United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Texas Agricultural
Experiment Station

Soil Survey of Madison County, Texas

How To Use This Soil Survey

General Soil Map

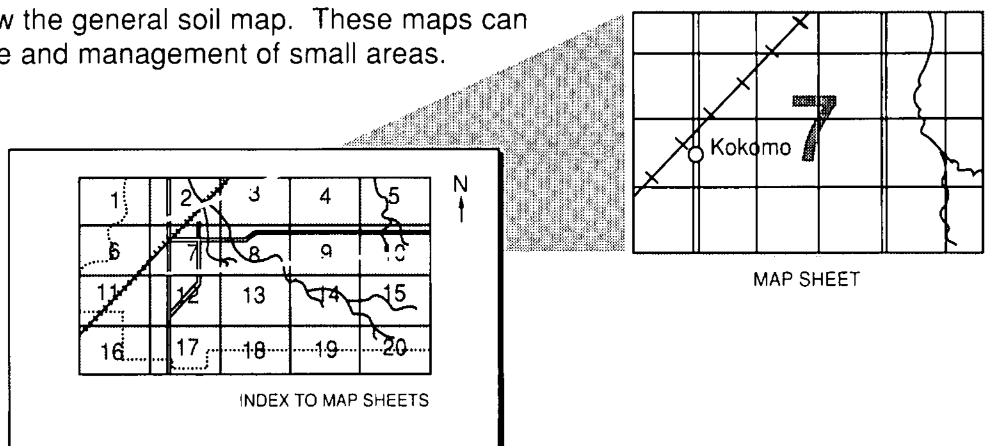
The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

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.

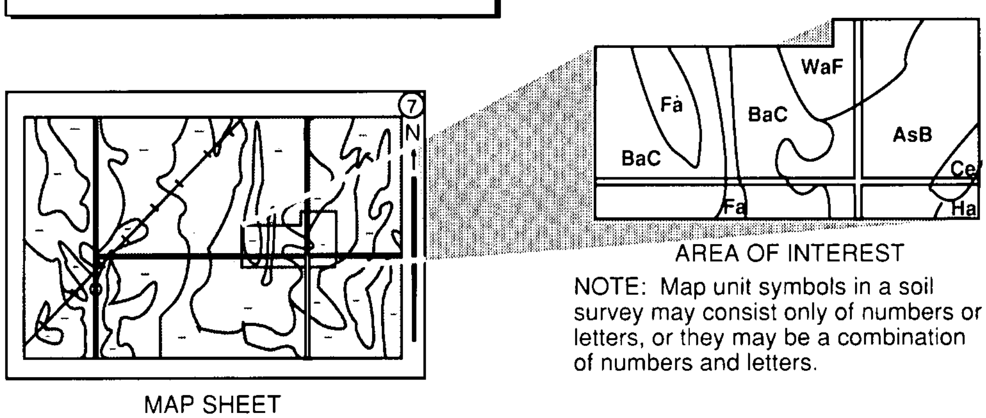
Detailed Soil Maps

The detailed soil maps follow the general soil map. These 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**, which precedes the soil maps. 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 **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **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 Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1988. Soil names and descriptions were approved in 1989. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1988. This survey was made cooperatively by the Soil Conservation Service and Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Bedias Creek 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 Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: Well managed pasture in an area of Boonville fine sandy loam, 1 to 3 percent slopes.

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Issued June 1994

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Foreword

This soil survey contains information that can be used in land-planning programs in Madison County, Texas. 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, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help themselves understand, protect, and enhance the environment.

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 Soil Conservation Service or the Cooperative Extension Service.

Harry W. Oneth
State Conservationist
Soil Conservation Service

Soil Survey of
Madison County, Texas

By Conrad L. Neitsch, Soil Conservation Service

Fieldwork by Conrad L. Neitsch, Joseph J. Castille, and Maurice R. Jurena, soil scientists, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Texas Agricultural Experiment Station

MADISON COUNTY is in the eastern part of central Texas (fig. 1). It is about 16 miles long and 35 miles wide and is irregularly shaped. It has a total area, including water areas, of 302,451 acres, or about 472 square miles.

The land surface is undulating to gently rolling and generally slopes to the southeast. Elevations range from about 420 feet above sea level in the north-central part of the county to about 140 feet above sea level in the southeastern part. Most of the county is at an elevation of 200 to 350 feet above sea level.

The major drainage system in Madison County is the Trinity River. The western third of the county, however, drains into the Navasota River.

Madison County is in three major land resource areas (MLRA's)—the Western Coastal Plain, the Texas Claypan Area, and the Texas Blackland Prairie. The Western Coastal Plain MLRA has mostly light colored sandy and loamy soils that formed under pine forest vegetation. The Texas Claypan Area MLRA has mostly light colored loamy soils that formed under post oak savannah vegetation. The Texas Blackland Prairie MLRA has dark loamy soils that formed under grass.

The major land use in Madison County is rangeland. About 42 percent of the county is used as rangeland or unimproved pasture, and 24 percent is densely covered with post oak and is used as rangeland or as wildlife habitat. About 28 percent is used as improved pasture and hayland, 2 percent is used for crops or orchards, slightly more than 1 percent is used for pines, and the remaining acreage is urban or water areas.

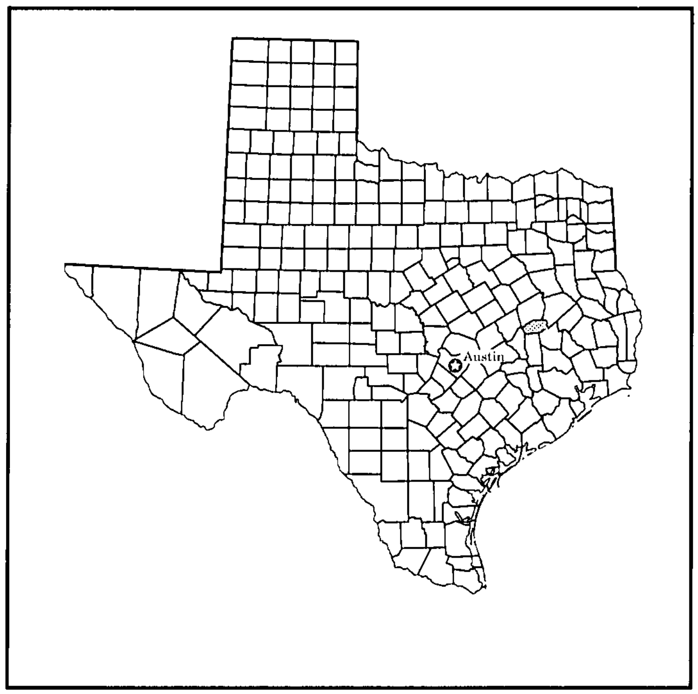

Figure 1.—Location of Madison County in Texas.

General Nature of the County

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

History and Settlement

This section was based mainly on a study by Cecil N. Neely *(20)*.

Madison County was organized in 1853 from parts of Grimes, Leon, and Walker Counties. It was named in honor of James Madison, the fourth president of the United States.

Indian tribes inhabited the survey area for thousands of years prior to exploration of the area by Europeans. To the east of the area were the tribes of the Caddo Confederacies. The Cenis tribe was the largest tribal group of the Caddoes. They occupied most of what is now eastern Texas, including parts of Madison County. Many of them lived on the banks of the Trinity River in large villages. Their homes were shaped like beehives and were about 40 feet tall. The Cenis raised mostly corn and squash. To the south of the Caddoes were the Atakapa. The Bedias, a branch of the Atakapa, lived along the Trinity River and Bedias Creek. Their main village was in the southeastern part of the county at the confluence of the two waterways. The Deadose, a family outgrowth of the Bedias, occupied most of what is now Madison County.

The first Europeans to explore Texas were Spanish and French. One of the earliest explorers was Luis de Moscoso, a Spaniard who was a member of the Hernando de Soto expedition. After De Soto's death in 1542, Moscoso continued the journey westward, crossed the Trinity River, and entered the southeastern part of the area that is now Madison County. He remained in the area for a few days before returning along the same route that he had come.

The French explorer René Robert Cavelier de la Salle also traveled in the area. Some historians believe that he was killed on March 20, 1687, directly south of present-day Madisonville.

In 1774, a Spanish settlement named Bucareli was organized by Gil Ybarbo and established on the west bank of the Trinity River as an outpost against French invasion. This community was originally located where present-day Texas Highway 21 crosses the Trinity River. Because of epidemics, raids by Comanches, and severe flooding, this site was abandoned in April 1779. The settlers moved east to the site that is now Nacogdoches.

In 1805, the Spanish established the settlement named Spanish Bluff south of the old Bucareli settlement. The purpose of this settlement was to keep a Spanish garrison in the area claimed by the United States.

In 1812, the Magee-Gutierrez expedition attempted to take control of the Texas territory from the Spanish. The attempt failed, and the surviving members of the expedition fled eastward toward the United States. About 80 of the survivors were captured and were executed at Spanish Bluff.

The early roads in Madison County have even more historical significance than the first settlements because they expedited the settlement of Texas. The north road, known as Old San Antonio Road, El Camino Real, or the King's Highway, connected the missions and settlements near Natchitoches and Nacogdoches with those at San Antonio and in Mexico. Another road, known as the La Bahia Road, split away in a southwesterly direction from the Old San Antonio Road near Midway. It connected the settlements in eastern Texas with the mission at Goliad. The approximate locations of these two roads are shown on a June 1858 property map of Madison County *(14)*. These roads show the historical importance of Madison County in the early settlement of Texas.

In 1836, the Old San Antonio Road and La Bahia Road played a part in the Texas revolution. During the "Runaway Scrape" in February of that year, the advancing army of Santa Anna caused the settlers to flee eastward along these two roads. It was along these two roads that the settlers received word that Santa Anna had been defeated at San Jacinto.

After the Texas revolution, settlement of Madison County proceeded rapidly. By the end of the 1800's, settlers had established communities throughout the county. In 1903, the first railroad was built in the survey area.

Agriculture

The production of livestock and hay are the main agricultural enterprises in Madison County. The production of crops, mainly cotton and corn, was once the primary land use. Pasture and hayland have replaced cultivated crops in most areas.

Most livestock operations in the county are cow-calf operations. The livestock usually are pastured in summer and given hay and feed supplements in winter. The cattle graze improved, cool-season grasses and legumes in winter, spring, and early summer. Coastal bermudagrass is the main species of grass grown on improved pastureland.

The main crops are hay and forage. A few areas are used for the production of cotton, corn, grain sorghum, or small grain or for truck crops, such as peas, beans, and greens. Pecan production is important in a few areas on the bottom land along the Trinity River.

A few small areas, mostly in the southeastern part of the county, are used for the commercial production of pine and hardwood timber.

Natural Resources

The most important natural resources in Madison County are soil, water, wildlife, petroleum, and natural gas. Soil is critical for the production of livestock, hay, forage, crops, and timber, which are the main sources of income in the county. Sand and gravel are mined on the terraces along the Trinity River. They are mainly used for the construction of roads and buildings.

Very limited amounts of timber are in the county. Improved woodland management could provide additional income to some landowners. Most of the soils in the southeastern part of the county have potential for pine or hardwood timber.

Water is abundant in the numerous small lakes, ponds, creeks, and rivers in the county. Most areas in the county have ample supplies of good-quality underground water for industrial, recreational, agricultural, and domestic uses.

Fish and wildlife provide opportunities for recreation and for added income for some landowners. Most areas of the county are leased for deer hunting.

Climate

Madison 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. Snowfall is infrequent. Annual total precipitation is normally adequate for the production of cotton, feed grain, and small grain.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Madisonville in the period 1951 to 1986. 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 52 degrees F and the average daily minimum temperature is 40 degrees. The lowest temperature on record, which occurred at Madisonville on February 2, 1951, is 6 degrees. In summer, the average temperature is 83 degrees and the average daily maximum temperature is 95 degrees. The highest recorded temperature, which occurred at Madisonville on July 25, 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 41.83 inches. Of this, 22 inches, or about 50 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 17 inches. The heaviest 1-day rainfall during the period of record was 7.52 inches at Madisonville on October 14, 1957. Thunderstorms occur on about 63 days each year.

The average seasonal snowfall is about 1 inch. The greatest snow depth at any one time during the period of record was 4 inches.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 90 percent. The sun shines 65 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 9 miles per hour, in spring.

Tornadoes and severe thunderstorms occasionally occur. These storms are of local extent and short duration. The pattern of damage varies and is spotty.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; 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 from 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 in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil 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-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 soil 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. 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 are generally 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 behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses 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 assure 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.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. 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 soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. In the detailed soil map units, these latter soils are called inclusions or included soils. In the general soil map units, they are called soils of minor extent.

Most inclusions have properties and behavioral patterns 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 (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small 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 and some minor soils. It is named for the major soils. The soils making up one 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 a 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. Zach-Zulch-Boonville

Very gently sloping to moderately sloping, loamy soils that are moderately well drained and somewhat poorly drained; on uplands

This map unit typically is on broad, smooth ridges and gently sloping side slopes. It is drained by small, shallow streams and creeks that generally flow in a southeastward direction into the Trinity River and Bedias Creek. Surface water in some areas in the southwestern part of the county drains into the Navasota River. Much of the rainfall runs off the surface before it can enter these very slowly permeable soils. Relief is mainly less than 50 feet within a distance of 1 mile. The underlying material is stratified clay, shale, and sandstone of the Yegua Formation.

This map unit makes up about 41 percent of the county. It is about 28 percent Zack soils, 23 percent Zulch soils, 15 percent Boonville soils, and 34 percent soils of minor extent (fig. 2).

Zack soils are on broad ridges, divides, and shoulder slopes. Typically, the surface layer is brownish fine sandy loam about 7 inches thick. The subsoil is reddish and brownish clay, which extends to a depth of about 36 inches. The underlying material to a depth of 80 inches is grayish shale that has a texture of clay. These soils are acid in the topsoil and subsoil and alkaline in the underlying material.

Zulch soils are on shoulder slopes, side slopes, and foot slopes. Typically, the surface layer is brownish fine sandy loam about 9 inches thick. The subsoil is grayish clay, which extends to a depth of 41 inches. The underlying material to a depth of 60 inches is grayish and olive, weakly consolidated shale that has a texture of clay. These soils are acid in the topsoil, neutral in the upper part of the subsoil, and alkaline in the lower part of the subsoil and in the underlying material.

Boonville soils are on the lower side slopes and on foot slopes. Typically, the surface layer is brownish fine sandy loam about 15 inches thick. The subsoil is grayish and brownish clay, which extends to a depth of 72 inches. The underlying material to a depth of 80 inches is grayish, stratified loam and clay. These soils are acid in the topsoil and the upper part of the subsoil and alkaline in the lower part of the subsoil and in the underlying material.

Of minor extent in this map unit are Chazos, Gowker, Gredge, Lufkin, Nahatche, Rader, Robco, and Tabor soils. Chazos and Gredge soils are on divides. Gowker and Nahatche soils are on flood plains along creeks and streams. Lufkin, Rader, and Tabor soils are on the lower slopes and terraces along creeks. Robco soils are at the head of drainageways, along poorly defined drainageways, and on toe slopes.

The soils in this map unit are used mainly as pasture, hayland, or range. A few small areas are used as cropland. Some areas are planted to rye, oats, or wheat for winter grazing.

Much of the pasture and hayland supports improved bermudagrass or bahiagrass. Droughtiness is the main limitation in the areas used for pasture and hay. Applications of fertilizer and lime are needed for sustained yields. Overseeding arrowleaf clover, subterranean clover, vetch, and singletary peas into the grasses lengthens the grazing season and improves fertility.

The areas of range support mid and tall grasses and

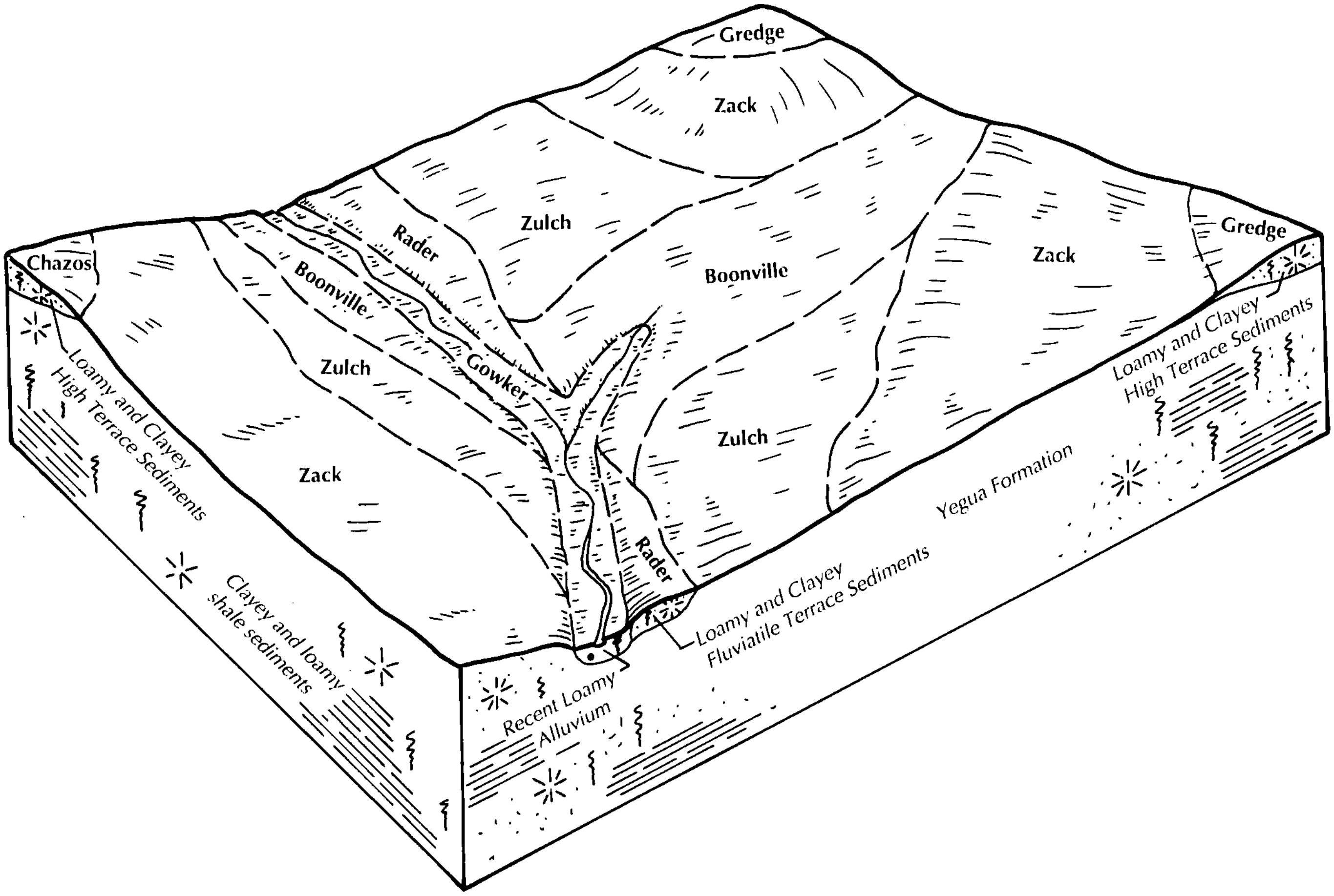

Figure 2.—Pattern of soils and parent material in the Zack-Zulch-Boonville general soil map unit.

elm, hackberry, and oak trees along drainageways. Mesquite has invaded some areas. Summer droughtiness is the main limitation in the areas used as range.

A few areas of this map unit are used for corn or small grain. Corn and cotton were grown to a large extent on these soils in the past. The soils are droughty during the summer. Cover crops, contour farming, and terraces help to control erosion. Crops respond well to applications of nitrogen and phosphorus fertilizer.

Seasonal wetness, a high shrink-swell potential in the subsoil, and restricted permeability limit the use of these soils for urban development. Properly designing structures can compensate for the shrinking and swelling of the clayey subsoil. Properly designing septic tank absorption fields can help to overcome the restricted permeability. Otherwise, sewage lagoons can be used rather than absorption fields. Low strength is a limitation on sites for local roads and streets.

2. Rader-Gredge-Chazos

Very gently sloping to moderately sloping, loamy and sandy soils that are moderately well drained; on high terraces and uplands

This map unit typically is on broad, smooth uplands and low, smooth ridges and divides. It is drained by small, shallow streams and creeks that generally flow in a southeastward direction into the Trinity River. In some areas surface water drains into the Navasota River. Relief is mainly less than 30 feet to 50 feet within a distance of 1 mile. The soils formed in a thin terrace veneer over stratified clay, shale, and sandstone of the Cook Mountain Formation.

