse angular blocky structure parting to moderate fine and medium angular blocky; very hard, very firm; few fine roots; few fine and medium pores; few fine grooved slickensides up to 50 centimeters across that are oriented at 45 to 60 degrees; common fine and medium calcium carbonate concretions; few fine and medium masses of gypsum; few black (10YR 2/1) streaks; slightly effervescent; moderately alkaline.

Solum thickness is greater than 80 inches. Reaction is slightly alkaline or moderately alkaline. The clay content of the particle size control section ranges from 40 to 60 percent. Some pedons have few concretions of calcium carbonate and iron-manganese.

The A horizon has a hue of 10YR, value of 2 to 5, and chroma of 1.

The B horizon has hue of 10YR to 5Y, value of 2 to 6, and chroma of 1 or 2. Some pedons have Bw, Bk, and Bky horizons with colors the same as the B horizon.

The C horizon, where present, has colors in shades of brown or gray. Texture is silty clay or clay.

Uhland Series

The Uhland series consists of very deep, moderately well drained, and moderately slowly permeable soils on flood plains. These soils formed in recent alluvium. Slopes are 0 to 1 percent. Soils of the Uhland series are coarse-loamy, siliceous, thermic Aquic Ustochrepts.

Typical pedon of Uhland fine sandy loam, frequently flooded; from the intersection of Texas Highway 14 and Texas Highway 7 in Kosse, 0.5 mile east on Texas Highway 7, 0.1 mile north on oil top road, 3.5 miles northeast on county road, 0.6 mile south on county road, and 50 feet north, in woods:

A—0 to 7 inches; dark brown (10YR 4/3) fine sandy loam, brown (10YR 5/3) dry; weak fine subangular blocky structure; soft, friable; many fine and medium and few coarse roots; few fine strong brown stains on faces of peds; slightly acid; clear smooth boundary.

Bw—7 to 30 inches; very pale brown (10YR 7/3) fine sandy loam, very pale brown (10YR 8/3) dry; common medium faint light brownish gray (10YR 6/2) and common medium prominent strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable; few coarse roots; slightly acid; gradual smooth boundary.

Bw2—30 to 48 inches; light brownish gray (10YR 6/2) fine sandy loam, light gray (10YR 7/2) dry; few medium prominent strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to weak very fine subangular blocky; soft, very friable; few thin strata of loamy fine sand material; slightly acid; gradual smooth boundary.

Bg1—48 to 60 inches; light gray (10YR 7/2) fine sandy loam, white (10YR 8/2) dry; few medium prominent reddish yellow (5YR 6/6) mottles; single grain; loose; few strata of loam material; slightly acid; gradual smooth boundary.

Bg2—60 to 80 inches; light gray (10YR 7/2) fine sandy loam, white (10YR 8/2) dry; few fine prominent brownish yellow (10 YR 6/6) mottles; single grain; loose; few strata of loam material; slightly acid.

Reaction ranges from slightly acid to moderately alkaline. Depth to gray colors is less than 20 inches.

The A horizon has a hue of 7.5YR or 10YR, value of 3 to 5, chroma of 2 to 4. Some pedons have few mottles in shades of brown.

The B horizon has colors in shades of brown, gray, or white. Some pedons have few to common mottles of brown, yellow, or gray, or the matrix is mottled in these colors. Texture is loamy fine sand, fine sandy loam, or loam, or it has strata with these textures.

Whitesboro Series

The Whitesboro series consists of very deep, moderately well drained, moderately permeable soils on the flood plains of rivers and creeks. These soils formed in loamy alluvial sediments. Slopes are 0 to 1 percent. Soils of the Whitesboro series are fine-loamy, mixed, thermic Cumulic Haplustolls.

Typical pedon of Whitesboro loam, frequently flooded; from the intersection of Highway 14 and Farm Road 1246 in Thornton, 0.9 mile northwest on Farm Road 1246; 0.5 mile southwest on county road; 215 feet southeast, in pasture.

A1—0 to 17 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure; slightly hard, friable; common fine and medium roots; common fine pores; common wormcasts; slightly alkaline; clear smooth boundary.

A2—17 to 26 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; few medium prominent strong brown (7.5YR 5/6) and few medium faint dark grayish brown (10YR 4/2) mottles; weak medium subangular blocky structure; slightly hard, friable; few fine roots; few pores; few fine black concretions; few wormcasts; slightly acid; clear smooth boundary.

Bw1—26 to 51 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; few fine distinct yellowish brown (10YR 5/6), common fine prominent strong brown (7.5YR 5/8), and few medium prominent yellowish red (5YR 4/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few fine black concretions; moderately acid; clear smooth boundary.

Bw2—51 to 58 inches; mottled grayish brown (10YR 5/2), yellowish brown (10YR 5/8), reddish yellow (7.5YR 7/6), and yellowish red (5YR 4/6) sandy clay loam; weak medium subangular blocky structure; hard, firm; few fine roots; few fine and medium black concretions and stains; moderately acid; clear smooth boundary.