This map unit makes up about 19 percent of the county. It is about 33 percent Rader soils, 13 percent Gredge soils, 10 percent Chazos soils, and 44 percent soils of minor extent (fig. 3).

Rader soils are on broad flats and the lower side slopes. Typically, the surface layer is brownish very fine sandy loam about 24 inches thick. The upper part of the subsoil, from a depth of 24 to 33 inches, is brownish and yellowish very fine sandy loam and loam. The lower part, from a depth of 33 to 61 inches, is brownish clay and clay loam. The underlying material to a depth of 80 inches is grayish clay loam. These soils are acid throughout.

Gredge soils are on broad ridges, divides, and shoulder slopes. Typically, the surface layer is brownish fine sandy loam about 7 inches thick. The upper part of the subsoil, from a depth of 7 to 21 inches, is reddish clay. The next part, from a depth of 21 to 32 inches, is grayish clay. The lower part, from a depth of 32 to 63 inches, is grayish sandy clay loam. Below this to a depth of 80 inches is grayish, loamy and clayey shale. These soils are acid to a depth of about 45 inches and alkaline in the lower part.

Chazos soils are mainly on ridges and divides. Typically, the surface layer is brownish loamy fine sand about 14 inches thick. The subsoil, from a depth of 14 to 63 inches, is brownish and grayish clay and sandy clay. The underlying material to a depth of 80 inches is grayish sandy clay loam. These soils are acid throughout.

Of minor extent in this map unit are Boonville, Derly, Gasil, Gowker, Kurten, Nahatche, Robco, Spiller, Tabor, Zack, and Zulch soils. Boonville and Robco soils are on the lower side slopes and at the head of drainageways. Gasil and Spiller soils are on ridges and divides. Gowker and Nahatche soils are on flood plains along creeks and streams. Kurten, Tabor, Zack, and Zulch soils are on side slopes. Derly soils are on low flats.

The soils in this map unit are used mainly as pasture, hayland, or range. These soils generally are not used as cropland, but some areas are planted to rye, oats, or wheat for winter grazing.

Most of the pasture and hayland supports improved bermudagrass or bahiagrass. Applications of fertilizer and lime are needed for sustained yields. Overseeding

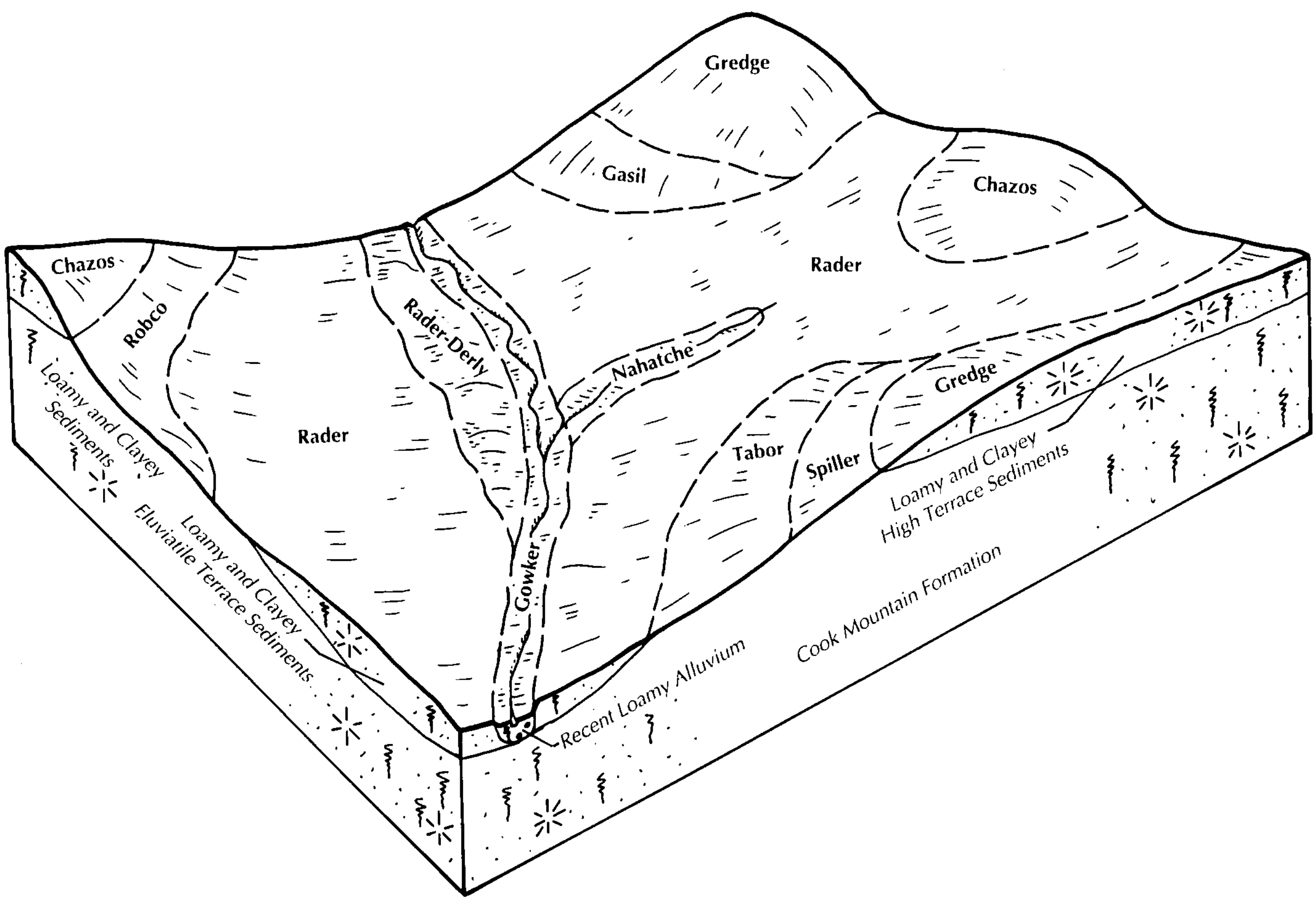

Figure 3.—Pattern of soils and parent material in the Rader-Gredge-Chazos general soil map unit.

arrowleaf clover, subterranean clover, vetch, and singletary peas into the grasses lengthens the grazing season and improves fertility.

The range plants in areas of this unit are tall grasses in an oak savannah.

Although crops generally are not planted on these soils, they have been grown on the soils in the past. Corn, cotton, grain sorghum, and small grain are suitable crops. The soils are droughty during the summer and wet during the winter.

A high shrink-swell potential and restricted permeability in the subsoil limit the use of these soils for urban development. Seasonal wetness also is a limitation in some areas. Properly designing structures can compensate for the shrinking and swelling of the clayey subsoil. Properly designing septic tank absorption fields can help to overcome the restricted permeability. Otherwise, sewage lagoons can be used rather than absorption fields.

3. Rader-Derly

Nearly level and very gently sloping, loamy soils that are moderately well drained and poorly drained; on terraces

This map unit typically is on broad, nearly level to gently undulating, mounded stream terraces. The terraces are 15 to 75 feet above the flood plains along streams and rivers. The drainage pattern is poorly defined. Relief is mainly less than 30 feet within a distance of 1 mile. The surface has been partly reworked by the wind. The underlying material is interbedded loamy and clayey material.

This map unit makes up about 11 percent of the county. It is about 42 percent Rader soils, 18 percent Derly soils, and 40 percent soils of minor extent.

Rader soils are on mounds and broad flats. Typically, the surface layer is brownish very fine sandy loam about 24 inches thick. The upper part of the subsoil, from a depth of 24 to 33 inches, is brownish and yellowish very fine sandy loam and loam. The lower part, from a depth of 33 to 61 inches, is brownish clay and clay loam. The underlying material to a depth of 80 inches is grayish sandy clay loam. These soils are acid throughout.

Derly soils are on nearly level flats and in areas between mounds. They occur mainly in a complex with the Rader soils. Typically, the surface layer is brownish and grayish silt loam about 7 inches thick. The subsoil is brownish and grayish clay, which extends to a depth of about 52 inches. The underlying material to a depth of 80 inches is grayish clay loam. These soils are acid in the surface layer and subsoil and neutral in the underlying material.

Of minor extent in this map unit are Chazos, Hatliff, Lufkin, Mabank, Nahatche, Silawa, and Tabor soils. Chazos and Silawa soils are slightly higher on the landscape than the Derly soils. Lufkin and Mabank soils are in the same landscape positions as the Derly soils or are in the slightly higher positions. Hatliff and Nahatche soils are on flood plains along creeks and streams. Tabor soils are in the same landscape position as the Rader soils.

The soils in this map unit are used mainly as pasture, hayland, or range. A few small areas are used as cropland. Some areas are planted to rye, oats, or wheat for winter grazing.

Most of the pasture and hayland supports improved bermudagrass or common bermudagrass. Overseeding clovers, vetch, and singletary peas into the grasses lengthens the grazing season and improves fertility. Applications of fertilizer and lime are needed for sustained production.

The range plants in areas of this unit are tall grasses in an oak savannah. The main limitations are wetness during winter and droughtiness during summer in areas of the Lufkin soils.

These soils are used as cropland only in small isolated areas. In the past the better drained areas have been used for corn or cotton. Applications of fertilizer and lime are needed for sustained production.

Wetness, the shrink-swell potential, and very slow permeability limit the use of these soils for urban development. Properly designing roads and structures can compensate for the shrinking and swelling of the clayey subsoil. Properly designing septic tank absorption fields can help to overcome the restricted permeability. Otherwise, sewage lagoons can be used rather than absorption fields.

4. Gowker-Nahatche

Nearly level, loamy soils that are moderately well drained and somewhat poorly drained; on flood plains

This map unit typically is on nearly level flood plains along streams in all parts of the county. Relief is mainly less than 5 feet to 10 feet within a distance of 1 mile. The soils formed in alluvial sediments derived from nearby terraces and uplands.

This map unit makes up about 9 percent of the county. It is about 62 percent Gowker soils, 25 percent Nahatche soils, and 13 percent soils of minor extent.

Gowker soils are in nearly level areas that generally are several hundred feet across. They are moderately well drained. Typically, the surface layer is brownish clay loam about 20 inches thick. The next layer is grayish and brownish clay loam, which extends to a depth of 45 inches. The underlying material to a depth of 80 inches is brownish clay loam. These soils are acid in the upper 45 inches and neutral or alkaline between depths of 45 and 80 inches.

Nahatche soils are in the lower areas. They are somewhat poorly drained. Typically, the surface layer is brownish loam about 8 inches thick. The next layer is brownish clay loam, which extends to a depth of 17 inches. Below this to a depth of 60 inches is brownish loam. These soils are acid throughout.

Of minor extent in this map unit are Gladewater, Hatliff, Portersprings, and Kaufman soils. Gladewater and Kaufman soils are on flood plains in areas where streams flow into the Trinity and Navasota Rivers. Gladewater soils are in the lower, wetter areas. Hatliff soils are on natural levees next to the stream channels and on flood plains along streams that drain areas of sandy soils. Portersprings soils are in the slightly higher landscape positions and are rarely flooded. Kaufman soils are in landscape positions similar to those of the Gowker soils.

The soils in this map unit are used as pasture, range, or woodland. They generally are not used as cropland because of flooding and wetness.

Most of the pasture supports common or improved bermudagrass and bahiagrass. Legumes, such as white clover, vetch, and singletary peas, grow well. Applications of fertilizer and lime are needed for sustained yields. Wetness and the hazard of flooding are the main management concerns.

These soils are used as range in some areas. The vegetation is tall grasses and hardwoods, woody shrubs, and vines.

In some areas these soils are used as woodland. Hardwood trees, such as water oak, willow oak, and sweetgum, are dominant. A few scattered loblolly pines grow in the southeastern part of the county. The native understory in the wooded areas is grazed by livestock and game animals.

Because of flooding and wetness, these soils are not suitable as homesites.

5. Robco-Padina-Silstid

Very gently sloping and gently sloping, sandy soils that are moderately well drained and well drained; on uplands

This map unit typically is on broad, sandy ridges and divides. The drainage pattern is poorly defined. There is very little runoff because these deep, loose sandy soils have a high infiltration rate. Seeps are common along the lower edge of the side slopes. Water that flows through the small drainageways eventually enters creeks that flow in a southeastward direction to the Trinity River or in a southwestward direction to the Navasota River. Relief is mainly 50 to 100 feet within a distance of less than 1 mile. The underlying material is interbedded sandy, loamy, and clayey sediments. The soils formed mainly in material derived from sandy members of the Cook Mountain and Yegua Formations.

This map unit makes up about 4 percent of the county. It is about 36 percent Robco soils, 19 percent Padina soils, 15 percent Silstid soils, and 30 percent soils of minor extent (fig. 4).

Robco soils are on side slopes and foot slopes. Typically, the surface layer is brownish loamy fine sand about 24 inches thick. The subsoil, from a depth of 24 to 73 inches, is yellowish and brownish sandy clay loam mottled with gray. The underlying material to a depth of 80 inches is whitish sandy clay loam. These soils are acid in the topsoil and subsoil and neutral in the underlying material.

Padina soils are on ridges and side slopes. Typically, the surface layer is brownish loamy fine sand about 52 inches thick. The subsoil to a depth of 80 inches is reddish and brownish sandy clay loam. These soils are acid throughout.

Silstid soils are on ridges, divides, and the upper side slopes. Typically, the surface layer is brownish loamy fine sand about 32 inches thick. The subsoil to a depth of 80 inches is brownish and yellowish sandy clay loam. These soils are acid throughout.

Of minor extent in this map unit are Chazos, Dutek, Gredge, and Rader soils. Chazos, Dutek, and Gredge soils are on ridges and the upper side slopes. Rader soils are on the lower side slopes.

The soils in this map unit are used mainly as pasture, hayland, or range. A few small areas are used as cropland.

Most of the pasture and hayland supports improved bermudagrass. Some areas support weeping lovegrass. Droughtiness and a low available water capacity limit the use of the Padina and Silstid soils for pasture and hay. Applications of fertilizer and lime are needed for sustained yields. Overseeding legumes, such as vetch and singletary peas, into the grasses lengthens the grazing season and improves fertility.

The range plants in areas of this unit are tall grasses in an oak savannah. Droughtiness is the main limitation in the areas used as range.

Only a few small areas of these soils are used as cropland. Corn is the major crop. Droughtiness is a limitation if crops are grown on the Padina and Silstid soils. Applications of fertilizer and lime are needed for sustained production.

Seasonal wetness in the Robco soils and the loose, permeable, sandy topsoil in all of the major soils are limitations affecting urban development. Seepage of effluent or other contaminants into the underground water is a serious hazard.

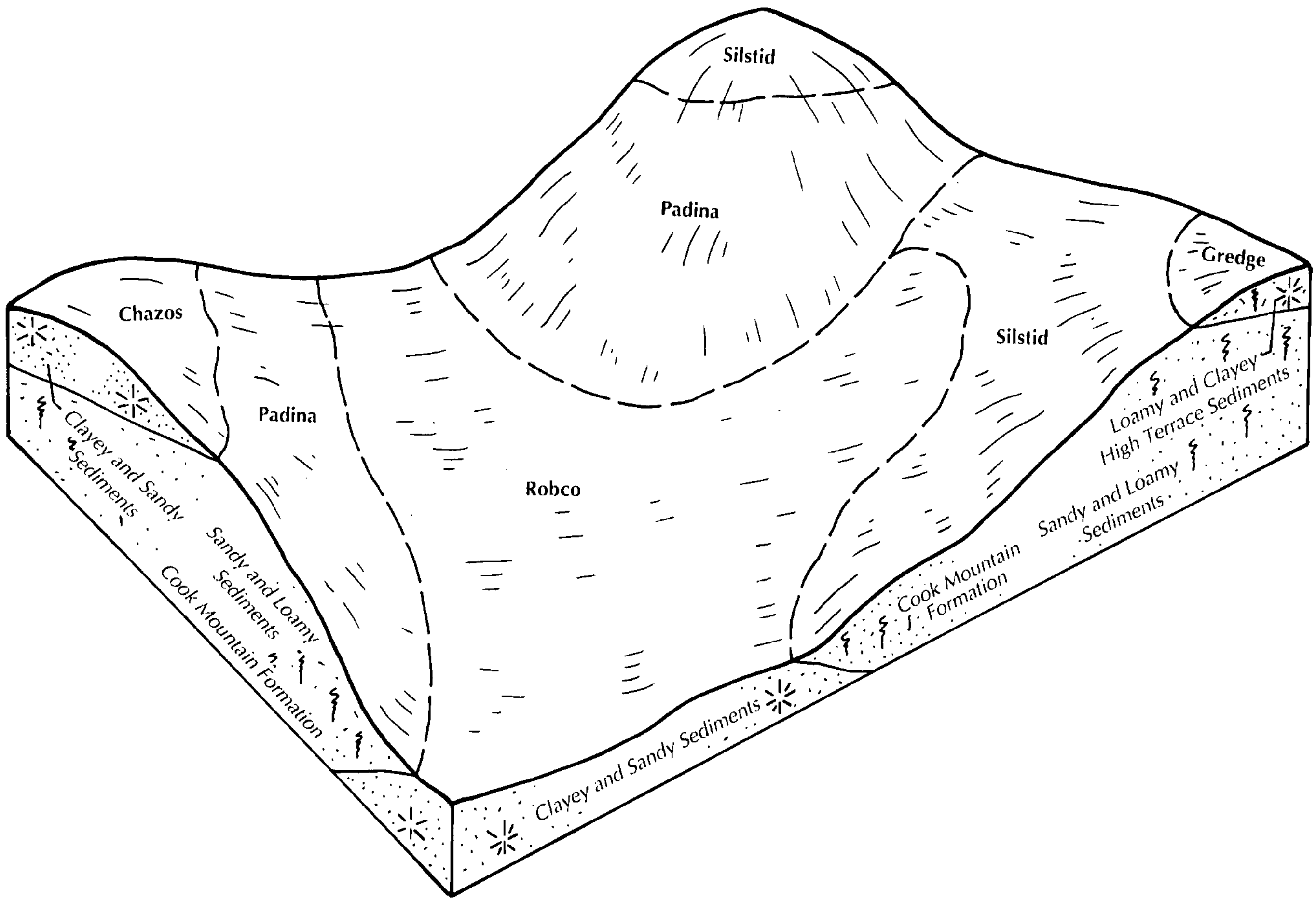

Figure 4.—Pattern of soils and parent material in the Robco-Padina-Silstid general soil map unit.

6. Kaufman-Gladewater

Nearly level, clayey soils that are somewhat poorly drained and poorly drained; on flood plains

This map unit typically is on nearly level flood plains along the Trinity River. These soils are flooded once every 2 to 20 years. Relief is mainly less than 10 feet within a distance of 1 mile. The soils formed in recent clayey sediments derived from sources upriver and outside the county, mainly from soils that formed in material derived from Cretaceous limestone and marl and small amounts of other material.

This map unit makes up about 4 percent of the county. It is about 58 percent Kaufman soils, 37 percent Gladewater soils, and 5 percent soils of minor extent.

Kaufman soils are on nearly level bottom land and are slightly higher on the landscape than the Gladewater soils. Typically, the surface layer is black clay about 58 inches thick. Below this to a depth of 80 inches is brownish clay. These soils are acid to neutral in the upper part and alkaline in the lower part.

Gladewater soils are on nearly level bottom land. Typically, the surface layer is brownish clay about 7 inches thick. The subsoil and underlying material to a depth of 80 inches are grayish clay. These soils are acid throughout.

Of minor extent in this map unit are Gowker, Hatliff, and Nahatche soils. These minor soils are mainly on flood plains in areas where streams flowing into the Trinity River deposit less clayey sediments. Generally, they are slightly higher on the landscape than the Kaufman and Gladewater soils.

The soils in this map unit are used for pasture, hayland, crops, or range.

Most of the pasture and hayland supports improved bermudagrass, common bermudagrass, and

Dallisgrass. Legumes, such as white clover and vetch, grow well. Applications of nitrogen and phosphorus fertilizer are needed for sustained yields.

The range plants in areas of this unit are tall grasses in a savannah that supports hardwoods, woody vines, and shrubs. The savannah has a 30 percent canopy.

The soils in the occasionally flooded areas of this map unit are suited to cotton, corn, grain sorghum, soybeans, and small grain. Pecans are grown in some areas. The wetness and the clayey texture are limitations. In most areas the flooding prevents economical crop production.

The flooding, wetness, a high shrink-swell potential, restricted permeability, and the clayey texture limit the use of these soils for urban development. The soils are not suitable as homesites.

7. Bienville

Very gently sloping, sandy soils that are somewhat excessively drained; on stream terraces

This map unit typically is on broad, very gently sloping, sandy terraces. The terraces are 5 to 50 feet above the flood plain. The drainage pattern is poorly defined. Most rainfall enters the deep, sandy soils. Relief is mainly less than 25 feet within a distance of less than 1 mile. The surface has been partly reworked by the wind. The underlying material is sandy terrace deposits from sandy formations that lay to the north of the county.

This map unit makes up about 3 percent of the county. It is about 52 percent Bienville and similar soils and 48 percent soils of minor extent.

Bienville soils are in the slightly higher, broad areas. They are brownish loamy fine sand to a depth of 80 inches. They are acid throughout.

Of minor extent in this map unit are Derly, Eufaula, Gowker, Hatliff, Navasan, Portersprings, and Rader soils. Derly soils are in the slightly lower and wetter areas. Eufaula soils are in the higher landscape positions. Gowker and Hatliff soils are subject to flooding. Navasan soils are adjacent to the flood plain. Portersprings soils are in about the same landscape position as the Bienville soils or are slightly lower. They are in a complex with the Gowker soils. Rader soils are in the higher landscape positions, next to uplands.

The soils in this map unit are used mainly as pasture and hayland. In some areas they are used as cropland or woodland. Some areas are used for the production of pecans.

Most of the pasture and hayland supports improved bermudagrass and weeping lovegrass. Droughtiness is the main limitation in the areas used for pasture and hay. Light applications of fertilizer and lime at frequent intervals are needed for high production. Overseeding legumes, such as vetch, crimson clover, and singletary peas, into the grasses lengthens the grazing season and improves fertility.

In cultivated areas, corn is the main crop. Applications of fertilizer and lime are needed for high production. Some areas have excellent pecan orchards.

The dominant commercial trees are loblolly pine, shortleaf pine, and water oak. The native understory is grazed by livestock and game animals.

The loose, permeable sand limits the use of these soils for some urban development. Seepage of effluent or other contaminants into the underground water is a serious hazard.

8. Crockett-Benchley-Dimebox

Nearly level to gently sloping, loamy and clayey soils that are moderately well drained; on uplands

This map unit typically is on broad, smooth ridges. It is drained by small, shallow streams that generally flow in a southward direction. Much of the rainfall flows into drainageways before it can enter the crusty surface of these slowly permeable and very slowly permeable soils. Relief is mainly less than 50 feet within a distance of 1 mile. The underlying material is stratified clay, shale, marl, and sandstone, mostly of the Cook Mountain Formation.

This map unit makes up 2 percent of the county. It is about 39 percent Crockett soils, 10 percent Benchley soils, 5 percent Dimebox soils, and 46 percent soils of minor extent (fig. 5).

Crockett soils are on broad, nearly level to gently sloping ridges and side slopes. Typically, the surface layer is brownish loam about 6 inches thick. The subsoil is brownish clay, which extends to a depth of 59 inches. The underlying material to a depth of 80 inches is grayish clay and shale. These soils are acid in the topsoil and the upper part of the subsoil, neutral in the lower part of the subsoil, and alkaline in the underlying material.

Benchley soils are on broad, gently sloping ridges and on lower slopes near drainageways. Typically, the surface layer is grayish clay loam about 12 inches thick. The upper part of the subsoil, from a depth of 12 to 29 inches, is brownish and grayish clay. The lower part, from a depth of 29 to 55 inches, is reddish clay. The underlying material to a depth of 80 inches is brownish clay. These soils are acid in the surface layer and subsoil and neutral to alkaline in the underlying material.

Dimebox soils are in broad, nearly level areas.

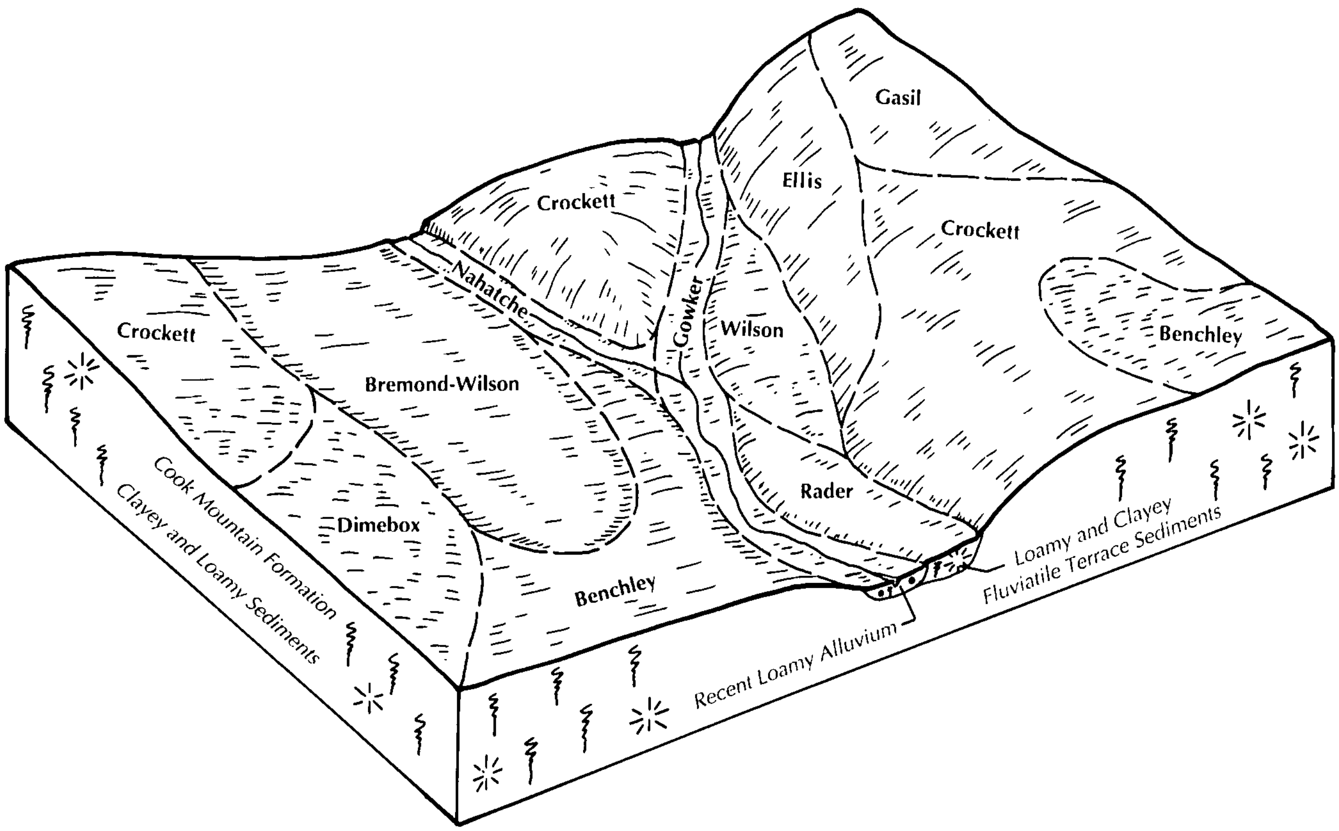

Figure 5.—Pattern of soils and parent material in the Crockett-Benchley-Dimebox general soil map unit.

Typically, the surface layer is grayish silty clay about 6 inches thick. The subsoil is black clay, which extends to a depth of 52 inches. The underlying material to a depth of 91 inches is grayish clay. These soils are acid in the topsoil and the upper part of the subsoil and alkaline in the lower part of the subsoil and in the underlying material.

Of minor extent in this map unit are Bremond, Ellis, Gasil, Gowker, Nahatche, Jedd, Rader, Spiller, and Wilson soils. Bremond, Rader, and Wilson soils are on smooth flats. Ellis and Jedd soils are on the steeper side slopes above drainageways. Gasil and Spiller soils are on the higher ridges. Gowker and Nahatche soils are on flood plains.

The soils in this map unit are used mainly as pasture and hayland. A few areas are used as range or cropland.

Most of the pasture and hayland supports improved bermudagrass. Droughtiness is the main limitation in the areas used for pasture and hay. Applications of fertilizer are needed for sustained yields. Overseeding arrowleaf clover, subterranean clover, vetch, and singletary peas into the grasses lengthens the grazing season and improves fertility.

The range plants in areas of this unit are tall grasses and a few elm and hackberry trees along drainageways. Mesquite has invaded a few areas. Summer droughtiness is the main limitation in the areas used as range.

A few areas of this map unit are used for corn or small grain. Corn and cotton were grown to a large extent on these soils in the past. The soils are droughty during the summer, and the surface is crusty when dry. Cover crops, contour farming, and terraces help to control erosion. Crops respond well to applications of nitrogen and phosphorus fertilizer.

A high shrink-swell potential in the subsoil and restricted permeability limit the use of these soils for urban development. Properly designing structures can compensate for the shrinking and swelling of the clayey subsoil. Properly designing septic tank absorption fields can help to overcome the restricted permeability. Otherwise, sewage lagoons can be used rather than absorption fields.

9. Elmina-Huntsburg

Very gently sloping and gently sloping, sandy soils that are somewhat poorly drained and moderately well drained; on uplands

This map unit typically is on broad, smooth ridges. It is drained by small, shallow streams that flow in a southward direction into Bedias Creek. Relief is less than about 50 feet within a distance of 1 mile. The underlying material is stratified clay, shale, and sandstone of the Yegua and Caddell Formations.

This map unit makes up 2 percent of the county. It is about 39 percent Elmina soils, 18 percent Huntsburg soils, and 43 percent soils of minor extent.

Elmina soils are on broad, gently sloping ridges. Typically, the surface layer is brownish loamy fine sand about 25 inches thick. The subsoil, which extends to a depth of 58 inches, is brownish clay in the upper part and grayish clay in the lower part. The underlying material is brown sandstone. These soils are acid throughout.

Huntsburg soils are on broad, gently sloping ridges and on side slopes near drainageways. Typically, the surface layer is brownish loamy fine sand about 18 inches thick. The upper part of the subsoil, from a depth of 18 to 25 inches, is brownish sandy clay. The next part, from a depth of 25 to 58 inches, is reddish clay. The lower part, from a depth of 58 to 74 inches, is grayish clay loam. Below this to a depth of 80 inches is grayish, stratified shale and sandstone. These soils are acid throughout.

Of minor extent in this map unit are Arriola, Bienville, Derly, Gowker, Hatliff, and Tonkavar soils. Arriola and Tonkavar soils are on side slopes above drainageways. Bienville and Derly soils are on low terraces above drainageways. Gowker and Hatliff soils are on flood plains.

The soils in this map unit are used mainly as woodland, pasture, or hayland. Some small areas are used as cropland.

Most of the pasture and hayland supports improved bermudagrass. Weeping lovegrass also is a suitable pasture plant. Applications of fertilizer and lime are needed for sustained yields. Overseeding legumes, such as arrowleaf clover, subterranean clover, vetch, and singletary peas, into the grasses lengthens the grazing season and improves fertility.

The soils in this unit have been used for corn, small grain, and cotton in the past. They are droughty during the summer.

In the wooded areas the dominant commercial trees are loblolly pine and shortleaf pine. The native understory is grazed by livestock and game animals in most of the wooded areas.

A high shrink-swell potential and restricted permeability in the subsoil limit the use of these soils for urban development. Seasonal wetness also is a limitation. Properly designing structures can compensate for the shrinking and swelling of the clayey subsoil. Properly designing septic tank absorption fields can help to overcome the restricted permeability. Otherwise, sewage lagoons can be used rather than absorption fields.

10. Jedd-Gasil

Gently sloping and strongly sloping, loamy soils that are well drained; on uplands

This map unit typically is on broad, smooth, gently sloping ridges and strongly sloping side slopes above drainageways. It is drained by small, shallow streams and creeks that flow in a southwestward direction into the Navasota River. Relief is mainly less than 50 feet within a distance of 1 mile. It is 70 feet or more, however, near the Navasota River. The soils formed in a thin terrace veneer over stratified clay, shale, and sandstone of the Cook Mountain Formation.

This map unit makes up about 2 percent of the county. It is about 36 percent Jedd soils, 30 percent Gasil soils, and 34 percent soils of minor extent.

Jedd soils are on strongly sloping side slopes. Typically, the surface layer is brownish fine sandy loam about 5 inches thick. The subsoil, from a depth of 5 to 25 inches, is reddish clay and sandy clay loam. Below this to a depth of 60 inches is yellowish and reddish, stratified shale and sandstone. These soils are acid throughout.

Gasil soils are on broad, gently sloping ridges. Typically, the surface layer is brownish fine sandy loam about 8 inches thick. The subsoil, from a depth of 8 to 62 inches, is brownish and yellowish sandy clay loam. The underlying material to a depth of 80 inches is brownish and yellowish fine sandy loam. These soils are acid in the topsoil and subsoil and neutral in the underlying material.

Of minor extent in this map unit are Gowker, Gredge, Rosanky, Silawa, Spiller, and Rader soils. Gowker soils are on flood plains along drainageways. Gredge, Rosanky, and Spiller soils are on ridgetops and divides. Silawa and Rader soils are on terraces above streams.

The soils in this map unit are used mainly as pasture, hayland, or range. They are not used for row crops. Some areas are planted to rye, oats, or wheat for winter grazing.

Most of the pasture supports improved bermudagrass or bahiagrass. Applications of fertilizer and lime are needed for sustained production. Overseeding arrowleaf clover, subterranean clover, vetch, and singletary peas into the grasses lengthens the grazing season and improves fertility.

The range plants in areas of this unit are mid and tall grasses in an oak savannah.

Although crops generally are not planted on these soils, they have been grown on the gently sloping soils in the past. Corn, cotton, grain sorghum, and small grain are suitable crops.

The slope limits the use of some of these soils for urban development. The shrink-swell potential in the subsoil also is a limitation in some of the soils.

11. Gladewater

Nearly level, clayey soils that are poorly drained; on flood plains

This map unit typically is on nearly level flood plains along the Navasota River. These soils are flooded at least once every 2 years. Relief is mainly less than 10 feet within a distance of 1 mile. The soils formed in recent clayey sediments derived from sources upriver and outside of the county. The sediments are derived mainly from soils that formed in limestone residuum and marl, but they include small amounts of material derived from other sources.

This map unit makes up about 2 percent of the county. It is about 74 percent Gladewater soils and 26 percent soils of minor extent.

Gladewater soils are on nearly level bottom land. Typically, the surface layer is brownish clay about 7 inches thick. The subsoil and underlying material to a depth of 80 inches are grayish clay. These soils are acid throughout.

Of minor extent in this map unit are Gowker, Nahatche, and Navasan soils. These minor soils generally are slightly higher on the landscape than the Gladewater soils. Gowker and Nahatche soils are on flood plains in areas where creeks and streams flowing into the Navasota River deposit less clayey sediments. Navasan soils are subject to rare flooding in some areas. The flooding has scoured out many small lakes in this unit, and small bodies of water have formed in abandoned oxbows.

The soils in this map unit are used as pasture or range. Most of the pasture supports common bermudagrass and Dallisgrass. Applications of nitrogen and phosphorus fertilizer are needed for sustained yields.

The range plants in areas of this unit are tall grasses in a savannah that supports hardwoods, woody vines, and shrubs. The savannah has a 30 percent canopy.

These soils are not suited to cropland or urban development because of the frequent flooding.

12. Burleson-Ellis-Wilson

Nearly level to moderately steep, clayey and loamy soils that are somewhat poorly drained to well drained; on high stream terraces and uplands

This map unit typically is on broad, nearly level terraces and moderately sloping side slopes near flood plains. The terraces are 30 to 75 feet above the flood plain along the Trinity River. The drainage pattern is poorly defined. Most of the rainfall runs off the crusty surface of these dense, clayey soils so slowly that the soils are wet for extended periods. In the strongly sloping areas, however, runoff is rapid. Relief is mainly less than 20 feet within a distance of 1 mile but is 50 feet within one-half mile in the strongly sloping areas. The underlying material is clayey deposits from sources upriver and outside of the county. These deposits are mainly from soils that formed in material derived from limestone and marl and small amounts of other material.

This map unit makes up about 1 percent of the county. It is about 43 percent Burleson soils, 19 percent Ellis soils, 17 percent Wilson soils, and 21 percent soils of minor extent.

Burleson soils are in broad, plane areas on terraces. Typically, the surface layer is black clay about 10 inches thick. The subsoil is black clay, which extends to a depth of 40 inches. The underlying material to a depth of 80 inches is grayish clay. These soils are acid in the topsoil, neutral in the subsoil, and alkaline in the underlying material.

Ellis soils are on side slopes above the flood plains. Typically, the surface layer is brownish clay about 3 inches thick. The subsoil is brownish clay, which extends to a depth of 25 inches. The underlying material to a depth of 80 inches is brownish and grayish clay. These soils are neutral in the surface layer and alkaline in the subsoil and underlying material.

Wilson soils are in broad, slightly convex areas on terraces. Typically, the surface layer is grayish loam about 6 inches thick. The subsoil, from a depth of 6 to 58 inches, is clay that is black in the upper part and grayish and brownish in the lower part. The underlying material to a depth of 80 inches is brownish clay. These soils are acid in the surface layer and the upper part of the subsoil and alkaline in the lower part of the subsoil and in the underlying material.

Of minor extent in this map unit are Bremond, Mabank, and Rader soils. Bremond soils are in the same landscape positions as the Wilson soils. Mabank soils are in the slightly higher, convex areas. Rader soils are in the slightly higher areas that are mounded.

The soils in this map unit are used mainly as pasture or range. Some areas are used as cropland.

Most of the pasture and hayland supports common bermudagrass, bahiagrass, and Dallisgrass. The main legumes are arrowleaf clover, white clover, and vetch. The main limitations in the areas used for pasture and hay are wetness and the dense, clayey layers. Applications of nitrogen and phosphorus fertilizer are needed for best yields.

The range plants in areas of this unit are tall prairie grasses and a few elm and hackberry trees.

The crops grown on these soils are corn, cotton, grain sorghum, and small grain. The wetness and the dense, clayey layers are limitations affecting crop production. The soils are crusty and droughty at times during the summer.

The very slow permeability, a high shrink-swell potential, the wetness, and the slope in some areas limit the use of these soils for urban development. The dense, clayey layers are also a limitation. Building roads and structures that can withstand the shrinking and swelling is expensive. Septic tank absorption fields fail in these very slowly permeable soils. Sewage lagoons can be used rather than absorption fields.

Detailed Soil Map Units

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

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil 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 or of the underlying material, 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 or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, 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, Zack fine sandy loam, 1 to 5 percent slopes, is a phase of the Zack series.

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

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Rader-Derly complex, 0 to 2 percent slopes, is an example.

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

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas.* Such areas have little or no soil material and support little or no vegetation. Gullied land in the Zack-Gullied land complex, 3 to 8 percent slopes, 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.

ArD—Arriola fine sandy loam, 5 to 8 percent slopes. This moderately deep, moderately sloping soil is on side slopes above drainageways. Individual areas are long and narrow or irregularly shaped and range from 10 to 180 acres in size.

Typically, the surface layer is slightly acid, brown fine sandy loam about 4 inches thick. The subsurface layer, from a depth of 4 to 8 inches, is strongly acid, pale brown fine sandy loam. The subsoil, from a depth of 8 to 36 inches, is very strongly acid clay. It is dark red in the upper part and grayish brown in the lower part. Below this to a depth of 50 inches is light gray, weakly cemented sandstone.

This soil is moderately well drained. Runoff is rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are areas of

Elmina, Huntsburg, and Tonkavar soils. Elmina soils are sandy to a depth of 20 to 40 inches. They are in the slightly higher landscape positions. Huntsburg and Tonkavar soils are in landscape positions similar to those of the Arriola soil. Huntsburg soils are sandy to a depth of less than 20 inches, and Tonkavar soils are sandy to a depth of more than 40 inches. Included soils make up less than 10 percent of the map unit.

The Arriola soil is used mainly as woodland. Shortleaf pine and loblolly pine are the main pine species. The understory vegetation, which consists of yaupon, greenbrier, longleaf uniola, and American beautyberry, is available for grazing by wildlife and livestock.