C—58 to 80 inches; yellowish brown (10YR 5/8) sandy clay loam, brownish yellow (10YR 6/8) dry; few medium prominent light brownish gray (10YR 6/2) and few fine prominent yellowish red (5YR 4/6) mottles; massive; hard, friable; few fine roots; few fine black concretions; moderately acid.

Solum thickness ranges from 40 to more than 60 inches. The mollic epipedon ranges from 20 to 49 inches thick.

The A horizon has a hue of 10YR, value of 2 to 4, and chroma of 1 to 3. Some pedons have few mottles in shades of brown or gray in the lower part. Reaction ranges from slightly acid to slightly alkaline.

The Bw horizon has a hue of 10YR or 2.5Y, value of 4 to 7, and chroma of 2 to 4. Some pedons have few to common mottles in shades of red, brown, yellow, and gray, or the matrix is mottled in these colors. Texture is loam, sandy clay loam, or clay loam. Reaction ranges from moderately acid to moderately alkaline.

The C horizon has colors in shades of brown or yellow. Some pedons have few mottles of yellowish red or light brownish gray. Texture is sandy clay loam or clay loam, or there is strata with textures of sand, loam, or sandy loam. Reaction ranges from moderately acid to moderately alkaline. Some pedons have buried A horizons that are very dark gray, very dark grayish brown, dark grayish brown, or brown.

Wilson Series

The Wilson series consists of very deep, moderately well drained, very slowly permeable soils on modern stream terraces and on ancient terraces in upland positions. These soils formed in alkaline clayey sediments. Slopes range from 0 to 2 percent. Soils of the Wilson series are fine, montmorillonitic, thermic, Oxyaquic Vertic Haplustalfs.

Typical pedon of Wilson clay loam, 0 to 2 percent slopes; from the intersection of Farm Road 339 and U.S. Highway 84 about 18 miles west of Groesbeck at Prairie Hill, 0.9 mile west on U.S. Highway 84, 0.5 mile southwest on county road, and 100 feet south, in cropland:

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure, massive when dry; very hard, firm; common fine and medium roots; few wormcasts; about 2 percent siliceous pebbles; slightly acid; abrupt wavy boundary.

Bt1—7 to 22 inches; black (10YR 2/1) clay, very dark gray (10YR 3/1) dry; few fine faint dark grayish brown mottles; moderate fine subangular blocky structure; very hard, firm; common fine roots; common thin patchy clay films on faces of peds; few pressure faces; few fine dark brown (7.5YR 4/4) stains on faces of peds; about 2 percent siliceous pebbles; slightly acid; clear wavy boundary.

Btg1—22 to 34 inches; dark gray (10YR 4/1) clay, gray (10YR 5/1) dry; few fine faint light brownish gray and grayish brown mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; common pressure faces; few fine calcium carbonate concretions; about 2 percent siliceous pebbles; few cracks filled with very dark gray materials; few fine dark brown (7.5YR 4/4) stains on faces of peds; slightly alkaline; gradual wavy boundary.

Btg2—34 to 43 inches; gray (10YR 5/1) clay, light gray (10YR 6/1) dry; few fine distinct yellowish brown (10YR 5/6) and few fine faint light brownish gray mottles; moderate fine subangular blocky structure; very hard, firm; few fine roots; few patchy clay films on faces of peds; common pressure faces; few fine and medium calcium carbonate concretions; few thin very dark gray streaks; moderately alkaline; gradual wavy boundary.

Btg3—43 to 56 inches; light gray (10YR 6/1) clay, light gray (10YR 6/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very hard, very firm; few fine roots; thin patchy clay films on faces of peds; few fine and medium calcium carbonate concretions; few fine black concretions; few thin black streaks; moderately alkaline; gradual wavy boundary.

BCk1—56 to 60 inches; light gray (10YR 6/1) clay, light gray (10YR 7/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse angular blocky structure; very hard, very firm; common fine and medium calcium carbonate concretions; few fine black concretions; about 2 percent fine siliceous pebbles; strongly effervescent; moderately alkaline; gradual wavy boundary.

BCk2—60 to 80 inches; light brownish gray (10YR 6/2) clay, light gray (10YR 7/2); common medium distinct yellowish brown (10YR 5/6) and brownish yellow (10YR 6/6) mottles; weak fine subangular blocky structure; very hard, very firm; common fine and medium calcium carbonate concretions; few fine black concretions; about 2 percent fine siliceous pebbles; about 2 percent fine shale fragments; strongly effervescent; moderately alkaline.

Solum thickness is more than 80 inches. Some pedons have few calcium carbonate concretions in the Bt horizon. Some pedons have up to 7 percent by volume siliceous pebbles in the surface layer and upper part of the B horizon.