A small acreage of this soil is used as pasture and hayland. Improved bermudagrass and bahiagrass are the main grasses. The main limitation is the dense, clayey subsoil. Pastures require applications of fertilizer and lime to maintain high production. Overseeding legumes, such as vetch, singletary peas, and arrowleaf clover, into the grasses lengthens the grazing season and improves fertility.

This soil is not suitable for crop production because of the severe hazard of erosion.

The suitability of this soil for most urban uses is limited because of the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The depth to bedrock is a limitation on sites for septic absorption fields, sewage lagoons, and sanitary landfills. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is VIe, and the woodland ordination symbol is 6C.

BeB—Benchley clay loam, 1 to 5 percent slopes. This very deep, gently sloping soil is on broad, smooth uplands and on the lower side slopes adjacent to streams. Individual areas are oblong or elongated and range from 10 to 40 acres in size.

Typically, the surface layer is medium acid, very dark gray clay loam about 12 inches thick. The upper part of the subsoil, from a depth of 12 to 29 inches, is medium acid, very dark grayish brown and very dark gray clay that has red, very dark gray, and brown mottles. The lower part, from a depth of 29 to 55 inches, is slightly acid, red clay that has dark gray and yellowish brown mottles. The upper part of the underlying material, from a depth of 55 to 72 inches, is neutral, yellowish brown clay that has dark gray and strong brown mottles. The lower part to a depth of 80 inches is mildly alkaline, yellowish brown clay.

This soil is moderately well drained. Runoff is medium. Permeability is slow. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Crockett, Bremond, Dimebox, Mabank, and Wilson soils. Crockett and Dimebox soils are in the slightly higher landscape positions. Bremond, Mabank, and Wilson soils are on the smooth, slightly lower parts of the landscape. Also included is a soil that is similar to the Benchley soil but has a surface layer of loam or sandy clay loam or generally is slightly steeper and has a dark surface layer that is less than 10 inches thick. Included soils make up less than 10 percent of the map unit.

Most areas of the Benchley soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, big bluestem, indiangrass, Florida paspalum, and Texas winter-grass and a few elm and hackberry trees.

This soil is suited to pasture and hay. Applications of fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, kleingrass, arrowleaf clover, crimson clover, white clover, and vetch.

This soil is suited to crops, such as cotton, corn, grain sorghum, and small grain. Cover crops, terraces, and contour farming are needed to control erosion.

The suitability of this soil for most urban uses is limited. The major limitation is the shrink-swell potential. The slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Clay Loam.

BnB—Bienville loamy fine sand, 0 to 3 percent slopes. This very deep, very gently sloping soil is on broad, smooth stream terraces. Individual areas are oblong or elongated and range from 40 to 250 acres in size.

Typically, the surface layer is slightly acid, yellowish brown loamy fine sand about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 42 inches, is slightly acid, dark brown loamy fine sand. The lower part to a depth of 80 inches is medium acid loamy fine sand. It is brown to a depth of 68 inches and light yellowish brown below that depth.

This soil is somewhat excessively drained. Runoff is slow. Permeability is moderately rapid. The available water capacity is moderate. Some areas are subject to overflow once in 20 to 100 years. The seasonal high water table is at a depth of 4 to 6 feet. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Chazos, Derly, Gowker, Portersprings, and Rader soils. Chazos, Portersprings, and Rader soils are in landscape positions similar to those of the Bienville soil. Derly soils are in small depressions and the lower landscape positions. Gowker soils are in the lower areas and are subject to flooding. Also included is a soil that is similar to the Bienville soil but is fine sand throughout. Included soils make up less than 20 percent of the map unit.

Most areas of the Bienville soil are used as woodland or pasture. This is one of the better soils in Madison County for the production of pine and hardwoods. The dominant trees are loblolly pine, shortleaf pine, and southern red oak. Droughtiness can result in the mortality of pine seedlings.

This soil can be used for the production of understory plants that can be grazed by livestock and game animals. Low natural fertility and droughtiness limit the production of forage plants. The major understory plants are pinehill bluestem, pineywoods dropseed, longleaf uniola, purple lovegrass, American beautyberry, yaupon, and blackberry.

This soil is suited to pasture and hay. The main limitation is the droughty, sandy surface layer. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, lovegrass, and vetch.

This soil can be used for crops, such as corn, peanuts, and watermelons. Applications of fertilizer and lime are essential for good yields. Cover crops, high-residue crops, and green manure crops help to maintain fertility and the content of organic matter.

This soil is suitable as a site for most urban uses. The seasonal high water table is a limitation on sites for septic tank absorption fields.

The capability subclass is IIs, and the woodland ordination symbol is 10S.

BoB—Boonville fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping soil is on uplands. It generally is on the lower, slightly concave side slopes or in broad, low, smooth areas. Individual areas are irregularly shaped or oval and range from 30 to 200 acres in size.

Typically, the surface layer is slightly acid, very dark grayish brown fine sandy loam about 15 inches thick. The upper part of the subsoil, from a depth of 15 to 24 inches, is medium acid, dark gray clay. The next part, from a depth of 24 to 40 inches, is mildly alkaline, dark grayish brown clay. The lower part, from a depth of 40 to 72 inches, is moderately alkaline, very pale brown clay. Below this to a depth of 80 inches is moderately alkaline, light gray, stratified, loamy and clayey material.

This soil is somewhat poorly drained. Runoff is medium. Permeability is very slow. The available water capacity is moderate. A perched seasonal high water table is at a depth of 0.5 to 1.0 foot. The hazard of erosion is moderate.

Included with this soil in mapping are areas of Gredge, Tabor, Zack, and Zulch soils. Gredge and Zack soils are in the higher landscape positions. Tabor and Zulch soils are in landscape positions similar to those of the Boonville soil. Included soils make up less than 10 percent of the map unit.

Most areas of the Boonville soil are used as pasture or range. The main limitation is the dense, clayey subsoil, which restricts the movement of air and water through the soil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, subterranean clover, and vetch.

This soil is suited to range. The major plants are little bluestem, indiangrass, switchgrass, hackberry, elm, honey locust, and oak.

This soil is suited to crops, such as cotton, corn, grain sorghum, and small grain. Applications of fertilizer and lime are needed for sustained production. Growing cover crops and leaving crop residue on the surface help to maintain tilth and the content of organic matter.

This soil is limited as a site for most urban uses because of wetness, low strength, and the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. The soil has a corrosive effect on uncoated steel.

The capability subclass is IIIe, and the range site is Claypan Prairie.

BrA—Bremond-Wilson complex, 0 to 2 percent slopes. These very deep, very gently sloping soils are on broad, smooth uplands. The surface generally is plane. Individual areas are irregularly shaped or oblong and range from 10 to 200 acres in size.

This unit is about 57 percent Bremond soil, 32 percent Wilson soil, and 11 percent included soils. These percentages were determined by sampling the soils in random transects across the mapped areas. The soils occur as areas so intricately mixed that mapping them separately is not practical at the scale of the soil maps.

Typically, the surface layer of the Bremond soil is medium acid, very dark grayish brown loam about 8 inches thick. The upper part of the subsoil, from a depth of 8 to 18 inches, is medium acid, dark reddish brown clay that has red mottles. The next part, from a depth of 18 to 46 inches, is neutral, light olive brown clay that has brownish mottles. The lower part to a depth of 80 inches is moderately alkaline, yellowish brown clay that has brownish and yellowish mottles.

Typically, the surface layer of the Wilson soil is slightly acid, very dark gray loam about 6 inches thick. From a depth of 6 to 20 inches, the subsoil is slightly acid, very dark gray clay that has very dark grayish brown mottles. From a depth of 20 to 42 inches, it is neutral, very dark gray clay that has brown and red mottles. From a depth of 42 to 56 inches, it is moderately alkaline, dark yellowish brown clay that has brownish yellow mottles. From a depth of 56 to 80 inches, it is moderately alkaline, yellowish brown clay that has dark grayish brown mottles in the upper part and brownish yellow mottles in the lower part.

The Bremond soil is moderately well drained, and the Wilson soil is somewhat poorly drained. Runoff is slow on both soils. Permeability is very slow. The available water capacity is high. The Wilson soil has a perched seasonal high water table 0.5 foot to 1.5 feet below the surface. The hazard of water erosion is moderate on both soils.

Included with these soils in mapping are small areas of Benchley and Dimebox soils. Benchley soils are on the lower side slopes adjacent to streams. Dimebox soils are in landscape positions similar to those of the Bremond and Wilson soils.

A large acreage of the Bremond and Wilson soils is used as pasture and hayland. Common and improved bermudagrass, kleingrass, and Johnsongrass are the main grasses. Overseeding arrowleaf clover, subterranean clover, vetch, and singletary peas into the grasses lengthens the grazing season and improves fertility. Applications of fertilizer are needed to sustain forage yields. Droughtiness reduces yields in the summer.

Some areas are used as range. These soils are well suited to range. The climax vegetation consists of tall prairie grasses and a few elm and hackberry trees along drainageways.

These soils are suited to crops, such as cotton, corn, grain sorghum, and small grain. Cover crops, terraces, and contour farming are needed to reduce the hazard of erosion. The soils are droughty during the summer, and the surface is crusty when dry.

These soils are limited as sites for dwellings, local roads and streets, and sanitary facilities, mainly because of the very slow permeability and the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. Wetness is an additional limitation in areas of the Wilson soil. The soils have a corrosive effect on uncoated steel.

The capability subclass is IIIe, and the range site is Claypan Prairie.

BuA—Burleson clay, 0 to 1 percent slopes. This very deep, nearly level soil is on broad, smooth stream terraces. Individual areas are broad and elongated and range from 30 to 350 acres in size.

Typically, the surface layer is slightly acid, black clay about 10 inches thick. The upper part of the subsoil, from a depth of 10 to 40 inches, is neutral, black clay. The lower part to a depth of 80 inches is moderately alkaline, very dark gray and dark gray clay that has brownish mottles. It has about 2 percent calcium carbonate.

This soil is moderately well drained. Runoff is slow. Permeability is very slow. The available water capacity is high. The hazard of erosion is slight.

Included with this soil in mapping are areas of Mabank, Rader, and Wilson soils. Mabank and Wilson soils are in landscape positions similar to those of the Burleson soil. Rader soils are on small mounds. Included soils make up less than 10 percent of the map unit.

Most areas of the Burleson soil are used as range or pasture. Some areas are used as cropland.

This soil is suited to range. The major plants are little bluestem, big bluestem, indiangrass, silver bluestem, Florida paspalum, elm, and hackberry.

This soil is suited to pasture and hay. The dense, clayey layers restrict the movement of air and water through the soil. Applications of fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, kleingrass, arrowleaf clover, crimson clover, and white clover.

This soil is suited to crops, such as corn, cotton, grain sorghum, and small grain. Leaving crop residue on the surface helps to maintain tilth and the content of organic matter.

This soil is unsuitable as a site for most urban uses. The major limitations are wetness and the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is IIw, and the range site is Blackland.

ChB—Chazos loamy fine sand, 1 to 5 percent slopes. This very deep, gently sloping soil is on high stream terraces. The surface is convex. Individual areas are irregular in shape and range from 10 to 70 acres in size.

Typically, the surface layer is slightly acid, brown loamy fine sand about 4 inches thick. The subsurface layer, from a depth of 4 to 14 inches, is medium acid, very pale brown loamy fine sand. The upper part of the subsoil, from a depth of 14 to 23 inches, is medium acid, yellowish brown clay that has red and grayish brown mottles. The next part, from a depth of 23 to 63 inches, is medium acid, grayish brown and light brownish gray sandy clay that has red mottles. The lower part to a depth of 80 inches is slightly acid, light gray sandy clay loam that has yellowish red mottles.

This soil is moderately well drained. Runoff is slow. Permeability also is slow. The available water capacity is moderate. The hazard of erosion also is moderate.

Included with this soil in mapping are areas of Derly, Gredge, Rader, and Robco soils. Derly soils are in small low areas. Gredge and Rader soils are in landscape positions similar to those of the Chazos soil. Robco soils are in the slightly lower landscape positions. Included soils make up less than 15 percent of the map unit.

Most areas of the Chazos soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, indiangrass, sand lovegrass, purpletop, and Florida paspalum.

This soil is suited to pasture and hay. Applications of fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suited to crops, such as corn, cotton, peanuts, and small grain. Applications of fertilizer and lime are essential for good yields. Cover crops, high-residue crops, and green manure crops help to control erosion and maintain fertility.

This soil is suited to most urban uses. The major limitation is the shrink-swell potential. The slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Sandy Loam.

CrB—Crockett loam, 1 to 3 percent slopes. This very deep, very gently sloping soil is on broad, smooth uplands. The surface generally is convex. Individual areas are mainly oblong or oval and range from 25 to 200 acres in size.

Typically, the surface layer is medium acid, brown loam about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 17 inches, is slightly acid, dark yellowish brown clay mottled with dark red. The lower part, from a depth of 17 to 59 inches, is neutral to moderately alkaline, olive brown and light olive brown clay. The underlying material to a depth of 80 inches is moderately alkaline, grayish clay that has a few concretions of calcium carbonate and a few crystals of calcium sulfate.

This soil is moderately well drained. Runoff is medium. Permeability is very slow. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Benchley, Bremond, Dimebox, Kurten, and Wilson soils. Benchley, Dimebox, and Kurten soils are in landscape positions similar to those of the Crockett soil. Bremond and Wilson soils are in the slightly lower landscape positions. Included soils make up less than 10 percent of the map unit.

Most areas of the Crockett soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, big bluestem, indiangrass, sideoats grama, Florida paspalum, Texas winter-grass, elm, hackberry, and post oak.

This soil is suited to pasture and hay. The main limitation is the dense, clayey subsoil, which restricts the movement of air and water through the soil. Applications of lime and fertilizer and good grazing management are needed for the best production of common and improved bermudagrass, kleingrass, Johnsongrass, arrowleaf clover, crimson clover, subterranean clover, and vetch.

This soil is suited to crops, such as cotton, grain sorghum, and small grain. Cover crops, terraces, and contour farming are needed to reduce the hazard of erosion.

This soil is not suitable as a site for most urban uses. The main limitation is the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is IIIe, and the range site is Claypan Prairie.

DdA—Derly silt loam, 0 to 1 percent slopes. This very deep, nearly level soil is in small depressions on stream terraces. Individual areas are oblong or elongated and range from 5 to 50 acres in size.

Typically, the surface layer is slightly acid, grayish brown silt loam about 4 inches thick. The subsurface layer, from a depth of 4 to 7 inches, is medium acid, light brownish gray silt loam. The upper part of the subsoil, from a depth of 7 to 23 inches, is medium acid, dark grayish brown clay that has tongues and interfingering of grayish brown silt loam. The next part, from a depth of 23 to 36 inches, is medium acid, dark gray clay. The lower part, from a depth of 36 to 71 inches, is neutral, grayish brown and light gray clay and clay loam. The underlying material to a depth of 80 inches is neutral, light gray, stratified loam, clay loam, and clay.

This soil is poorly drained. Runoff is slow or ponded. Permeability is very slow. The available water capacity is high. A perched seasonal high water table is within a depth of 1.5 feet.

Included with this soil in mapping are areas of Bienville, Chazos, Lufkin, and Rader soils. Bienville, Chazos, and Rader soils are in the slightly higher landscape positions. Lufkin soils are in landscape positions similar to those of the Derly soil. Included soils make up less than 10 percent of the map unit.

Most areas of the Derly soil are used as woodland or pasture. This soil is unsuitable for most crops because of poor drainage.

This soil is suited to the production of hardwoods. The dominant trees are water oak, willow oak, and sweetgum. The main limitation is wetness.

This soil is suited to pasture and hay. The main limitation is wetness. Applications of lime and fertilizer and good grazing management are needed for the best production of bahiagrass, tall fescue, and white clover.

This soil is unsuitable as a site for most urban uses. The main limitations are wetness and the shrink-swell potential. The very slow permeability and wetness are limitations on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIw, and the woodland ordination symbol is 4W.

DeA—Derly-Rader complex, 0 to 1 percent slopes. These very deep soils are in broad, mounded areas on high terraces that are generally 20 to 70 feet above the present flood plains along streams. The Rader soil is on round or oblong mounds that are 10 to 30 inches high and 40 to 150 feet across. The Derly soil is in low areas between the mounds. Slopes are 0 to 1 percent. Individual areas are irregular in shape and range from 40 to 600 acres in size.

Areas of this unit are 50 to 60 percent Derly soil, 30 to 40 percent Rader soil, and 5 to 15 percent included soils. These percentages were determined by sampling the soils in random transects across the mapped areas. The soils occur as areas so intricately mixed that mapping them separately is not practical at the scale of the soil maps.

Typically, the surface layer of the Derly soil is slightly acid, dark grayish brown loam about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 23 inches, is slightly acid, dark grayish brown clay. The next part, from a depth of 23 to 38 inches, is slightly acid, grayish brown clay. The lower part, from a depth of 38 to 58 inches, is mildly alkaline, light brownish gray sandy clay loam. The underlying material to a depth of 80 inches is mildly alkaline, light gray sandy clay loam.

Typically, the surface layer of the Rader soil is slightly acid, brown fine sandy loam about 13 inches thick. The subsurface layer, from a depth of 13 to 24 inches, is medium acid, pale brown fine sandy loam. From a depth 24 to 34 inches, the subsoil is very strongly acid, light yellowish brown and yellow fine sandy loam. From a depth of 34 to 50 inches, it is strongly acid, brownish yellow clay. From a depth of 50 to 65 inches, it is slightly acid, brown sandy clay loam. From a depth of 65 to 80 inches, it is neutral, light gray sandy clay loam.

The Derly soil is somewhat poorly drained, and the Rader soil is moderately well drained. Runoff is slow on both soils. Permeability is very slow. The available water capacity is high in the Derly soil and moderate in the Rader soil. Both soils have a perched seasonal high water table during periods of heavy rainfall. The water table is within a depth of 1.5 feet in the Derly soil and is at a depth of 2.0 to 5.0 feet in the Rader soil. The Derly soil is sometimes ponded for short periods. The hazard of water erosion is slight on both soils.

Included with these soils in mapping are small areas of Robco, Tabor, and Lufkin soils. Robco soils are sandy to a depth of 20 to 40 inches. They are on the mounds. Tabor soils have a dense, yellow subsoil. They are in areas between the mounds. Lufkin soils are similar to the Derly soil. They are slightly higher on the landscape than the Derly soil.

Most areas of the Derly and Rader soils are used as pasture and hayland. Wetness is the main limitation in areas of the Derly soil. Common and improved bermudagrass, bahiagrass, Dallisgrass, switchgrass, tall fescue, singletary peas, and white clover are the main grasses and legumes. Applications of fertilizer and lime are needed for the best forage production.

Some areas are used as range. The climax vegetation is tall grasses in an oak savannah. The main trees on the Derly soil are water oak, post oak, and hickory. The main trees on the Rader soil are post oak, blackjack oak, elm, and hickory.

The suitability of these soils for crops is limited because of wetness. Applications of fertilizer and lime are needed for sustained yields.

Because of wetness, the very slow permeability, low strength, and the shrink-swell potential, these soils are limited as sites for dwellings, local roads and streets, and sanitary facilities. The soils have a corrosive effect on uncoated steel and concrete.

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

DmA—Dimebox silty clay, 0 to 1 percent slopes. This very deep, nearly level soil is on broad, smooth uplands. The surface generally is plane and has gilgai microrelief. Individual areas are oblong or irregularly shaped and range from 5 to 100 acres in size.

Typically, the surface layer is slightly acid, very dark gray silty clay about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 52 inches, is slightly acid or neutral, black clay. The lower part, from a depth of 52 to 73 inches, is neutral, dark gray clay. The underlying material to a depth of about 91 inches is moderately alkaline, yellowish brown clay that has mottles in shades of brown and gray.

This soil is moderately well drained. Runoff is slow. Permeability is very slow. The available water capacity is high. Water penetrates the surface rapidly when the soil is dry and cracked and very slowly when it is moist. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Benchley, Bremond, Crockett, and Wilson soils. These soils are in landscape positions similar to those of the Dimebox soil. Also included is a soil that is similar to the Dimebox soil but has slopes of 1 to 3 percent. Included soils make up less than 10 percent of the map unit.

Most areas of the Dimebox soil are used as pasture or range. This soil is suited to range. The main management needs are range seeding, proper stocking rates, and controlled grazing. The major range plants are little bluestem, big bluestem, yellow indiangrass, silver bluestem, splitbeard bluestem, Florida paspalum, switchgrass, elm, and hackberry.