The A horizon has a hue of 10YR, value of 2 to 5, and chroma of 1 or 2. Reaction ranges from moderately acid to neutral. Thickness ranges from 4 to 10 inches, but is as much as 15 inches over subsoil troughs.

The Bt1 horizon has a hue of 10YR or 2.5Y, value of 2 to 4, and chroma of 1 or less. Reaction ranges from moderately acid to slightly alkaline.

The Btg horizon has a hue of 10YR or 2.5Y, value of 3 to 6, and chroma of 1 or 2. Some pedons have few to common mottles in shades of brown and yellow. Reaction ranges from moderately acid to moderately alkaline. Some pedons have few calcium carbonate concretions.

The BC or BCk horizon has the same colors as the lower part of the Bt horizon and is typically more mottled. Texture is clay loam, silty clay, or clay. Reaction ranges from neutral to moderately alkaline. Few to common calcium carbonate concretions and masses are in some pedons.

Formation of the Soils

In this section, the factors of soil formation are discussed and related to the soils in Limestone County. In addition, the processes of soil formation and the geology of the survey area are described.

Factors of Soil Formation

The characteristics of a soil depend on the action and interaction of five major factors: parent material, climate, plant and animal life, relief, and time. All of these factors are important; however, some have more influence than others on the formation of a given soil. It is difficult to isolate and evaluate the effects of any one factor in most cases. The following paragraphs discuss each factor separately and the probable effects of each on soil formation.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the chemical and mineral content of the soil. In Limestone County, the parent material consists of unconsolidated sediments of Upper Cretaceous, Eocene, Pleistocene, and Recent age. Additional information about parent material is in the section, “Geology.”

Climate

The climate of Limestone County is warm and subhumid. The moderate amount of rainfall promotes moderately rapid soil development. Although climate is uniform throughout the county, local rainfall and steepness of slope can cause runoff and modify the effect of climate on soil development. The differences between the soils within the survey area are not directly attributed to climatic differences.

Plant and Animal Life

In Limestone County, plants, animals, micro-organisms, earthworms, other forms of living organisms, and human activities have contributed to the development of the soils. Plant and animal life cause gains and losses in organic matter and nitrogen in soils, gains or losses in plant nutrients, and changes in structure and porosity.

Hardwood trees, grasses, and shrubs have played a major role in soil development. Decayed roots have left pores and holes that serve as passageways for water and air. Earthworms and other soil organisms feed on the decomposed roots. The borings of the earthworms also help channel water and air through the soil. Fungi and bacteria help break down the decaying plant materials to more useful organic matter that helps maintain fertility.

Human activities have also influenced soil formation. Cultivation has encouraged runoff and erosion, reducing the content of organic matter. Tillage and continuous livestock grazing have compacted the soils and reduced aeration, infiltration, and permeability.

Relief

The degree of profile development or horizonation is greatly influenced by relief, or topography. In Limestone County, soils that are more sloping generally have more distinct horizonation. This is related to the amount of water that moves through the soil, the depth of moisture penetration, and the frequency of wetting and drying cycles. The nearly level Lufkin and Wilson soils have less distinct horizons, mainly because they receive more water and stay wet longer. In more sloping areas, soils such as Edge, Gasil, and Silstid have distinct horizonation because runoff limits the depth and frequency of moisture penetration. Soils on the steeper slopes are generally not as deeply developed because of less moisture penetration and a higher rate of erosion. The Ellis, Ferris, and Lamar soils are examples.

Time

The length of time that the soil forming factors have acted on the parent material determines, to a large degree, the characteristics of the soil. The differences in the length of time that the parent material has been in place are commonly reflected in the degree of development of the soil horizons. Young soils have very little horizon development and old soils have well-expressed horizons. In Limestone County, Tinn and Kaufman soils are examples of young soils. These soils retain most of the characteristics of their clayey parent material. Edge soils are an example of older soils that have well developed horizons. The Edge soils have distinct A and B horizons that bear little resemblance to the original parent material.

Processes of Soil Formation

The formation of horizons in soils involves several processes, including accumulation of organic matter, leaching of calcium carbonates and bases, and formation and translocation of silicate clay minerals. In most soils, more than one of these processes have been active in the development of horizons.

Accumulation of organic matter in the surface layer helps to form an A horizon. The soils in the survey area range from low to medium in organic matter content.

The amount of rainfall has been large enough to cause leaching of carbonates and bases in most of the soils. This process contributes to the formation of horizons. Once leaching has occurred, the soils tend to become acid.

Crockett, Edge, and Gasil are examples of soils in which the downward translocation of clay minerals has contributed to horizon development. The Bt horizon in these soils contains appreciably more silicate clay than the A horizon.

Before the downward movement of silicate clays, the parent materials were leached of some carbonates and soluble salts. The leaching and downward movement are among the more important processes responsible for horizonation in the soils of the survey area.

Geology

David L. Amsbury, geologist, National Aeronautic and Space Administration, prepared this section.

All Limestone County soils were developed from a variety of parent materials that are referred to here as “bedrock”; although one type, ancient stream deposits, are not strictly “rocks.” These materials include calcareous shale, sand or sandstone, limestone, and stream deposits derived from these rocks.

The type of bedrock determines relative resistance to erosion, and thus topographic position. Bedrock also affects the chemical composition and physical texture of the soil. Relatively pure limestones tend to produce thin, stony soils, whereas clayey units and old stream deposits tend to have very deep, clayey and loamy soils. Sand units provide material for very deep, well-drained sandy soils.

Rocks that underlie the soils of Limestone County are sedimentary; that is, the rock-forming material was deposited originally as particles of sand, clay, fossil shell fragments, or lime mud. Most sediments that formed the bedrock of the central and western parts of the county were deposited in the waters of ancient seas that covered central and eastern Texas periodically through geological history. Sediments that formed the bedrock of the eastern part of the county were deposited in large river systems and their deltas. These river systems drained the Rocky Mountain area and fed into the East Texas Basin when the ancestral Gulf of Mexico extended into what are now Anderson, Cherokee, and Houston Counties. Some much younger deposits were laid down by streams that eroded the older deposits, during and after the last glacial age.

Sedimentary rocks are deposited in layers. Where the same kind of rock is exposed all around a hill, it is assumed that similar material forms a layer that extends throughout the area under the hill. The assumption can be verified or refuted by examining exposures (for example, a road cut or railroad cut) or by studying drill cuttings. Similarly, when recognizable layers of rock are seen on both sides of a valley, it can be assumed that the layers were once continuous across the valley but have been eroded away.

Within a body of sedimentary rock that was deposited by water, layers in the lowest position were deposited first and those in the highest position were deposited last. Therefore, the youngest rocks are normally at the highest elevation. This is the rule of superposition, and it is very helpful in interpreting geological history. In many places older rocks are found at higher elevations than younger rocks. This may occur where older rocks are uplifted by gentle tilting or by mountain-building forces, where younger rocks are dropped down in a faulted block, or where older rocks are dissected by streams so younger stream deposits lie in valley bottoms.

No record of mountain-building episodes has been found in the rocks exposed at the surface in Limestone County, but faulting of linear blocks was an important part of the history of these rocks. Remnants of the faulted blocks determined the distinctive landscapes of the county, and recognition of the faults played an important part in the discovery of oil, gas, and ground water.

Actual dating of rock layers is a complex process that includes the study of fossils, laboratory measurements of radioactive elements in rocks, and reconstructions of geological history worldwide. The approximate ages given here are the best current estimates published by the Geological Society of America.

Surface Geology

There is a general correspondence between the major soil types of Limestone County (shown on the general soil map) and the surface geology (shown on the Waco Sheet of the Geologic Atlas of Texas *(21)*). Similar patterns are shown on the smaller scale Geologic Map of Texas *(22)* and on the Land Resource Map *(11)*. Surface exposure of geological units forms long, narrow bands trending north-northeast to south-southwest across the county. The relatively high series of ridges that extend through the Groesbeck and Tehuacana areas formed on limestone and sandstone units. To the west, an expanse of blackland prairie formed on calcareous shales, and to the east, post oak woodland and discontinuous prairies formed on sand and sandy shale units.

The present landscape of Limestone County was formed during the great ice age, termed the Pleistocene Period or Quaternary Era. During this time, the youngest “rocks” of the county were deposited as sediments of ancient streams. These sediments are now a part of ancient and recent stream terraces. These terraces are prominent along the Navasota River and its tributaries, and on Pin Oak Creek, Steele Creek, and Big Creek.

The southeastward-flowing streams of the county have gradients of 8 to 10 feet per mile. Underlying bedrock units dip eastward at about 80 feet per mile. Because the rock layers are tilted eastward more than the bottoms of stream channels, the oldest rocks are exposed in valleys in the western part of the county. The youngest rocks (other than the ancient stream sediments) are exposed only in the easternmost corner of the county.

The basic named geologic map unit is the formation. Named or unnamed members may be recognized within formations. The rock name that accompanies a map unit is derived from the most typical exposure, or from the rock type at the place where the unit was first named; for example, the Simsboro Sand was named by W. A. Reiter from typical exposures near the town of Simsboro in Freestone County *(15)*.

The following paragraphs briefly describe the surface geology from the youngest to the oldest units.

Recent Alluvium. Flood plain deposits of major streams are the youngest geological units in the county. Also included are low, indistinct terrace deposits. They form relatively narrow bottom lands inset into higher, wider, and older terrace deposits. Major floods overtop the lower portions of terraces and deposit overbank material on them. Most stream deposits consist of material reworked from older alluvium, plus material eroded and transported from valley sides and hilltops within the county. Evidence of water transport can be seen in vertical streambanks and in excavations. This may include relict stream bottom sand bars and gravel lenses, crossbedding, a general upward decrease in gravel content and grain size, and a mixture of material, including marine fossils derived from older units upstream. Similar alluvial deposits in many parts of Central Texas contain scattered bones and teeth of mammoths, extinct bison, other prehistoric animals, and rare ancient Indian spearpoints, as well as the more abundant hearths, grinding stones, and flint tools of later prehistoric Indians. Evidently, these deposits have been forming sporadically since the end of the latest ice age, or about the last 12,000 years.