This soil is suited to pasture and hay. The dense, clayey layers restrict the movement of air and water through the soil. Some formerly cultivated areas have been planted to improved bermudagrass and kleingrass.

This soil is well suited to crops, such as cotton, corn, and grain sorghum. Leaving crop residue on the surface and growing cover crops help to maintain tilth and the content of organic matter.

This soil is unsuitable as a site for most urban uses. The main limitation is the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The very slow permeability is a limitation on sites for septic tank absorption fields. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIw, and the range site is Blackland.

DuC—Dutek loamy fine sand, 1 to 5 percent slopes. This very deep, gently sloping soil is on high stream terraces and broad interstream divides. Individual areas are oblong or irregularly shaped and range from 5 to 45 acres in size.

Typically, the surface layer is medium acid loamy fine sand about 26 inches thick. It is brown in the upper 7 inches and strong brown in the lower 19 inches. The subsoil, from a depth of 26 to 45 inches, is strongly acid, red sandy clay loam. The underlying material to a depth of 80 inches is fine sandy loam. It is red and strongly acid in the upper part and yellowish red and very strongly acid in the lower part.

This soil is well drained. Runoff is slow. Permeability and the available water capacity are moderate. The hazard of water erosion also is moderate. The hazard of wind erosion is severe in bare areas.

Included with this soil in mapping are areas of Chazos, Padina, Robco, and Silstid soils. Chazos, Padina, and Robco soils have mottled red, yellow, and gray subsoils. Chazos soils have more than 35 percent clay in the subsoil. Silstid soils have a subsoil that is yellower than that of the Dutek soil. Included soils make up less than 10 percent of the map unit.

A large acreage of the Dutek soil is used as pasture and hayland. Improved bermudagrass and weeping lovegrass are the main grasses. The main limitation is droughtiness. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Overseeding legumes, such as vetch and singletary peas, into the grasses lengthens the grazing season and improves fertility.

A large acreage of this soil is used as range. The climax vegetation is tall grasses in an oak savannah. The main limitation is droughtiness.

Because of droughtiness and the hazard of erosion, this soil generally is not used for crops. It is suited to peanuts, watermelons, peas, and sweet potatoes. Applications of fertilizer and lime are essential for good yields. Cover crops, high-residue crops, and green manure crops help to control erosion and maintain fertility.

This soil is suitable as a site for dwellings and local roads and streets. Seepage is a hazard on sites for most sanitary facilities. The soil has a corrosive effect on concrete and uncoated steel.

The capability subclass is IIIe, and the range site is Sandy.

EeE—Ellis clay, 5 to 15 percent slopes. This soil is moderately deep to shale. It is on strongly sloping to moderately steep side slopes near the Trinity and Navasota Rivers. Individual areas are irregularly shaped or are long and narrow. They range from 30 to 200 acres in size.

Typically, the surface layer is neutral, brown clay about 3 inches thick. The subsoil, from a depth of 3 to 25 inches, is moderately alkaline, olive brown clay that is calcareous in the lower part. The underlying material to a depth of 80 inches is calcareous, moderately alkaline, light yellowish brown shale that has a texture of clay. It is mottled in shades of gray, yellow, and brown.

This soil is well drained. Runoff is rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are areas of a soil that is similar to the Ellis soil but is very dark grayish brown to a depth of more than 12 inches or has more than 5 percent calcium carbonate in the subsoil. Included soils make up less than 15 percent of the map unit.

A large acreage of the Ellis soil is used as range. The climax vegetation consists of tall prairie grasses and a few elm and hackberry trees along drainageways.

Some areas of this soil are used as pasture and hayland. Common and improved bermudagrass, kleingrass, and Johnsongrass are the main grasses. Overseeding arrowleaf clover, subterranean clover, vetch, and singletary peas into the grasses lengthens the growing season and improves fertility. The main limitation is the dense, clayey texture, which makes the soil difficult to work, especially when a seedbed is prepared. The slope also is a limitation. Nitrogen and phosphorus fertilizer are needed to sustain forage yields.

This soil is unsuitable for crop production because of the slope and the severe hazard of erosion.

This soil is unsuitable as a site for most urban uses. The main limitations on sites for dwellings, local roads and streets, and sanitary facilities are the shrink-swell potential, the very slow permeability, the clayey texture, and the slope. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is VIe, and the range site is Eroded Blackland.

EmB—Elmina loamy fine sand, 1 to 3 percent slopes. This deep, very gently sloping soil is on broad uplands and on divides. Individual areas are mainly oblong and range from 30 to 230 acres in size.

Typically, the surface layer is strongly acid, brown loamy fine sand about 5 inches thick. The subsurface layer, from a depth of 5 to 25 inches, is strongly acid, pale brown loamy fine sand. The subsoil, from a depth of 25 to 58 inches, is very strongly acid. The upper part is grayish brown clay that has mottles in shades of red, brown, and yellow. The lower part is light brownish gray sandy clay that has mottles in shades of brown and yellow. Below this is very strongly acid, very pale brown, weakly cemented sandstone.

This soil is somewhat poorly drained. Runoff is medium. Permeability is very slow. The available water capacity is moderate. The soil has a perched seasonal high water table at a depth of 1.5 to 3.5 feet. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Arriola, Huntsburg, and Tonkavar soils. Arriola soils are fine sandy loam to a depth of less than 10 inches. They are on adjacent side slopes. Huntsburg soils are loamy fine sand to a depth of less than 20 inches. Tonkavar soils are sandy to a depth of more than 40 inches. Included soils make up less than 15 percent of the map unit.

Because of seasonal droughtiness, the Elmina soil generally is not used for crops. It is suited to peanuts, watermelons, peas, and sweet potatoes. Applications of fertilizer and lime are essential for good yields. Cover crops, high-residue crops, and green manure crops help to control erosion and maintain fertility.

This soil is used mainly as woodland (fig. 6). It is well suited to the production of shortleaf pine and loblolly pine. The understory vegetation, which consists of yaupon, greenbrier, longleaf uniola, and American beautyberry, is available for grazing by wildlife and livestock.

A small acreage of this soil is used as pasture and hayland. Improved bermudagrass and weeping lovegrass are the main grasses. The main limitation is droughtiness. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Overseeding legumes, such as vetch and singletary peas, into the grasses lengthens the grazing season and improves fertility.

This soil is limited as a site for most urban uses. Wetness is the major limitation. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the woodland ordination symbol is 8S.

EuB—Eufaula loamy fine sand, 1 to 5 percent slopes. This very deep, gently sloping soil is on stream terraces about 10 to 40 feet above the present flood plains. Individual areas are oblong or long and narrow and mostly range from 20 to 100 acres in size.

Typically, the surface layer is neutral, brown loamy fine sand about 12 inches thick. The next layer, from a depth of 12 to 60 inches, is slightly acid, strong brown loamy fine sand. Below this to a depth of 80 inches is slightly acid, reddish yellow fine sand that has thin bands of yellowish red fine sandy loam.

This soil is somewhat excessively drained. Runoff is slow. Permeability is rapid. The available water capacity is low. The hazard of wind erosion is severe. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Dutek,

Figure 6.—A wooded area of Elmina loamy fine sand, 1 to 3 percent slopes.

Navasan, Rader, and Silawa soils. Dutek and Silawa soils are in the higher landscape positions. Navasan soils are in the lower landscape positions and are occasionally flooded. Rader soils are in landscape positions similar to those of the Eufaula soil. Included soils make up less than 10 percent of the map unit.

A large acreage of the Eufaula soil is used as pasture and hayland. Improved bermudagrass and weeping lovegrass are the main grasses. The main limitation is droughtiness. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Overseeding legumes, such as vetch and singletary peas, into the grasses lengthens the grazing season and improves fertility.

Some areas are used as range. The climax vegetation is tall grasses in an oak savannah. The main limitation is droughtiness.

This soil generally is not used for crops because of droughtiness.

This soil is suitable as a site for urban uses, such as local roads and streets and buildings. Seepage is a hazard on sites for sanitary facilities.

The capability subclass is IVe, and the range site is Deep Sand.

EuE—Eufaula loamy fine sand, 5 to 15 percent slopes. This very deep, strongly sloping to moderately steep soil is on stream terraces, usually adjacent to the flood plain. Individual areas are oblong or long and narrow and range from 10 to 50 acres in size.

Typically, the surface layer is slightly acid, dark grayish brown loamy fine sand about 5 inches thick. The next layer, from a depth of 5 to 48 inches, is slightly acid, pale brown loamy fine sand. Below this to a depth of 80 inches is neutral, pale brown loamy fine sand that has thin bands of strong brown fine sandy loam.

This soil is somewhat excessively drained. Runoff is slow. Permeability is rapid. The available water capacity is low. The hazard of water erosion is severe.

Included with this soil in mapping are areas of Dutek, Rader, and Silawa soils. Dutek and Silawa soils are in the higher landscape positions. Rader soils are in landscape positions similar to those of the Eufaula soil. Included soils make up less than 15 percent of the map unit.

Most areas of the Eufaula soil are used as pasture or range. In the areas used for pasture and hay, the main management concerns are the droughty, sandy surface layer and the hazard of erosion. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass.

Some areas are used as range. The main management concerns are the droughty, sandy surface layer and the hazard of erosion. The main management needs are range seeding, proper stocking rates, and controlled grazing. The major plants are little bluestem, yellow indiangrass, sand lovegrass, low panicums, low paspalums, purpletop, switchgrass, blackjack oak, bluejack oak, post oak, and yaupon.

This soil is unsuitable for crop production because of droughtiness and the slope.

This soil is suitable as a site for most urban uses. Seepage and the slope are limitations on sites for sanitary facilities and buildings.

The capability subclass is VIe, and the range site is Deep Sand.

FtB—Flatonia clay loam, 1 to 3 percent slopes. This very gently sloping soil is deep to shale. It is on smooth, convex slopes on uplands. It generally is on the lower side slopes or in broad, smooth areas. Individual areas are mainly irregular in shape and range from 20 to 150 acres in size.

Typically, the surface layer is slightly acid, very dark gray clay loam about 7 inches thick. From a depth of 7 to 40 inches, the subsoil is black clay. It is neutral in the upper part and moderately alkaline in the lower part. From a depth of 40 to 48 inches, it is moderately alkaline, gray clay that has grayish mottles. Below this to a depth of 80 inches is moderately alkaline, pale olive, weakly cemented shale that has a texture of clay.

This soil is moderately well drained. Runoff is medium. Permeability is very slow. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Gredge, Tabor, Zack, and Zulch soils. Gredge, Tabor, and Zack soils are in the slightly higher landscape positions. Zulch soils are in landscape positions similar to those of the Flatonia soil. Included soils make up less than 15 percent of the map unit.

Most areas of the Flatonia soil are used as pasture or range. The suitability for pasture and hay is limited by the dense, clayey subsoil, which restricts the movement of air and water through the soil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, and crimson clover.

This soil is suited to range plants. The major plants are little bluestem, big bluestem, sideoats grama, yellow indiangrass, Florida paspalum, and Texas winter-grass. The major trees are elm, hackberry, and post oak.

This soil is suited to crops, such as corn, cotton, grain sorghum, and small grain. The main limitation is the dense, clayey subsoil, which restricts the movement of air and water through the soil. Leaving crop residue on the surface helps to maintain the content of organic matter and control erosion.

This soil is unsuitable as a site for most urban uses. The main limitations are wetness and the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is IIe, and the range site is Clay Loam.

GaB—Gasil fine sandy loam, 1 to 5 percent slopes. This very deep, gently sloping soil is in broad areas on uplands and high terraces. Individual areas are mainly oval or elongated and range from 20 to 100 acres in size.

Typically, the surface layer is medium acid, brown fine sandy loam about 4 inches thick. The subsurface layer, from a depth of 4 to 8 inches, is medium acid, light yellowish brown fine sandy loam. The upper part of the subsoil, from a depth of 8 to 42 inches, is strongly acid, strong brown and yellowish brown sandy clay loam. The lower part, from a depth of 42 to 62 inches, is medium acid, yellow sandy clay loam. The underlying material to a depth of 80 inches is neutral, mottled very pale brown and yellow sandy loam.

This soil is well drained. Runoff is slow. Permeability is moderate. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Rader, Rosanky, Silawa, and Silstid soils. Rader soils are in the slightly lower landscape positions. Rosanky soils are in the slightly higher landscape positions. Silawa and Silstid soils are in landscape positions similar to those of the Gasil soil. Also included is a soil that is similar to the Gasil soil but has a surface layer of loamy fine sand. Included soils make up less than 15 percent of the map unit.

Most areas of the Gasil soil are used as pasture or range. This soil is suited to pasture and hay (fig. 7). Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suitable for range. The major plants are little bluestem, eastern gamagrass, yellow indiangrass, brownseed paspalum, and switchgrass.

This soil is suited to crops, such as cotton, corn, grain sorghum, and small grain. Applications of lime and fertilizer are essential for good yields. Cover crops, terraces, and contour farming are needed to control erosion.

This soil is suitable as a site for most urban uses. The shrink-swell potential is a limitation on sites for local roads and streets and for small buildings.

The capability subclass is IIIe, and the range site is Sandy Loam.

Figure 7.—An area of Gasil fine sandy loam, 1 to 5 percent slopes, used for pasture.

Gg—Gladewater clay, occasionally flooded. This very deep, nearly level soil is on flood plains, mostly along the Trinity River. Areas of this soil are flooded once every 2 to 10 years for a few days and remain wet for several months. Slopes are 0 to 1 percent. Individual areas are irregularly shaped or oblong and range from 40 to 500 acres in size.

Typically, the surface layer is medium acid, very dark grayish brown clay about 9 inches thick. The subsoil, from a depth of 9 to 51 inches, is slightly acid, dark gray clay that has yellowish brown mottles. The underlying material to a depth of 80 inches is moderately alkaline, grayish clay.

This soil is poorly drained. Runoff is very slow. Permeability also is very slow. The available water capacity is high. The seasonal high water table is within a depth of 3.5 feet. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Gladewater soils that are frequently flooded and areas of Kaufman soils. The frequently flooded soils are in the slightly lower areas. Kaufman soils are in landscape positions similar to those of this Gladewater soil. Included soils make up about 20 percent of the map unit.

Most areas of the Gladewater soil are used as pasture or cropland. This soil is suited to pasture and hay. The main limitations are wetness and the dense, clayey layers. Applications of fertilizer and good grazing management are needed for the best production of common bermudagrass, Dallisgrass, white clover, and vetch. Soil compaction is a problem if pastures are grazed during the wet season.

This soil is suited to crops, such as cotton, soybeans, grain sorghum, and small grain. The main limitation is the flooding. Wetness limits production in some years.

This soil is not suitable as a site for urban uses. Flooding is a hazard, and the shrink-swell potential is a limitation. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IVw, the range site is Clayey Bottomland, and the woodland ordination symbol is 6W.

Gh—Gladewater clay, frequently flooded. This very deep, nearly level soil is on flood plains along large streams. Areas of this soil are flooded at least once every 2 years for a few days and remain wet for long periods of time. Slopes are 0 to 1 percent. Individual areas are generally long and narrow and range from 10 to 1,500 acres in size.

Typically, the surface layer is medium acid, very dark grayish brown clay about 7 inches thick. The subsoil, from a depth of 7 to 47 inches, is medium acid and strongly acid, dark gray clay. The underlying material to a depth of 80 inches is strongly acid, gray clay.

This soil is poorly drained. Runoff is very slow. Permeability also is very slow. The available water capacity is high. The seasonal high water table is within a depth of 3.5 feet. The hazard of water erosion is slight.

Included with this soil in mapping are Gladewater soils that are in the slightly higher areas and are occasionally flooded. Also included are Kaufman soils, which are in landscape positions similar to those of this Gladewater soil. Included soils make up about 15 percent of the map unit.

Most areas of the Gladewater soil are used as pasture or range. This soil is suitable as pasture. The main limitations are the flooding, wetness, and the dense, clayey layers. Applications of fertilizer and good grazing management are needed for the best production of common bermudagrass, Dallisgrass, white clover, and singletary peas. Soil compaction is a problem if pastures are grazed during the wet season.

This soil is suitable for range. The main limitations are the wetness and the dense, clayey layers. The major plants are Virginia wildrye, beaked panicum, sedge, eastern gamagrass, switchgrass, and panicum.

This soil is not suitable for crop production. The main limitation is the flooding.

This soil is not suitable as a site for urban uses. Flooding is a hazard, and the shrink-swell potential is a limitation. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is Vw, the range site is Clayey Bottomland, and the woodland ordination symbol is 6W.

Gn—Gladewater and Nahatche soils, frequently flooded. These very deep, undulating soils are on flood plains adjacent to major streams. Areas of these soils have been scarified by the river during flooding. These soils are flooded at least once each year and are inundated for several weeks. Slopes range from 1 to 8 percent over short distances. Individual areas range from 10 to 145 acres in size. They generally are long and narrow, but some are oval. The texture of the surface layer of these soils ranges from clay to fine sandy loam.

Areas of this unit are 40 to 60 percent Gladewater soil, 30 to 40 percent Nahatche soil, and 10 to 20 percent included soils. These percentages were determined by sampling the soils in random transects across the mapped areas.

Typically, the surface layer of the Gladewater soil is slightly acid, very dark grayish brown clay about 9 inches thick. The subsoil, from a depth of 9 to 40 inches, is slightly acid, dark grayish brown clay. The underlying material to a depth of 80 inches is mildly alkaline, grayish brown clay that has dark reddish brown mottles.

Typically, the surface layer of the Nahatche soil is neutral, dark grayish brown clay loam about 13 inches thick. The upper part of the subsoil, from a depth of 13 to 57 inches, is mildly alkaline, dark grayish brown sandy clay loam and clay loam having brownish mottles. The lower part to a depth of 80 inches is mildly alkaline, dark grayish brown sandy clay loam that has brownish mottles.

The Gladewater soil is poorly drained, and the Nahatche soil is somewhat poorly drained. Runoff is very slow on the Gladewater soil and slow on the Nahatche soil. Permeability is very slow in the Gladewater soil and moderate in the Nahatche soil. The available water capacity is high in the Gladewater soil and moderate in the Nahatche soil. The seasonal high water table is within a depth of 3.5 feet in the Gladewater soil and is at a depth of 0.5 foot to 1.5 feet in the Nahatche soil. The hazard of water erosion is slight on both soils.

Included with these soils in mapping are areas of Gowker and Hatliff soils. Gowker soils are in landscape positions similar to those of the Gladewater and Nahatche soils. Hatliff soils are in the slightly lower areas adjacent to the river.

Areas of the Gladewater and Nahatche soils are used mainly as woodland or pasture. These soils are suited to the production of hardwoods. The dominant trees are water oak, pecan, sweetgum, willow oak, cottonwood, elm, and sycamore.

These soils are suited to the production of plants that can be grazed by livestock and game animals. The main limitation is wetness. The dominant understory plants are sedges, Canada wildrye, eastern gamagrass, beaked panicum, plumegrass, purpletop, low panicums, Virginia wildrye, and switchcane.

These soils are unsuitable for crop production because of the frequent flooding.

These soils are not suitable as sites for urban uses because of the flooding and wetness. They have a corrosive effect on uncoated steel and concrete.

The capability subclass is Vw, and the woodland ordination symbol is 6W. The Gladewater soil is in the Clayey Bottomland range site, and the Nahatche soil is in the Loamy Bottomland range site.

Go—Gowker clay loam, frequently flooded. This very deep, nearly level soil is mostly on flood plains along the smaller streams. Areas of this soil are flooded at least once every 2 years for several days. Slopes are 0 to 1 percent. Individual areas are mainly long and narrow and range from 10 to 250 acres in size.

Typically, the surface layer is medium acid, dark brown, very dark gray, and very dark grayish brown clay loam about 45 inches thick. The subsoil, from a depth of 45 to 60 inches, is neutral, dark grayish brown clay loam that has yellowish brown mottles. The underlying material to a depth of 80 inches is mildly alkaline, yellowish brown clay loam that has strong brown mottles.

This soil is moderately well drained. Runoff is slow. Permeability also is slow. The available water capacity is high. A perched high water table is at a depth of 0.5 foot to 2.5 feet. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Gladewater, Hatliff, Kaufman, and Nahatche soils. Gladewater and Kaufman soils are in the slightly lower landscape positions. Hatliff and Nahatche soils are in landscape positions similar to those of the Gowker soil. Included soils make up less than 20 percent of the map unit.

Most areas of the Gowker soil are used as woodland or pasture. This soil is well suited to woodland. The dominant trees are sweetgum, water oak, southern red oak, and green ash. The flooding is the major hazard.