Soils on recent flood plains are in the Kaufman-Tinn general soil map unit along the Navasota River, the Whitesboro unit on Christmas and Steele Creeks which drain blackland prairies, and the Uhland-Nahatche unit in the eastern part of the county in which streams drain sandy bedrock.

Pleistocene Terrace Deposits. Ancient stream terraces are widespread along the Navasota River and its larger tributaries. These terraces are formed from clayey and loamy deposits west of the fault zone that extends across the county, and are formed from sandy deposits in the eastern part of the county. Many of these terraces contain gravel, derived from scattered deposits, that cap many high hills. Areas of “Quaternary high gravel” *(21)* form a small part of the Pleistocene terrace deposits.

Exposures of terrace material in gullies and manmade cuts indicate at least some of the deposits are thicker than those of the modern streams. Furthermore, the old valley flood plains are much wider than modern ones. Throughout Central and East Texas, where ancient meander loops are preserved as oxbow lakes (either in bedrock or in the alluvium), meander size is much greater than those of modern streams. Evidently, the ancient deposits were formed during one or more periods when rainfall, and thus stream discharge, was several times greater than at present. Such evidence is widespread in Central Texas and, indeed, throughout the state. The significance to soil development is that most of the soils in Limestone County must have formed over a long period of time (at least a half-million years), under conditions that varied greatly in rainfall, temperature, and vegetation. Soil characteristics, therefore, reflect bedrock and parent material as well as the changes in vegetation and climate.

The Wilson-Mabank general soil map unit is in terrace positions within the Houston Black-Ferris-Heiden unit along Christmas Creek and other tributaries of the upper Navasota River drainage. The Axtell-Rader unit is in terrace positions in the eastern sandy portion of the county. The Groesbeck-Personville-Lavender unit is in intermediate positions on the Tehuacana Limestone and may also represent old terrace deposits. Most of the sand in the soils of the Groesbeck-Personville-Lavender unit certainly did not weather from the underlying limestone bedrock.

High Gravel Deposits. Locally impressive bodies of coarse gravel are scattered on the tops of the highest hills of Limestone County. These areas are not shown on the latest geologic atlas *(21)*, probably because the map scale is too small. Nevertheless, the high gravels provide economically important sources for road material, particularly in the eastern corner of the county. In the western part of the county, high gravels occur on top of the Wolfe City Sand at elevations of 650 to 670 feet. In the eastern part, similar gravels occur at elevations above 450 feet on Calvert Bluff Sand. Gravel migrates downhill on many slopes to mingle with material weathered from the underlying bedrock, and thus becomes incorporated in terrace deposits.

High gravel deposits are composed of quartzite and sandstone, vein quartz, and chert. The closest western source for such material is the Ogalalla Formation that caps the High Plains, but ultimately the gravel was derived from the southern Rocky Mountains. Evidently, strong streams flowed from the High Plains (or even the Rocky Mountains) and crossed Limestone County at the level of the highest hilltops before the modern stream valleys were cut. At present, there is no procedure for dating these deposits. They could be as young as early Pleistocene (about one million years) or as old as Eocene (50 million years). The Normangee gravelly clay loam soil in the Crockett-Normangee unit developed over these old gravel deposits.

Calvert Bluff Formation. The Calvert Bluff Formation is the youngest member of the Wilcox Group, which is assigned to the earliest part of the Eocene epoch (about 60-55 million years). This formation is mostly sand in Limestone County, although mudstone (interbedded silt and clay) and lignite (low-grade coal) are locally important. Petrified wood and ironstone concretions are common. The Calvert Bluff is exposed on rolling hills and in pits in the easternmost part of the county. Lignite seams are being mined in adjacent counties to provide fuel for power plants. The Calvert Bluff was deposited in a complex series of deltas; sand bodies represent the distributary channels, whereas mudstone beds and lignite represent interdistributary lakes and swamps *(5,10)*. Soils in the Silstid-Gasil-Padina and Edge-Tabor general soil map units developed over the Calvert Bluff Formation.

Simsboro Sand. The Simsboro, another member of the Wilcox group, forms a continuous band of rolling hills with sand outcrops across eastern Limestone County *(21)*. Native vegetation was post oak woodland. The unit is 200 to 300 feet thick, based on projections from wells downdip. Most of the unit is quartz sand, cross-bedded with cut-and-fill structures, although layers and pods of shale and clay-pebble conglomerate occur. Glass sand and kaolin clay are mined from the upper part of the Simsboro near Harmony. The formation serves as an excellent aquifer downdip from the outcrop belt. The Simsboro was deposited in the channels and overbank flood plains of a river system that flowed southeastward *(6)* as part of a larger alluvial system that dominated the landscape of western East Texas and eastern Central Texas at that time *(5,10)*. Soils of the Silstid-Gasil-Padina general soil map unit developed over the Simsboro Sand.

Hooper Formation. The Hooper Formation is the oldest member of the Wilcox Group. It is composed of sand lenses, clay, silt, and discontinuous thin lignite beds *(15)*. It forms rolling hills that tend to be at a higher elevation than surfaces formed on the Wills Point Formation to the west. Bremond, Kosse, Thornton, Shiloh, and several other small communities are on Hooper outcrops. Like the Calvert Bluff, the Hooper was formed as deposits within a complex delta formed by streams flowing southeastward across the state *(5,10)*. Soils of the Edge-Tabor general soil map unit developed over the Hooper Formation.

Mexia Fault Zone. The dominant feature of the geology of Limestone County is the Mexia Fault Zone. This fault zone determined the location of much of the oil and gas discovered within the county prior to deep drilling in the 1970’s. It also determined the distribution of surface geological formations and the soils that formed from them. Faults branch and rejoin in a complex braided pattern within the zone. Most faults along the east side of the zone are downdropped to the west; whereas faults along the west side are downdropped to the east *(21)*. The fault zone thus forms a trough within the upper part of the Earth‘s crust. Displacement on individual faults ranges up to 600 feet and dips of fault planes range from 25 to 45 degrees *(12)*.

The Mexia Fault Zone is thought to have formed at the same time (lower Miocene, about 25 to 20 million years ago) as the similar Balcones Fault Zone which parallels it 25 miles to the west. There is evidence from thickening and thinning of formations of Lower and Upper Cretaceous age, including the depositional patterns of the Woodbine and Nacatoch Sands, that a gentle trough was persistent at that time along the general trend of the later Mexia Fault Zone. No unequivocal evidence of Cretaceous faulting, that is, actual breakage of rock layers, is known. Within Limestone County, the fault zone can only be dated as certainly younger than the lower Tertiary rocks that it cuts, and probably older than the deposition of the high gravel deposits that cap the present hills. No historical faulting is known, so the fault zone should not be considered a seismic hazard.

Wills Point Formation. The Wills Point is the youngest formation of the Midway Group, which has been assigned to the Paleocene epoch (65 to 60 million years) *(21)*. An excellent description is available of the Wills Point and other Midway units, which is based on careful field work and drill-core descriptions made by many geologists mostly during the 1920’s *(15)*. The Midway Group contained the most easily recognized distinctive beds and fossils within a broad expanse of prairie and post oak woodland. Furthermore, outcrops of the Midway provided keys to surface mapping of potentially oil-bearing structures when geophysical techniques did not exist, increasing the efficiency of the drill bit as an exploration tool.

The Wills Point is 300 to 500 feet thick and consists of laminated clay shale, siltstone, and glauconitic sandstone. Zones of distinctive concretions and thin fossiliferous beds are at various levels within the formation. The fossils include gastropods, clams, corals, and calcareous foraminifera. The indicated environment of deposition is open marine water at least tens and perhaps hundreds of feet deep.

Despite the usefulness of the Wills Point in geological interpretations, it forms a relatively featureless outcrop. Soils of the Crockett-Normangee general soil map unit developed over the Wills Point Formation.

Tehuacana Limestone. Limestone County was named for the Tehuacana Limestone member of the Kincaid Formation, the lower unit of the Midway Group. It forms the ridge that extends northward from Lake Mexia past Tehuacana, and at various elevations within the Mexia Fault Zone *(21)*. The limestone was a source of building stone in the past but now is being quarried extensively for road material. The limestone ranges up to 40 feet thick, thinning northward and southward from Mexia *(12)*. It is composed almost entirely of fossil shells and shell fragments, grading locally to glauconitic sandstone. The unit was the premier mapping horizon in the early days of oil exploration in Limestone and Freestone Counties.

The occurrence of the Tehuacana Limestone requires some explanation. Along the west side of the Mexia Fault Zone, the limestone has been faulted down against Upper Cretaceous shales. Because it dips eastward like the other bedrock formations, it forms west-facing escarpments. Presumably, the limestone also occurred west of the fault zone, but if so, the rock has been eroded away because it overlay soft shales that had little resistance to erosion. Along the east side of the fault zone, the limestone occurs in the subsurface underneath outcrops of the Wills Point and Hooper Formations. It is exposed in small outcrops where the Navasota River has cut through the fault zone at Springfield Lake.

Soils of the Groesbeck-Personville-Lavender general soil map unit developed over the Tehuacana Limestone outcrops. The Personville and Lavender soils clearly were formed in sand that was laid on table-like eroded surfaces of the limestone. The deeper horizons of Groesbeck soils may also have been transported, if only from nearby slopes containing silt and clay.