This soil is suited to pasture and hay. The main limitations are wetness and the flooding. Applications of lime and fertilizer and good grazing management are needed for the best production of improved and common bermudagrass, Dallisgrass, white clover, and vetch.

Some areas of this soil are used as range. The soil is well suited to range.

This soil is poorly suited to crop production because of flooding.

This soil is not suitable as a site for urban uses because of flooding and wetness. It has a corrosive effect on uncoated steel and concrete.

The capability subclass is Vw, the range site is Loamy Bottomland, and the woodland ordination symbol is 6W.

GpA—Gowker-Portersprings complex, 0 to 2 percent slopes. These very deep, very gently sloping soils are on the flood plains along the Trinity River. The topography consists of a series of ridges and low areas formed by relict meander scars. The ridges are about 1 to 3 feet above the low areas. The Gowker soils are in the meander lows, and the Portersprings soils are on the meander ridges. This map unit is completely flooded about once every 20 to 50 years. The Gowker soil, however, may be flooded as often as once every 5 to 20 years because of its lower position on the landscape. Individual areas are oblong and range from 25 to 200 acres in size.

On the average, this unit is about 50 percent Gowker soil, 34 percent Portersprings soil, and 16 percent included soils.

Typically, the Gowker soil has a surface layer of slightly acid, black sandy clay loam about 25 inches thick. From a depth of 25 to 51 inches, the soil is slightly acid, very dark gray sandy clay loam. From a depth of 51 to 70 inches, it is slightly acid, dark gray sandy clay loam. The underlying material to a depth of 80 inches is slightly acid, very dark gray loamy sand.

Typically, the Portersprings soil has a surface layer of slightly acid, very dark grayish brown fine sandy loam about 15 inches thick. The upper part of the subsoil, from a depth of 15 to 34 inches, is slightly acid, dark brown sandy clay loam that has brown and red mottles. The lower part, from a depth of 34 to 58 inches, is medium acid, brownish yellow sandy clay loam that has red mottles. The underlying material to a depth of 80 inches is medium acid, very pale brown fine sandy loam that has brown mottles.

These soils are moderately well drained. Runoff is slow. Permeability is slow in the Gowker soil and moderately slow in the Portersprings soil. The available water capacity is high in the Gowker soil and moderate in the Portersprings soil. The Gowker soil has a perched seasonal high water table at a depth of 0.5 foot to 2.5 feet. The Portersprings soil has a seasonal high water table at a depth of 2 to 3 feet.

Figure 8.—An area of Gowker-Portersprings complex, 0 to 2 percent slopes. These soils are suited to pecan trees and pasture.

Included with these soils in mapping are Bienville, Derly, Hatliff, Rader, and Silawa soils. Bienville soils are at the higher elevations and are sandy throughout the profile. Derly soils are in landscape positions similar to those of the Gowker and Portersprings soils. They have a dense, clayey subsoil. Hatliff soils are in the lower landscape positions. They are loamy throughout. Rader and Silawa soils are at the higher elevations. They have a subsoil that is redder and yellower than that of the Gowker and Portersprings soils. Included soils make up less than 16 percent of the map unit.

Most areas of the Gowker and Portersprings soils are used as woodland or pasture. Some areas are used for native pecan orchards (fig. 8). The dominant trees are water oak, willow oak, pecan, elm, green ash, and bitternut hickory. The flooding is the major hazard.

These soils are suited to pasture and hay. The main limitation is wetness. Applications of lime and fertilizer and good grazing management are needed for the best production of improved and common bermudagrass, Dallisgrass, white clover, and vetch.

These soils are suited to crop production. The main hazard is the flooding.

Because of the flooding and wetness, these soils are not suitable as sites for urban uses. They have a corrosive effect on uncoated steel and concrete.

The capability subclass is IIw. The woodland ordination symbol is 6W in areas of the Gowker soil and 6A in areas of the Portersprings soil.

GrC—Gredge fine sandy loam, 1 to 5 percent slopes. This very deep, gently sloping soil is on broad, smooth uplands and terraces. Individual areas generally are oblong, but those near drainageways are long and narrow. They range from about 10 to 50 acres in size.

Typically, the surface layer is very strongly acid, light yellowish brown fine sandy loam about 7 inches thick. From a depth of 7 to 21 inches, the subsoil is very strongly acid, red clay that has grayish mottles. From a depth of 21 to 32 inches, it is strongly acid, light brownish gray clay that has reddish mottles. From a depth of 32 to 63 inches, it is light brownish gray sandy clay loam that has reddish and brownish mottles and is slightly acid in the upper part and mildly alkaline in the lower part. The underlying material to a depth of 80 inches is moderately alkaline, light brownish gray clay loam.

This soil is moderately well drained. Runoff is medium. Permeability is very slow. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Boonville, Lufkin, Rader, Tabor, Zack, and Zulch soils. Boonville, Lufkin, Rader, Zack, and Zulch soils are in the slightly lower landscape positions. Tabor soils are in landscape positions similar to the Gredge soil. Also included, generally at the crest of small hills, is a soil that is similar to the Gredge soil but has a surface layer of gravelly fine sandy loam. Included soils make up less than 15 percent of the map unit.

Most areas of the Gredge soil are used as pasture or range. This soil is suited to pasture and hay. The main limitation is the dense, clayey subsoil, which restricts the movement of air and water through the soil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, crimson clover, and arrowleaf clover.

This soil is suited to range plants. The main limitation is the dense, clayey subsoil. The native plant community consists of little bluestem, silver bluestem, tall dropseed, arrowfeather threeawn, low panicums, blackjack oak, post oak, and yaupon.

This soil is suited to crop production. Because of the dense, clayey subsoil, the soil is difficult to work in most moisture conditions. Although crops generally are not planted on this soil, corn and cotton have been grown in some areas in the past.

This soil is limited as a site for most urban uses because of the slope, the very slow permeability, low strength, and the shrink-swell potential. It has a highly corrosive effect on uncoated steel.

The capability subclass is IVe, and the range site is Claypan Savannah.

GrD—Gredge fine sandy loam, 5 to 8 percent slopes. This very deep, moderately sloping soil is on terraces and uplands. Most areas are on side slopes near drainageways. Individual areas are mainly long and narrow and range from about 10 to 80 acres in size.

Typically, the surface layer is strongly acid, pale brown fine sandy loam about 4 inches thick. The upper part of the subsoil, from a depth of 4 to 24 inches, is very strongly acid, yellowish red and light brownish gray clay mottled with red and gray. The lower part, from a depth of 24 to 46 inches, is very strongly acid, light gray and pale brown clay loam. The underlying material to a depth of 80 inches is medium acid, light gray sandy clay loam stratified with fine sandy loam, loam, and loamy fine sand.

This soil is moderately well drained. Runoff is rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are areas of Boonville, Lufkin, Rader, Tabor, Zack, and Zulch soils. These soils are higher on the landscape than the Gredge soil. Also included is a soil that is similar to the Gredge soil but has a surface layer of gravelly fine sandy loam. Included soils make up less than 20 percent of the map unit.

Most areas of the Gredge soil are used as pasture or range. This soil is suited to pasture and hay. The main limitation is the dense, clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, crimson clover, and arrowleaf clover.

This soil is suited to range plants. The main limitation is the dense, clayey subsoil. The native plant community consists of little bluestem, silver bluestem, tall dropseed, arrowfeather threeawn, low panicums, blackjack oak, post oak, and yaupon.

This soil is not suitable for crop production because of the severe hazard of erosion.

Because of the slope, the very slow permeability, low strength, and the shrink-swell potential, this soil is limited as a site for most urban uses. It has a highly corrosive effect on uncoated steel.

The capability subclass is VIe, and the range site is Claypan Savannah.

Ha—Hatliff fine sandy loam, frequently flooded. This very deep, nearly level soil is mostly on flood plains along the smaller streams. Slopes are 0 to 1 percent. This soil is flooded more than once every 2 years for several days. Individual areas are mainly long and narrow and range from about 20 to 200 acres in size.

Typically, the surface layer is slightly acid, dark grayish brown fine sandy loam about 9 inches thick. The subsoil, from a depth of 9 to 62 inches, is slightly acid to strongly acid, brown fine sandy loam that is stratified with thin layers of loamy fine sand. The underlying material to a depth of 80 inches is neutral, grayish brown fine sandy loam.

This soil is moderately well drained. Runoff is slow. Permeability is moderately rapid. The available water capacity is low. The seasonal high water table is within a depth of 2 feet. It saturates the soil for periods of a few days to a few weeks, mainly during winter and early spring. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Nahatche soils in landscape positions similar to those of the Hatliff soil. The Nahatche soils contain more clay than the Hatliff soil and have a higher available water capacity. Also included is a soil that has a subsoil that is loamy fine sand throughout. Included soils make up less than 20 percent of the map unit.

Most areas of the Hatliff soil are used as woodland or improved pasture. Some areas are used as range.

This soil is suited to the production of pine trees. The dominant trees are sweetgum, water oak, and willow oak. Wetness is a limitation.

This soil is suitable for the production of understory plants that can be grazed by livestock and game animals. The major understory plants are pinehill bluestem, broomsedge bluestem, beaked panicum, brownseed paspalum, and wax-myrtle.

This soil is suited to pasture and hay. Wetness is the major limitation. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass and bahiagrass.

This soil is not suitable for cultivation because of the frequent flooding.

This soil is not suitable as a site for urban uses, mainly because of the flooding and wetness.

The capability subclass is Vw, the woodland ordination symbol is 10W, and the range site is Loamy Bottomland.

HuC—Huntsburg loamy fine sand, 1 to 5 percent slopes. This very deep, gently sloping soil is on uplands on interstream divides and oblong ridges in the southeastern part of the county. Individual areas are generally oval or oblong and range from 20 to 200 acres in size.

Typically, the surface layer is slightly acid, brown loamy fine sand about 7 inches thick. The subsurface layer, from a depth of 7 to 18 inches, is medium acid, yellowish brown loamy fine sand. The upper part of the subsoil, from a depth of 18 to 25 inches, is medium acid, yellowish brown sandy clay mottled with red and light brownish gray. The next part, from a depth of 25 to 58 inches, is strongly acid, mottled dark red and gray clay that has yellow mottles. The lower part, from a depth of 58 to 74 inches, is very strongly acid, light brownish gray clay loam that has reddish, brownish, and grayish mottles. Below this to a depth of 80 inches is strongly acid, light olive gray, stratified shale and sandstone.

This soil is moderately well drained. Runoff is slow. Permeability is very slow. The available water capacity is moderate. The seasonal water table is perched above the subsoil during periods of prolonged rainfall. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Arriola, Elmina, and Tonkavar soils. Arriola soils have a surface layer of fine sandy loam. Elmina soils are loamy fine sand to a depth of more than 20 inches. Tonkavar soils are loamy fine sand to a depth of more than 40 inches. Included soils make up less than 20 percent of the map unit.

Most areas of the Huntsburg soil are used as pasture or woodland. This soil is suited to pasture and hay. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, arrowleaf clover, and vetch.

This soil is suited to woodland. The main limitations are erosion and seedling mortality. The major woodland plants are loblolly pine and shortleaf pine.

This soil is suited to crops, such as corn, cotton, and small grain. Applications of fertilizer and lime are essential for good yields. Cover crops, high-residue crops, and green manure crops help to control erosion and maintain fertility.

This soil is limited as a site for most urban uses. The main limitations affecting sanitary facilities and building site development are wetness and the shrink-swell potential. The soil has a corrosive effect on uncoated steel and concrete.

The Huntsburg soil is in capability subclass IVe, and the woodland ordination symbol is 10S.

JeD—Jedd fine sandy loam, 5 to 12 percent slopes. This moderately deep, strongly sloping soil is on long, narrow knolls and side slopes in the uplands. Individual areas are elongated or oblong and range from 20 to 150 acres in size.

Typically, the surface layer is slightly acid, brown fine sandy loam about 5 inches thick. The subsoil, from a depth of 5 to 25 inches, is strongly acid and very strongly acid, yellowish red clay and sandy clay loam. Below this to a depth of 60 inches is very strongly acid, reddish yellow and yellowish red, stratified sandstone.

This soil is well drained. Runoff is rapid. Permeability is moderately slow. The available water capacity is low. The hazard of water erosion is severe.

Included with this soil in mapping are areas of Padina, Rosanky, and Silstid soils. Padina and Silstid soils are in landscape positions similar to those of the Jedd soil and in the slightly higher positions. Rosanky soils are on ridgetops. Also included is a soil that is similar to the Jedd soil but has bedrock within a depth of 20 inches. Included soils make up less than 20 percent of the map unit.

Most areas of the Jedd soil are used as range or pasture. This soil is suited to range plants. The main limitations are a clayey subsoil and the depth of the solum. The major grasses are little bluestem, longleaf uniola, yellow indiangrass, beaked panicum, brownseed paspalum, and switchgrass. The major tree and shrubs are post oak, blackjack oak, elm, and yaupon.

This soil is suited to pasture and hay. The main limitations are the clayey subsoil and the depth to bedrock. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is unsuitable for crop production. The main limitation is the severe hazard of erosion.

This soil is limited as a site for most urban uses, mainly because of the slope. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is VIe, and the range site is Sandy Loam.

Ka—Kaufman clay, occasionally flooded. This very deep, nearly level soil is on flood plains along the Trinity River. Areas of this soil are flooded once every 2 to 20 years for several days. Slopes are 0 to 1 percent. Individual areas are elongated and range from 85 to 1,500 acres in size.

Typically, the surface layer is medium acid to neutral, black clay about 24 inches thick. The upper part of the subsoil, from a depth of 24 to 58 inches, is neutral, black clay. The lower part to a depth of 80 inches is moderately alkaline, dark brown clay.

This soil is somewhat poorly drained. Runoff is slow. Permeability is very slow. The available water capacity is high. Water penetrates the surface rapidly when the soil is dry and cracked and very slowly when the soil is wet and the cracks have closed. The seasonal high water table is at a depth of 1.5 to 4.0 feet. The hazard of water erosion is slight.

Included with this soil in mapping are Gladewater and Gowker soils. Gladewater soils are in landscape positions similar to those of the Kaufman soil. Gowker soils are in the slightly lower landscape positions. Also included is a soil that is similar to the Kaufman soil but is calcareous throughout. Included soils make up about 10 percent of the map unit.

Most areas of the Kaufman soil are used as range or pasture. This soil is suited to range plants. The major plants are Canada wildrye, rustyseed paspalum, Virginia wildrye, sedges, eastern gamagrass, and beaked panicum. The major trees are water oak, willow oak, cottonwood, elm, and pecan. The production of pecans is important in some areas.

This soil is suited to pasture and hay. The main limitations are wetness and the dense, clayey layers. Applications of fertilizer and good grazing management are needed for the best production of improved bermudagrass, common bermudagrass, Dallisgrass, white clover, and vetch.

This soil is suited to crops, such as cotton, grain sorghum, corn, soybeans, and small grain. Production is limited in some years because of the flooding.

Because of the flooding and the shrink-swell potential, this soil is not suitable as a site for urban uses. It has a corrosive effect on uncoated steel.

The capability subclass is IIw, the woodland ordination symbol is 4W, and the range site is Clayey Bottomland.

Kf—Kaufman clay, frequently flooded. This very deep, nearly level soil is on flood plains along the Trinity River. Areas of this soil are flooded at least once in 2 years for several days. Slopes are 0 to 1 percent. Individual areas are long and narrow and range from 40 to 200 acres in size.

Typically, the surface layer is neutral, black clay about 10 inches thick. The upper part of the subsoil, from a depth of 10 to 54 inches, is neutral, very dark gray clay that has brown mottles. The lower part to a depth of 80 inches is moderately alkaline, gray clay that has dark yellowish brown mottles.

This soil is somewhat poorly drained. Runoff is slow. Permeability is very slow. The available water capacity is high. Water penetrates the surface rapidly when the soil is dry and cracked and very slowly when the soil is wet and the cracks have closed. The seasonal high water table is at a depth of 1.5 to 4.0 feet. The hazard of water erosion is slight.

Included with this soil in mapping are Gladewater, Gowker, and Nahatche soils. These soils are in landscape positions similar to those of the Kaufman soil. Also included is a soil that is similar to the Kaufman soil but is calcareous throughout. Included soils make up about 10 percent of the map unit.

Most areas of the Kaufman soil are used as range or pasture. This soil is suited to range plants. The major plants are Canada wildrye, rustyseed paspalum, Virginia wildrye, sedges, eastern gamagrass, and beaked panicum. The major trees are water oak, willow oak, cottonwood, elm, and pecan.

This soil is suited to pasture and hay. The main limitations are wetness and the very slow permeability. Applications of fertilizer and good grazing management are needed for the best production of improved bermudagrass, Dallisgrass, white clover, and vetch.

This soil is not suitable for crop production because of the flooding.

Because of the flooding and the shrink-swell potential, this soil is not suitable as a site for urban uses. It has a corrosive effect on uncoated steel.

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

KuC—Kurten fine sandy loam, 1 to 5 percent slopes. This deep, gently sloping soil is on broad uplands. It is usually on the convex, lower slopes and flats. Individual areas are mainly oblong or irregularly shaped and range from about 10 to 100 acres in size.

Typically, the surface layer is medium acid, dark brown fine sandy loam about 4 inches thick. The subsurface layer, from a depth of 4 to 8 inches, is medium acid, brown fine sandy loam. The subsoil extends to a depth of 58 inches. From a depth of 8 to 24 inches, it is strongly acid, dark reddish brown clay; from a depth of 24 to 36 inches, it is very strongly acid, red clay that has grayish mottles; from a depth of 36 to 51 inches, it is very strongly acid, light brownish gray clay that has reddish mottles; and from a depth of 51 to 58 inches, it is strongly acid, weak red clay that is stratified with thin layers of shale. The underlying material to a depth of 80 inches is strongly acid, weak red and reddish brown, stratified clay and very fine sandy loam.

This soil is moderately well drained. Runoff is medium. Permeability is very slow. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Bremond, Crockett, Spiller, and Tabor soils. Bremond and Crockett soils are in the slightly lower landscape positions. Spiller and Tabor soils are in the slightly higher landscape positions. Also included are areas where the slope is less than 1 percent and small eroded areas that have only 1 or 2 inches of topsoil. Included soils make up about 15 to 20 percent of the map unit.

The Kurten soil is used mainly as pasture or range. It is suited to pasture and hay. The main limitation is the dense, clayey subsoil, which restricts the movement of air and water through the soil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, crimson clover, and arrowleaf clover.

This soil is suited to range plants. The main limitation is the dense, clayey subsoil. The native plant community consists of little bluestem, silver bluestem, tall dropseed, arrowfeather threeawn, low panicums, blackjack oak, post oak, and yaupon.

This soil is suited to crop production. The main limitation is the dense, clayey subsoil. Although crops generally are not planted on this soil, corn and cotton have been grown in some areas in the past.

This soil is limited as a site for most urban uses because of low strength and the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IVe, and the range site is Claypan Savannah.

LfA—Lufkin fine sandy loam, 0 to 1 percent slopes. This very deep, nearly level soil is in broad areas on uplands. Individual areas are irregularly shaped or oblong and range from 5 to 90 acres in size.

Typically, the surface layer is slightly acid, dark grayish brown fine sandy loam about 5 inches thick. The subsurface layer, from a depth of 5 to 9 inches, is medium acid, grayish brown fine sandy loam. The upper part of the subsoil, from a depth of 9 to 44 inches, is slightly acid to strongly acid, grayish brown to gray clay. The lower part, from a depth of 44 to 56 inches, is moderately alkaline, light brownish gray clay. The underlying material to a depth of 80 inches is moderately alkaline, light brownish gray clay stratified with thin layers of clay loam and very fine sand.

This soil is somewhat poorly drained. Runoff is slow. Permeability is very slow. A perched seasonal high water table is at a depth of 0.5 to 1.0 foot. The available water capacity is moderate. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Gredge, Rader, Tabor, Zack, and Zulch soils in the slightly higher landscape positions. These soils make up less than 15 percent of the map unit.

Most areas of the Lufkin soil are used as pasture or range. This soil is suited to pasture and hay. The main limitations are the dense, clayey subsoil and wetness. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suitable for range. The main limitation is the dense, clayey subsoil. The major plants are little bluestem, silver bluestem, tall dropseed, arrowfeather threeawn, low panicums, Florida paspalum, and purpletop. The major trees are post oak and blackjack oak.

The suitability of this soil for crop production is limited. The main limitations are wetness and the dense, clayey subsoil. Management of crop residue helps to maintain the content of organic matter and tilth.