Kincaid Formation (lower part). The lower part of the Kincaid Formation consists of the Littig and Pisgah Members, which are undivided on the geologic atlas *(21)*. They provide similar materials for soil formation; consisting mostly of clay shale with some glauconitic sandstone, siltstone, and zones of concretions and phosphatic nodules. This formation is 116 feet thick at the type section just west of Tehuacana *(15)*. Fossils include oysters, clams, marine gastropods, and calcareous foraminifera. Soils of the Crockett-Normangee general soil map unit developed over lower Kincaid substrates, which are very similar to those of the Wills Point Formation.

Navarro Formation. The Upper Cretaceous Epoch is represented in Limestone County by the Navarro Formation, Upper Taylor Marl, Pecan Gap Chalk, and Wolfe City Sand. These units crop out in the western part of the county and form blackland prairie uplands. They consist mostly of clay shale that was deposited in marine water during a period when the Gulf of Mexico extended across much of central North America.

Three units within the Navarro Formation (or Group) are the Kemp Clay, Nacatoch Sand, and Neylandville Marl. The Navarro on outcrop consists mostly of calcareous clay shale, containing thin beds of siltstone, sandstone, concretions, and fossiliferous strata *(1)*. It is about 800 to 1,000 feet thick *(12)*. Soils of the Houston Black-Ferris-Heiden general soil map unit developed over the Navarro Formation.

Upper Taylor Marl and Pecan Gap Chalk. These two units are shown separately on geology maps *(21)*, but in Limestone County they are similar in composition and have developed similar soils. The Upper Taylor Marl is a marly clay containing considerable sandy marl, sand, and some chalk. The marl typically contains varying amounts of silt-sized quartz, glauconite pellets, phosphate nodules, calcite fragments, macrofossils, and microfossils. In Limestone County, the Pecan Gap Chalk is mostly calcareous marine shale or marl *(7)*. Soils of the Houston Black-Ferris-Heiden general soil map unit developed over the Upper Taylor Marl and the Pecan Gap Chalk.

Wolfe City Sand. The Wolfe City Sand consists of sandy or silty marl interbedded with thin sandstone lenses that are commonly 1 to 2 inches thick *(7)*. A few marine fossils may occur. The Wolfe City forms relatively high, rolling hills that include the highest hilltops within the county. Typical blackland prairie soils did not develop from this unit, probably because of the sand and silt content and because at least some of the hilltops within the general Wolfe City outcrop belt are capped by old, high gravels. Soils of the Crockett-Normangee general soil map unit developed over the Wolfe City Sand.

Subsurface Geology

A summary of subsurface geology is provided because oil, gas, and ground water have been so important to the twentieth-century history of Limestone County. Subsurface units are described from the base upward.

All of Limestone County is underlain at some depth by rocks assigned to the Paleozoic Era or about 550 to 250 million years ago. These rocks are not exposed at the surface, but they are found in deep wells. Rocks of this age are exposed far to the west in Brown, Mills, Lampasas, and Burnet Counties *(22)*.

Rocks that represent the Jurassic Period and the lower part of the Cretaceous Period of the Mesozoic Era overlie those of the Paleozoic Era *(1)*. Neither Jurassic nor Lower Cretaceous rocks are exposed at the surface within the county. The Jurassic Smackover Limestone and Cotton Valley Sandstone are important gas-bearing rocks in the eastern part of the county. These formations are at depths of 8,000 feet or more and overlie the LouAnn Salt which has flowed to form many deep structural traps for fluids. Jurassic rocks (deposited about 160 to 150 million years ago) wedge out westward in central Limestone County and never reach the surface. Lower Cretaceous rocks (deposited between 105 and 95 million years ago) do extend westward and form prominent hills and valleys in western McLennan and in Coryell and Bosque Counties *(21)*.

Upper Cretaceous rocks that underlie Limestone County include the Woodbine Sand and Austin Chalk *(1)*. Woodbine Sand was deposited in deltas of streams that entered the county from the north about 95 million years ago *(14)*. The sand pinches out westward and southward into shale units. Woodbine Sand is the reservoir rock for the Mexia oil field and other similar oil fields in central and northern Limestone County *(2,9,12)*. Long after the sand and overlying Upper Cretaceous rocks were deposited, gentle structural movements tilted them eastward toward the East Texas Basin. North-northeast to south-southwest trending faults caused shale and chalk layers to move downward against the sand, forming a trap for oil and gas that was migrating from the basin toward the outcrop areas to the west.

Austin Chalk underlies all of Limestone County. At the Mexia Oil Field the top of the formation lies at about 2,000 feet below sea level. Ignoring the complex faults which largely compensate for each other on a large scale, the formation dips eastward at about 80 feet per mile (slightly less than one degree) from the outcrop area in McLennan County.