This soil is limited as a site for most urban uses, mainly because of wetness and the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIw, and the range site is Claypan Savannah.

MaA—Mabank fine sandy loam, 0 to 1 percent slopes. This very deep, nearly level soil is in broad, smooth, flat areas on uplands. Individual areas are irregularly shaped or oblong and range from 20 to 100 acres in size.

Typically, the surface layer is medium acid, dark grayish brown fine sandy loam about 10 inches thick. The upper part of the subsoil, from a depth of 10 to 33 inches, is slightly acid, black clay. The lower part, from a depth of 33 to 65 inches, is neutral, very dark gray and dark gray clay and sandy clay loam. The underlying material to a depth of 80 inches is neutral, light brownish gray clay stratified with layers of sandstone.

This soil is somewhat poorly drained. Runoff is slow. Permeability is very slow. The available water capacity is moderate. A perched seasonal high water table is at a depth of 0.5 to 1.0 foot. The hazard of water erosion is slight.

Included with this soil in mapping are small areas of Benchley, Dimebox, Crockett, and Kurten soils in the slightly higher landscape positions. These soils make up less than 15 percent of the map unit.

Most areas of the Mabank soil are used as pasture or range. This soil is suited to pasture and hay. The main limitations are the dense, clayey subsoil and wetness. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suited to range plants. The major plants are little bluestem, big bluestem, sideoats grama, yellow indiangrass, Florida paspalum, switchgrass, and Texas winter-grass. The major trees are elm, hackberry, and post oak.

The suitability of this soil for crop production is limited. The major limitations are the dense, clayey subsoil and wetness. Cotton, corn, grain sorghum, and small grain can be grown. Leaving crop residue on the surface helps to maintain tilth and the content of organic matter.

This soil is limited as a site for most urban uses, mainly because of wetness and the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The very slow permeability is a limitation on sites for septic tank absorption fields. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIw, and the range site is Claypan Prairie.

Na—Nahatche loam, frequently flooded. This very deep, nearly level soil is mostly on flood plains along the smaller streams. A few areas are on flood plains along rivers. Slopes are 0 to 1 percent. This soil is flooded more often than once every 2 years for a few days. Individual areas are mainly long and narrow and range from about 10 to 400 acres in size.

Typically, the surface layer is slightly acid, dark brown loam about 8 inches thick. The subsoil layers are stratified and extend to a depth of 60 inches. They are slightly acid, dark grayish brown and grayish brown clay loam and loam. They have thin strata of fine sandy loam.

This soil is somewhat poorly drained. Runoff is slow. Permeability is moderate. The available water capacity also is moderate. The seasonal high water table, which is at a depth of 0.5 foot to 1.5 feet, keeps the soil saturated for periods of a few days to a few weeks, mainly during winter and early spring. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Gladewater, Gowker, and Hatliff soils. Gladewater soils are slightly lower on the landscape than the Nahatche soil. Gladewater soils are clayey throughout and are confined to the broad flood basins of the Navasota River and some areas of the Trinity River. Gowker and Hatliff soils are slightly higher on the landscape than the Nahatche soil. Gowker soils have darker solum than the Nahatche soil, and Hatliff soils are sandier throughout the solum. The included soils make up less than 20 percent of the map unit.

Most areas of the Nahatche soil are used as woodland or improved pasture. This soil is suited to the production of hardwoods. The dominant trees are water oak, willow oak, and eastern cottonwood. The flooding and wetness are limitations.

This soil is suited to the production of understory plants that can be grazed by livestock and game animals. The major understory plants are hairy wildrye, spreading panicum, beaked panicum, brownseed paspalum, and wax-myrtle.

This soil is suited to pasture and hay. Wetness and the flooding are the major limitations. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass and bahiagrass.

Some areas of this soil are used as rangeland. This soil is well suited to range.

This soil is not suited to crop production because of the frequent flooding.

Because of the flooding and wetness, this soil is not suitable as a site for urban uses. It has a corrosive effect on uncoated steel and concrete.

The capability subclass is Vw, the woodland ordination symbol is 6W, and the range site is Loamy Bottomland.

NvB—Navasan loamy fine sand, 1 to 3 percent slopes. This very deep, very gently sloping soil is on low terraces on or adjacent to flood plains. It is adjacent to the Navasota River and to local streams. It is in areas 3 to 10 feet above the flood plains. In some areas it is subject to rare flooding. Individual areas are generally oval and range from 10 to 50 acres in size.

Typically, the surface layer is slightly acid, brown loamy fine sand about 8 inches thick. The subsurface layer, from a depth of 8 to 45 inches, is medium acid, loamy fine sand. It is brown in the upper part and very pale brown in the lower part. The upper part of the subsoil, from a depth of 45 to 65 inches, is medium acid, yellowish brown and grayish brown fine sandy loam and sandy clay loam. The lower part, from a depth of 65 to 75 inches, is slightly acid, mottled yellowish brown, light gray, and yellowish red fine sandy loam.

This soil is moderately well drained. Runoff is slow. Permeability is rapid in the upper part of the soil and moderately slow in the lower part. The available water capacity is moderate. A perched seasonal high water table is at a depth of 3 to 5 feet for short periods following heavy rainfall. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Eufaula, Silawa, and Rader soils. Eufaula soils are in landscape positions similar to those of the Navasan soil. They have thin layers of more clayey material in the lower part of the solum. Silawa soils are in the higher landscape positions. They have a subsoil that is dominated by red colors. Rader soils are in the slightly higher landscape positions. They have a loamy surface layer. Included soils make up less than 20 percent of the map unit.

Most areas of the Navasan soil are used as range or pasture. This soil is suited to range plants. The main limitation is the droughty, sandy surface layer. The major plants are little bluestem, low panicums, low paspalums, post oak, and yaupon. Overgrazing has allowed brush species to invade and increase in some areas.

This soil can be used for pasture and hay. The main limitation is the droughty, sandy surface layer. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass and lovegrass.

This soil is suited to crops, such as corn, peanuts, and watermelons. The main limitation is the droughty, sandy surface layer. Applications of fertilizer and lime are essential for good yields.

This soil is limited as a site for most urban uses, mainly because of the flooding. Wetness is a limitation on sites for sanitary facilities. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Deep Sand.

PaC—Padina loamy fine sand, 1 to 5 percent slopes. This very deep, gently sloping soil is in broad, smooth or convex areas on uplands. Individual areas are generally oval or elongated and range from 10 to 200 acres in size.

Typically, the surface layer is medium acid, brown loamy fine sand about 5 inches thick. The subsurface layer, from a depth of 5 to 52 inches, is medium acid, light yellowish brown loamy fine sand. The subsoil to a depth of 80 inches is strongly acid, yellowish red and strong brown sandy clay loam.

This soil is well drained. Runoff is slow. Permeability is moderate. The available water capacity is low. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Dutek, Jedd, Robco, Rosanky, and Silstid soils. Dutek and Silstid soils are loamy fine sand to a depth of 20 to 40 inches. They are in landscape positions similar to those of the Padina soil. Jedd and Rosanky soils have a surface layer of fine sandy loam. They are on the steeper side slopes and on small knolls and narrow ridgetops. Robco soils have a surface layer of loamy fine sand. They are in the lower concave areas and at the head of drainageways. Also included are areas of a soil that is similar to the Padina soil but has a surface layer of fine sand and areas of a soil having thin layers of more clayey material in the lower part of the solum. Included soils make up less than 20 percent of the map unit.

Most areas of the Padina soil are used as range or pasture. This soil is suited to range plants. The main limitation is the droughty, sandy surface layer. The major plants are little bluestem, yellow indiangrass, sand lovegrass, purpletop, low panicums, low paspalums, and switchgrass. The major trees are blackjack oak, bluejack oak, post oak, and yaupon.

This soil is suited to pasture and hay. The main limitation is the droughty, sandy surface layer. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass and lovegrass.

The suitability of this soil for most crops, except for peanuts and watermelons, is limited. The main limitation is the droughty, sandy surface layer.

This soil is suitable as a site for most urban uses. Seepage is a hazard on sites for most kinds of sanitary facilities. The soil has a corrosive effect on concrete and uncoated steel.

The capability subclass is IIIe, and the range site is Deep Sand.

RaB—Rader fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping soil is on broad, slightly mounded terraces; in the lower concave areas; and at the head of drainageways. Individual areas are oblong or elongated and range from 15 to 400 acres in size.

Typically, the surface layer is neutral, brown fine sandy loam about 10 inches thick. The subsurface layer, from a depth of 10 to 25 inches, is neutral, light yellowish brown fine sandy loam. The subsoil extends to a depth of 96 inches or more. From a depth of 25 to 34 inches, it is strongly acid, yellow loam that has streaks and pockets of light yellowish brown fine sandy loam; from a depth of 34 to 50 inches, it is strongly acid, grayish brown clay that has red and yellow mottles; from a depth of 50 to 75 inches, it is very strongly acid, grayish brown sandy clay loam that has red and yellow mottles; and from a depth of 75 to 96 inches, it is strongly acid, light brownish gray sandy clay loam that has yellow mottles.

This soil is moderately well drained. Runoff is slow. Permeability is very slow. The available water capacity is moderate. A perched seasonal high water table is above the subsoil during periods of prolonged rainfall. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Derly, Lufkin, Robco, and Tabor soils. Tabor soils are in the slightly higher landscape positions. Derly and Lufkin soils are slightly lower on the landscape than the Rader soil. Robco soils are in landscape positions similar to those of the Rader soil. Included soils make up less than 10 percent of the map unit.

The Rader soil is used mainly as pasture or range. This soil is suited to pasture and hay. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, white clover, and vetch.

This soil is suited to range plants. The major plants are little bluestem, eastern gamagrass, yellow indiangrass, beaked panicum, brownseed paspalum, purpletop, longleaf uniola, and switchgrass. The major trees are post oak, blackjack oak, hickory, and elm.

This soil is suited to most crops, such as corn, cotton, grain sorghum, soybeans, and small grain. Leaving crop residue on the surface helps to maintain tilth and the content of organic matter.

This soil is suitable as a site for most urban uses. The main limitations are wetness and the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The very slow permeability is a limitation on sites for septic tank absorption fields. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Sandy Loam.

RbA—Rader-Derly complex, 0 to 2 percent slopes. These very deep, nearly level soils are in broad, distinctly mounded areas on terraces. The Rader soil is on round or oblong mounds that are 10 to 30 inches high and 40 to 150 feet across. The Derly soil is in low areas between the mounds. Slopes are mainly 1 percent but range from 0 to 2 percent. Individual areas are irregularly shaped or oval and range from 15 to 500 acres in size.

Areas of this unit are 60 to 70 percent Rader soil, 20 to 30 percent Derly soil, and 5 to 15 percent included soils. These percentages were determined by sampling the soils in random transects across the mapped areas. The soils occur as areas so intricately mixed that mapping them separately is not practical at the scale of the soil maps.

Typically, the surface layer of the Rader soil is slightly acid, brown very fine sandy loam about 6 inches thick. The subsurface layer, from a depth of 6 to 24 inches, is medium acid, yellowish brown very fine sandy loam. The subsoil extends to a depth of 80 inches or more. From a depth of 24 to 29 inches, it is very strongly acid, strong brown very fine sandy loam that is mixed with light yellowish brown fine sandy loam; from a depth of 29 to 33 inches, it is very strongly acid, yellow loam; from a depth of 33 to 45 inches, it is very strongly acid, grayish brown clay; from a depth of 45 to 61 inches, it is medium acid, yellowish brown clay loam; and from a depth of 61 to 80 inches, it is moderately alkaline, light gray clay loam. It is mottled in shades of red, yellow, and brown.

Typically, the surface layer of the Derly soil is medium acid, dark grayish brown loam about 8 inches thick. The upper part of the subsoil, from a depth of 8 to 22 inches, is medium acid, dark gray clay. The next part, from a depth of 22 to 46 inches, is neutral, dark grayish brown clay loam. The lower part to a depth of 80 inches is neutral, clay loam mottled in shades of gray, yellow, and red.

The Rader soil is moderately well drained, and the

Derly soil is somewhat poorly drained. Runoff is slow on both soils. Permeability is very slow. The available water capacity is moderate in the Rader soil and high in the Derly soil. The Derly soil has a perched seasonal high water table within a depth of 1.5 feet during periods of heavy rainfall. It is sometimes ponded for short periods. The Rader soil has a perched seasonal high water table at a depth of 2 to 5 feet. The hazard of water erosion is slight on both soils.

Included with these soils in mapping are Lufkin and Silawa soils. Lufkin soils are in positions similar to those of the Derly soil. Silawa soils are in the slightly higher, better drained areas.

A large acreage of the Rader and Derly soils is used as pasture and hayland. Wetness is the main limitation in areas of the Derly soil. Common and improved bermudagrass, bahiagrass, Dallisgrass, switchgrass, tall fescue, singletary peas, and white clover are the main grasses and legumes. Applications of fertilizer and lime are needed for the best forage production.

Some areas of this unit are used as range. The climax vegetation is tall grasses in an oak savannah. The main trees on the Rader soil are post oak, blackjack oak, elm, and hickory. The main trees on the Derly soil are water oak, post oak, and hickory.

These soils are generally not used for cropland because of wetness. If crops are grown on these soils, applications of fertilizer and lime are needed for sustained yields.

These soils are limited as sites for dwellings, local roads and streets, and sanitary facilities because of wetness, the very slow permeability, low strength, and the shrink-swell potential. The soils have a corrosive effect on uncoated steel and concrete.

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

RcB—Robco loamy fine sand, 1 to 3 percent slopes. This very deep, very gently sloping soil is on concave side slopes, on small knolls, or near the head of drainageways on uplands. Individual areas are generally irregular in shape and range from 5 to 250 acres in size.

Typically, the surface layer is strongly acid, brown loamy fine sand about 8 inches thick. The subsurface layer, from a depth of 8 to 24 inches, is medium acid, very pale brown loamy fine sand. The upper part of the subsoil, from a depth of 24 to 28 inches, is medium acid, brownish yellow loam that has streaks and pockets of very pale brown loamy fine sand. The next part, from a depth of 28 to 73 inches, is very strongly acid, grayish brown and pale brown sandy clay loam that has mottles in shades of yellow, gray, and red. The lower part to a depth of 80 inches is neutral, white sandy clay loam that has yellowish mottles.

This soil is moderately well drained. Runoff is slow or medium. Permeability is slow. The available water capacity is moderate. A perched water table is above the subsoil during periods of prolonged rainfall. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Padina, Rader, Silstid, Spiller, and Tabor soils. Padina and Silstid soils are in the higher, better drained positions. Rader, Spiller, and Tabor soils are in landscape positions similar to those of the Robco soil. Also included is a soil that is similar to the Robco soil but has a clayey subsoil. Included soils make up less than 15 percent of the map unit.

Most areas of the Robco soil are used as pasture or range. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, arrowleaf clover, and vetch.

This soil can be used for range. The main limitation is the droughty, sandy surface layer. The major plants are little bluestem, yellow indiangrass, sand lovegrass, beaked panicum, brownseed paspalum, and purpletop. The major trees are post oak, blackjack oak, and yaupon.

This soil can be used for crops, such as hay, watermelons, corn, and peanuts (fig. 9). The main limitation is the droughty, sandy surface layer. Applications of fertilizer and lime are essential for good yields.

This soil is limited as a site for most urban uses, mainly because of wetness. It has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIe, and the range site is Sandy.

RoC—Rosanky fine sandy loam, 1 to 5 percent slopes. This very deep, gently sloping soil is on broad ridges and side slopes in the uplands. Individual areas are generally irregularly shaped or oblong and range from 5 to 200 acres in size.

Typically, the surface layer is medium acid, dark brown fine sandy loam about 5 inches thick. The upper part of the subsoil, from a depth of 5 to 39 inches, is very strongly acid or strongly acid, red clay. The lower part, from a depth of 39 to 50 inches, is very strongly acid, red clay loam that has grayish brown and brownish yellow mottles. The underlying material, from a depth of 50 to 64 inches, is very strongly acid, red clay loam. Below this to a depth of 80 inches is strongly acid, stratified, very pale brown sandstone.

This soil is well drained. Runoff is medium or rapid.

Figure 9.—Hay in an area of Robco loamy fine sand, 1 to 3 percent slopes.

Permeability is moderately slow. The available water capacity is moderate. The hazard of water erosion also is moderate.

Included with this soil in mapping are areas of Gasil, Jedd, and Rader soils. Gasil and Rader soils are in the slightly lower landscape positions. Jedd soils are on the steeper side slopes. Included soils make up less than 15 percent of the map unit.

Most areas of the Rosanky soil are used as pasture or range. This soil is suited to pasture and range. The main limitation is the clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suited to range plants. The major plants are little bluestem, eastern gamagrass, yellow indiangrass, beaked panicum, longleaf uniola, brownseed paspalum, and switchgrass. The major trees are post oak, blackjack oak, and elm. The major understory species is yaupon.

A few areas are used for crops, such as cotton, corn, and grain sorghum. Erosion is a hazard. Cover crops, terraces, and contour farming are needed to control erosion. Applications of lime and fertilizer are essential for good yields.

This soil is suitable as a site for most urban uses. The main limitation is the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is IIIe, and the range site is Claypan Savannah.

RvC—Rosanky gravelly fine sandy loam, 1 to 5 percent slopes. This very deep, gently sloping soil is on small knobs and ridges in the uplands. Individual areas are generally oval and range from 5 to 40 acres in size.

Typically, the surface layer is very strongly acid, brown gravelly fine sandy loam about 10 inches thick. The upper part of the subsoil, from a depth of 10 to 28 inches, is very strongly acid, red clay. The lower part, from a depth of 28 to 48 inches, is very strongly acid, stratified yellowish brown and light brownish gray clay. Below this to a depth of 80 inches is very strongly acid, yellowish brown and light brownish gray shale and weakly cemented sandstone bedrock.

This soil is well drained. Runoff is medium. Permeability is moderately slow. The available water capacity is moderate. The hazard of water erosion generally is moderate, but it is severe in small areas where the topsoil has been removed.

Included with this soil in mapping are areas of Gasil and Jedd soils. Gasil soils are in the slightly lower landscape positions. Jedd soils are on the steeper side slopes. Some areas have had the topsoil removed. Included soils make up less than 20 percent of the map unit.

Most areas of the Rosanky soil are used as pasture or range. In the areas used for pasture and hay, the main limitation is the clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suited to range plants. The major plants are little bluestem, eastern gamagrass, yellow indiangrass, beaked panicum, longleaf uniola, brownseed paspalum, and switchgrass. The major trees are post oak, blackjack oak, elm, and yaupon.

This soil is not used for crop production because of the gravelly surface layer.

This soil is limited as a site for most urban uses, mainly because of the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is IIIe, and the range site is Sandy Loam.

SaB—Silawa fine sandy loam, 1 to 5 percent slopes. This very deep, gently sloping soil is in convex areas on terraces and uplands. Individual areas are generally irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is medium acid, brown fine sandy loam about 5 inches thick. The subsurface layer, from a depth of 5 to 10 inches, is medium acid, strong brown fine sandy loam. The subsoil, from a depth of 10 to 57 inches, is strongly acid or very strongly acid, red sandy clay loam. The underlying material to a depth of 80 inches is strongly acid, yellowish red fine sandy loam.

This soil is well drained. Runoff is slow or medium. Permeability and the available water capacity are moderate. The hazard of water erosion also is moderate.

Included with this soil in mapping are areas of Dutek, Gasil, and Silstid soils. Dutek and Gasil soils are in landscape positions similar to those of the Silawa soil. Silstid soils are in the slightly lower landscape positions. Also included are areas of a soil that is similar to the Silawa soil but has a surface layer of loamy fine sand and a few areas where slopes are about 6 to 8 percent and that generally are less than 5 acres in size. Included soils make up less than 15 percent of the map unit.

Most areas of the Silawa soil are used as pasture or range. This soil is suited to pasture and hay. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is suited to range plants. The major plants are little bluestem, yellow indiangrass, beaked panicum, purpletop, brownseed paspalum, and switchgrass. The major trees are blackjack oak, post oak, and elm.

This soil can be used for crops, such as cotton, corn, grain sorghum, and small grain. Applications of lime and fertilizer are essential for good yields. Cover crops, terraces, and contour farming are needed to control erosion.

This soil is suitable as a site for most urban uses. It has a corrosive effect on uncoated steel.

The capability subclass is IIIe, and the range site is Sandy Loam.