References

(1) Adkins, W.S. 1932. The Mesozoic Systems in Texas. *In* Sellards, E.H., W.S. Adkins, and F.B. Plummer, The Geology of Texas, Vol. I, Stratigraphy. Univ. Tex. Bur. Econ. Geol. Bull. 3232.

(2) Alexander, C.I. 1951. History of discovery and development of Woodbine fields in East Texas. *In* F. E. Lozo, ed., The Woodbine and adjacent strata of the Waco area of Central Texas. South. Methodist Univ. Press, Fondren Sci. Ser., No. 4, pp. 12-20.

(3) American Association of State Highway and Transportation Officials. 1986. Standard specifications for highway materials and methods of sampling and testing. Ed. 14, 2 vols.

(4) American Society for Testing and Materials. 1993. Standard classification of soils for engineering purposes. ASTM Stand. D 2487.

(5) Ayers, W.B., Jr., and A.H. Jewis. 1985. The Wilcox Group and Carrizo Sand (Paleocene) in East-Central Texas: depositional systems and deep-basin lignite. Univ. Tex. Bur. Econ. Geol. Geological and Hydrological Folio, Spec. Publ. 85.

(6) Bammel, Bobby H. Stratigraphy of the Simsboro Formation, East-Central Texas. Baylor Geol. Stud. Bull. No. 37.

(7) Beall, Arthur O. 1964. Stratigraphy of the Taylor Formation (Upper Cretaceous), East-Central Texas. Baylor Geol. Stud. Bull. No. 6.

(8) Hawkins, Jack R. Limestone County History. *In* A family history of Limestone County. Limestone County Historical Museum Members, Vol. 1, pp. 4-5.

(9) Hudnall, James S. 1951. Mexia Field, Limestone County, Texas. *In* Herald, Frank A., ed., Occurrence of oil and gas in Northeast Texas. Univ. Tex. Publ. No. 5116, pp. 231-235.

(10) Kaiser, W.R. and others. 1986. Geology and ground-water hydrology of deep-basin lignite in the Wilcox Group of East Texas. Univ. Tex. Bur. Econ. Geol. Spec. Rep. 86.

(11) Kier, R.S., L.E. Garner, and L.F. Brown, Jr. 1977. Land resources of Texas. Univ. Tex. Bur. Econ. Geol.

(12) Lahee, Frederick H. 1929. Oil and gas fields of the Mexia and Tehuacana fault zones, Texas. *In* Hull, J.P.D., ed., Structure of typical American oil fields, Vol. I. Am. Assoc. Pet. Geol., pp. 304-388.

(13) Milligan Tri-County Guide (Limestone-Freestone-Leon). 1984. Growth & development, pp. 15-16, Limestone County.

(14) Oliver, William B. 1971. Depositional systems in the Woodbine Formation (Upper Cretaceous), Northeast Texas. Univ. Tex. Bur. Econ. Geol. Rep. Invest. No. 73.

(15) Plummer, F.B. 1932. Cenozoic Systems in Texas. *In* Sellards, E.H., W.S. Adkins, and F.B. Plummer, The Geology of Texas, Vol. I, Stratigraphy. Univ. Tex. Bur. Econ. Geol. Bull. 3232, pp. 519-818.

(16) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210.

(17) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. U.S. Dep. Agric. Handb. 436.

(18) United States Department of Agriculture, Soil Conservation Service. 1991. Soil survey laboratory methods manual. Soil Surv. Invest. Rep. 42.

(19) 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.

(20) United States Department of Agriculture. 1993. Soil survey manual. U.S. Dep. Agric. Handb. 18.

(21) University of Texas, Bureau of Economic Geology. 1970. Geologic Atlas of Texas, Waco Sheet.

(22) University of Texas, Bureau of Economic Geology. Geologic Map of Texas, MM 14. 1932 (revised edition in press).

(23) Walter, Ray A. 1959. A History of Limestone County, pp 1-22.

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.

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

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

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hillsides. Back slopes in profile are commonly steep, are linear, and may or may not include cliff segments.

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.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

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.

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.

Conglomerate. A coarse grained, clastic rock composed of rounded or subangular rock fragments more than 2 millimeters in diameter. It commonly has a matrix of sand and finer textured material. Conglomerate is the consolidated equivalent of gravel.

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.

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.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. Synonym: scarp.

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 sodium (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Fallow. Cropland left idle in order to restore productivity through accumulation of moisture. Summer fallow is common in regions of limited rainfall where cereal grain is grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

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.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

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.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

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.

Knoll. A small, low, rounded hill rising above adjacent landforms.

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.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal amounts.

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).

Mudstone. Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

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.

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.

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.

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.

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.

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.

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	8to 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.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

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.

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.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

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.”

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.

Toxicity (in tables). Excessive amount of toxic substances, such as sodium or sulfur, that severely hinder establishment of vegetation or severely restrict plant growth.

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.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded 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.

Tables

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