SdB—Silstid loamy fine sand, 1 to 5 percent slopes. This very deep, gently sloping soil is in broad areas on uplands. Individual areas are generally irregular in shape and range from 15 to 75 acres in size.

Typically, the surface layer is medium acid, brown loamy fine sand about 38 inches thick. The subsurface layer, from a depth of 8 to 32 inches, is medium acid, light yellowish brown loamy fine sand. From a depth of 32 to 60 inches, the subsoil is medium acid sandy clay loam. It is yellowish brown in the upper part and brownish yellow in the lower part. From a depth of 60 to 80 inches, it is medium acid, mottled brownish yellow, red, and light gray sandy clay loam.

This soil is well drained. Runoff is slow. Permeability and the available water capacity are moderate. The hazard of water erosion also is moderate.

Included with this soil in mapping are areas of Dutek, Gasil, Padina, Chazos, and Robco soils. Dutek and Padina soils are in the slightly higher landscape positions. Gasil and Chazos soils are in landscape positions similar to those of the Silstid soil. Robco soils are on the lower side slopes and in concave areas. Included soils make up less than 15 percent of the map unit.

A large acreage of the Silstid soil is used as pasture and hayland. Improved bermudagrass and weeping lovegrass are the main grasses. The main limitation is droughtiness. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Overseeding legumes, such as vetch and singletary peas, into the grasses lengthens the grazing season and improves fertility.

A large acreage of this soil is used as range. The climax vegetation is tall grasses in an oak savannah. The main limitation is droughtiness.

Because of droughtiness and the hazard of erosion, this soil is generally not used for crops. It is suited to peanuts, watermelons, peas, and sweet potatoes. Applications of fertilizer and lime are essential for good yields. Cover crops, high-residue crops, and green manure crops help to control erosion and maintain fertility.

This soil is suited to most urban uses. It has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Sandy.

SpB—Spiller fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping soil is in broad areas on uplands. Individual areas are irregular in shape and range from 5 to 100 acres in size.

Typically, the surface layer is neutral, dark brown fine sandy loam about 7 inches thick. The subsurface layer, from a depth of 7 to 14 inches, is neutral, brown fine sandy loam. The subsoil, from a depth of 14 to 56 inches, is strongly acid to neutral, yellowish brown clay loam and clay. It has red and brown mottles in the upper part and light gray mottles in the lower part. The underlying material to a depth of 80 inches is neutral, stratified, weakly consolidated, yellowish brown clay loam and light gray shale that has a texture of clay.

This soil is moderately well drained. Runoff is medium. Permeability is slow. The available water capacity is moderate. The hazard of water erosion also is moderate.

Included with this soil in mapping are areas of Gasil, Rader, Robco, Chazos, Tabor, and Silstid soils. Gasil and Silstid soils are in landscape positions similar to those of the Spiller soil. Rader, Robco, Chazos, and Tabor soils are in the slightly lower landscape positions. Included soils make up less than 15 percent of the map unit.

A large acreage of the Spiller soil is used as pasture and hayland. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

Large areas of this soil are used for range. The major plants are little bluestem, eastern gamagrass, yellow indiangrass, brownseed paspalum, and switchgrass.

This soil is suited to crops, such as cotton, corn, grain sorghum, and small grain. Cover crops, terraces, and contour farming are needed to control erosion. Applications of fertilizer and lime are essential for good yields.

This soil is suitable as a site for most urban uses. The main limitations are the slow permeability, the shrink-swell potential, and low strength. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Sandy Loam.

TaB—Tabor fine sandy loam, 1 to 3 percent slopes. This very deep, very gently sloping soil is on uplands. It is usually in broad, smooth areas or on the convex, lower side slopes. Individual areas are generally irregular in shape and range from 15 to 200 acres in size.

Typically, the surface layer is medium acid, brown fine sandy loam about 7 inches thick. The subsurface layer, from a depth of 7 to 14 inches, is medium acid, light yellowish brown fine sandy loam. The upper part of the subsoil, from a depth of 14 to 43 inches, is strongly acid to slightly acid, yellowish brown clay that has reddish and grayish mottles. The next part, from a depth of 43 to 58 inches, is moderately alkaline, light olive brown clay. The lower part, from a depth of 58 to 70 inches, is moderately alkaline, light yellowish brown sandy clay loam. The underlying material to a depth of 80 inches is moderately alkaline, light brownish gray clay.

This soil is moderately well drained. Runoff is slow or medium. Permeability is very slow. The available water capacity is high. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Boonville, Chazos, Gredge, Rader, Zack, and Zulch soils. Boonville, Chazos, Gredge, Zack, and Zulch soils are in landscape positions similar to those of the Tabor soil or are in the slightly higher positions. Rader soils are in the nearby slightly lower positions. Included soils make up less than 20 percent of the map unit.

A large acreage of the Tabor soil is used as pasture and hayland. Common and improved bermudagrass, bahiagrass, weeping lovegrass, kleingrass, and Johnsongrass are the main grasses. Overseeding legumes, such as arrowleaf clover, crimson clover, subterranean clover, vetch, and singletary peas, into the grasses lengthens the grazing season and improves fertility. Applications of fertilizer are needed for sustained production.

A large acreage of this soil is used as range. This soil is well suited to this use. The climax vegetation is tall grasses in an oak savannah.

This soil generally is not used for crops. The main management concerns are the hazard of erosion, the slope, and the dense, clayey subsoil. This soil can be used for corn, cotton, grain sorghum, and small grain. Applications of fertilizer and lime are essential for good yields.

This soil is limited as a site for dwellings and for local roads and streets, mainly because of the shrink-swell potential. Low strength is a limitation on sites for local roads and streets. The very slow permeability is a limitation on sites for sanitary facilities. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Sandy Loam.

ToD—Tonkavar loamy fine sand, 1 to 8 percent slopes. This very deep, very gently sloping to moderately sloping soil is on uplands. Individual areas are oblong or long and narrow and range from 10 to 70 acres in size.

Typically, the surface layer is medium acid, loamy fine sand about 6 inches thick. The subsurface layer, from a depth of 6 to 48 inches, is strongly acid, pale brown loamy fine sand. The subsoil, from a depth of 48 to 72 inches, is very strongly acid and strong brown. It is sandy clay loam in the upper part and sandy loam in the lower part. Below this to a depth of 80 inches is reddish yellow, weakly cemented sandstone.

This soil is well drained. Runoff is slow. Permeability is moderate. A perched seasonal high water table is at a depth of 4 to 6 feet. The available water capacity is low. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Arriola, Elmina, and Huntsburg soils. Arriola soils are fine sandy loam to a depth of less than 10 inches. Elmina soils are sandy to a depth of 20 to 40 inches. Huntsburg soils are sandy to a depth of less than 20 inches. The included soils are usually higher on the landscape than the Tonkavar soil. They make up less than 15 percent of the map unit.

The Tonkavar soil is used mainly as woodland. Shortleaf pine and loblolly pine are the main pine species. The understory vegetation, which consists of yaupon, greenbrier, longleaf uniola, and American beautyberry, is available for grazing by wildlife and livestock.

A small acreage of this soil is used as pasture and hayland. Improved bermudagrass and weeping lovegrass are the main grasses. The main limitation is droughtiness in the surface and subsurface layers. Pastures require light applications of fertilizer and lime at frequent intervals for high production. Overseeding legumes, such as vetch and singletary peas, into the grasses lengthens the grazing season and improves fertility.

The suitability of this soil for most crops is limited. The main limitation is the droughty, sandy surface and subsurface layers. Applications of lime and fertilizer are essential for good production.

This soil is suitable as a site for most urban uses. Seepage is a hazard on sites for most kinds of sanitary facilities. The soil has a corrosive effect on concrete and uncoated steel.

The capability subclass is IVs, and the woodland ordination symbol is 8S.

WcA—Wilson loam, 0 to 1 percent slopes. This very deep, nearly level soil is in small, smooth, flat areas on ancient terraces and uplands. Individual areas are irregular in shape and range from 15 to 75 acres in size.

Typically, the surface layer is medium acid, very dark gray loam about 6 inches thick. The upper part of the subsoil, from a depth of 6 to 43 inches, is slightly acid or neutral clay. It is black to a depth of 21 inches and very dark gray to a depth of 43 inches. The lower part of the subsoil, from a depth of 43 to 80 inches, is moderately alkaline clay. It is dark grayish brown to a depth of 58 inches and light olive brown to a depth of 80 inches. The subsoil has mottles in shades of brown throughout.

This soil is somewhat poorly drained. Runoff is slow. Permeability is very slow. The available water capacity is high. A perched seasonal high water table is at a depth of 0.5 foot to 1.5 feet. The hazard of water erosion is slight.

Included with this soil in mapping are areas of Bremond, Crockett, Gredge, Lufkin, Mabank, and Tabor soils. Crockett, Gredge, and Tabor soils are in the slightly higher landscape positions. Bremond, Lufkin, and Mabank soils are in landscape positions similar to those of the Wilson soil. Included soils make up less than 15 percent of the map unit.

Most areas of the Wilson soil are used as pasture or range. In the areas used for pasture, the main limitations are wetness and the dense, clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, and white clover.

This soil is suited to range plants. The major plants are little bluestem, big bluestem, sideoats grama, yellow indiangrass, Florida paspalum, and Texas winter-grass. The major trees are elm, hackberry, and post oak.

This soil is suited to crops, such as corn, cotton, grain sorghum, and small grain. The main limitations are seasonal wetness and the dense, clayey subsoil. Applications of lime and fertilizer are needed to maintain high levels of production.

This soil is limited as a site for most urban uses, mainly because of the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on concrete and uncoated steel.

The capability subclass is IIIw, and the range site is Claypan Prairie.

ZaB—Zack fine sandy loam, 1 to 5 percent slopes. This gently sloping soil is moderately deep to shale. It is on broad and narrowly dissected uplands. Individual areas are irregular in shape and range from 15 to 150 acres in size.

Typically, the surface layer is medium acid, yellowish brown fine sandy loam about 7 inches thick. The upper part of the subsoil, from a depth of 7 to 24 inches, is strongly acid, yellowish red clay that has olive yellow mottles. The lower part, from a depth of 24 to 36 inches, is medium acid to moderately alkaline clay. It is light olive brown between depths of 14 and 30 inches and light yellowish brown between depths of 30 and 36 inches. Below this to a depth of 80 inches is moderately alkaline, light gray, stratified shale that has a texture of clay.

This soil is moderately well drained. Runoff is slow to rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion also is moderate.

Included with this soil in mapping are areas of Boonville, Gredge, Lufkin, Mabank, Tabor, Wilson, and Zulch soils. Boonville, Lufkin, Mabank, Tabor, Wilson, and Zulch soils are in the slightly lower landscape positions. Gredge soils are in landscape positions similar to those of the Zack soil. Included soils make up less than 15 percent of the map unit.

Most areas of the Zack soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, big bluestem, indiangrass, sideoats grama, Florida paspalum, Texas winter-grass, elm, hackberry, post oak, and mesquite. Some areas are heavily infested with mesquite. As a result, the abundance of range plants is decreased.

This soil is suited to pasture and hay. The main limitation is the dense, clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, subterranean clover, and vetch.

This soil is suited to crops, such as cotton, grain sorghum, and small grain. Cover crops, terraces, and contour farming are needed to reduce the hazard of erosion. Applications of fertilizer and lime are needed for sustained production.

This soil is limited as a site for most urban uses, mainly because of the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is IVe, and the range site is Claypan Prairie.

ZaC2—Zack fine sandy loam, 3 to 8 percent slopes, eroded. This gently sloping and moderately sloping soil is moderately deep to shale. It is on broad and narrowly dissected eroded side slopes in the uplands. In many areas the surface layer is 50 to 75 percent eroded. These areas have gullies that can be crossed by agricultural machinery. Some areas have been eroded to the extent that the subsoil is exposed. Individual areas are irregular in shape and range from 5 to 45 acres in size.

Typically, the surface layer is medium acid, brown fine sandy loam about 7 inches thick. The upper part of the subsoil, from a depth of 7 to 14 inches, is medium acid, reddish brown clay that has red and grayish brown mottles. The next part, from a depth of 14 to 26 inches, is strongly acid, yellowish brown clay that has grayish brown and red mottles. The lower part, from a depth of 26 to 36 inches, is strongly acid, pale brown clay that has red mottles. Below this to a depth of 80 inches is neutral, light yellowish brown, stratified shale that has brownish yellow and very pale brown mottles.

This soil is moderately well drained. Runoff is rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are areas of Gredge and Zulch soils. Gredge soils are in landscape positions similar to those of the Zack soil. Zulch soils are in the slightly lower landscape positions. Included soils make up less than 15 percent of the map unit.

Most areas of the Zack soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, big bluestem, indiangrass, sideoats grama, Florida paspalum, Texas winter-grass, elm, hackberry, post oak, and mesquite. Some areas are heavily infested with mesquite. As a result, the abundance of range plants is decreased.

The suitability of this soil for pasture and hay is limited, mainly because of the dense, clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is limited as a site for most urban uses, mainly because of the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is VIe, and the range site is Claypan Prairie.

ZaD—Zack fine sandy loam, 5 to 8 percent slopes. This moderately sloping soil is moderately deep to shale. It is on side slopes in the uplands. Individual areas are long and narrow and range from 5 to 25 acres in size.

Typically, the surface layer is slightly acid, brown, fine sandy loam about 5 inches thick. The upper part of the subsoil, from a depth of 5 to 17 inches, is neutral, dark reddish brown clay that has dark yellowish brown mottles. The next part, from a depth of 17 to 33 inches, is mildly alkaline, pale brown clay that has yellowish brown mottles. Below this to a depth of 60 inches is mildly alkaline, white shale and weakly cemented sandstone bedrock.

This soil is moderately well drained. Runoff is rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion is severe.

Included with this soil in mapping are areas of Gredge and Zulch soils. Gredge soils are in landscape positions similar to those of the Zack soil. Zulch soils are on the lower side slopes. Also included are some small areas of Zack soil that have the topsoil completely removed by erosion. Included soils make up less than 15 percent of the map unit.

Most areas of the Zack soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, indiangrass, sideoats grama, Florida paspalum, Texas winter-grass, elm, post oak, hackberry, and mesquite.

This soil is suited to pasture and hay. The main limitation is the dense, clayey subsoil. Applications of lime and fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, and vetch.

This soil is not suitable for crop production because of the severe hazard of erosion.

This soil is limited as a site for most urban uses, mainly because of the shrink-swell potential. The very slow permeability is a limitation on sites for septic tank absorption fields. Low strength is a limitation on sites for local roads and streets. The soil has a corrosive effect on uncoated steel.

The capability subclass is VIe, and the range site is Claypan Prairie.

ZgC3—Zack-Gullied land complex, 3 to 8 percent slopes. This map unit consists of a gently sloping and moderately sloping Zack soil intermingled with areas of gullies. The unit is on uplands. Slopes are mainly concave. Gully erosion is severe. Individual areas are irregular in shape and range from 5 to 35 acres in size. The U-shaped gullies are 5 to 20 feet deep and 10 to 75 feet wide (fig. 10). Some gullies are isolated, and others are grouped in a successive pattern. The bottom of the gullies is beginning to revegetate naturally, and erosion is slowly declining. In some areas about 30 percent of the surface is covered with siliceous pebbles and petrified wood. The Zack soil makes up about 50 percent of most areas.

Typically, the Zack soil has a surface layer of medium acid, light yellowish brown fine sandy loam about 4 inches thick. The upper part of the subsoil, from a depth of 4 to 11 inches, is medium acid, dark reddish brown clay. The lower part, from a depth of 11 to 38 inches, is strongly acid, light brownish gray clay that has yellowish red mottles. Below this to a depth of 80 inches is mildly alkaline, light gray shale and weakly cemented sandstone bedrock.

The Zack soil is moderately well drained. Runoff is rapid. Permeability is very slow. The available water capacity is moderate. The hazard of water erosion is severe.

This unit is not suited to cultivated crops because of the gullies. Most areas have been cultivated in the past. Most of the gullies formed when the soil was used as cropland.

Most areas of this unit are used as range. The Zack soil is suited to range plants. The gullies generally are barren, except on the bottom where some vegetation is becoming reestablished. Some areas are heavily infested with mesquite. As a result, the abundance of range plants is decreased.

Reclamation of areas of this unit is difficult because the amount of soil for use as backfill is limited. Revegetating the areas by planting ground cover is possible. A plant cover can be established, but in some areas the content of salts inhibits revegetation. Some areas have been shaped and are used as pond sites.

Because of the hazard of erosion, this unit is not suitable as a site for urban uses. The soil has a corrosive effect on uncoated steel.

The capability subclass is VIe, and the range site is Claypan Prairie.

ZuB—Zulch fine sandy loam, 1 to 3 percent slopes. This gently sloping soil is moderately deep to shale. It is on plane to slightly convex slopes on uplands. Individual areas are irregularly shaped or oval and range from 20 to 200 acres in size.

Typically, the surface layer is strongly acid, brown fine sandy loam about 9 inches thick. The upper part of

Figure 10.—Large gullies in an area of Zack-Gullied land complex, 3 to 8 percent slopes.

the subsoil, from a depth of 9 to 18 inches, is neutral, very dark gray clay loam. The next part, from a depth of 18 to 41 inches, is moderately alkaline, very dark gray and dark gray clay and clay loam. The lower part, from a depth of 41 to 47 inches, is moderately alkaline, light brownish gray clay. Below this to a depth of 60 inches is moderately alkaline, pale olive shale that has a texture of clay.

This soil is somewhat poorly drained. Runoff is medium. Permeability is very slow. The available water capacity is moderate. A perched seasonal high water table is at a depth of 0.5 to 1.0 foot. The hazard of water erosion is moderate.

Included with this soil in mapping are areas of Boonville, Gredge, Tabor, and Zack soils. Boonville and Tabor soils are in landscape positions similar to those of the Zulch soil. Gredge and Zack soils are in the higher positions. Included soils make up less than 15 percent of the map unit.

Most areas of the Zulch soil are used as range or pasture. This soil is suited to range. The major plants are little bluestem, indiangrass, switchgrass, hackberry, elm, honey locust, oak, and mesquite. Some areas are heavily infested with mesquite. As a result, the abundance of range plants is decreased.

This soil is suited to pasture and hay. The main limitation is the dense, clayey subsoil. Applications of fertilizer and good grazing management are needed for the best production of improved bermudagrass, bahiagrass, arrowleaf clover, crimson clover, subterranean clover, and vetch.

This soil is suited to crops, such as cotton, grain sorghum, and small grain. Cover crops, terraces, and contour farming are needed to reduce the hazard of erosion. Applications of lime and fertilizer are needed for sustained production.

This soil is limited as a site for most urban uses because of the shrink-swell potential, wetness, and low strength. The very slow permeability is a limitation on sites for septic tank absorption fields. The soil has a corrosive effect on uncoated steel and concrete.

The capability subclass is IIIe, and the range site is Claypan Prairie.

Prime Farmland

In this section, prime farmland is defined. The soils in Madison County that are considered prime farmland are listed in table 5.

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. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, State, and Federal levels, as well as individuals, must encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to food, feed, forage, fiber, and oilseed crops. Such soils have properties that favor the economic production of sustained high yields of crops. The soils need only to be treated and managed by acceptable farming methods. The moisture supply must be adequate, and the growing season must be sufficiently long. Prime farmland soils produce the highest yields with minimal expenditure of energy and economic resources. Farming these soils results in the least damage to the environment.

Prime farmland soils may presently be used as cropland, pasture, or woodland or for other purposes. They are used for food or fiber or are available for these uses. Urban or built-up land, public land, and water areas cannot be considered prime farmland. Urban or built-up land is any contiguous unit of land 10 acres or more in size that is used for such purposes as housing, industrial, and commercial sites, sites for institutions or public buildings, small parks, golf courses, cemeteries, railroad yards, airports, sanitary landfills, sewage treatment plants, and water-control structures. Public land is land not available for farming in National forests, National parks, military reservations, and State parks.

Prime farmland soils usually receive an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 5 percent.

The map units that are considered prime farmland in Madison County are shown in table 5. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

Soils that are frequently flooded during the growing season qualify as prime farmland only in areas where this hazard has been overcome by flood-control measures. If applicable, the need for these measures is indicated in parentheses after the map unit name in table 5. Onsite evaluation is necessary to determine if the hazard has been overcome by corrective measures.

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 for 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, parks and other recreational facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

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

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

John C. Copeland, agronomist, Soil Conservation Service, helped to prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants that are commonly grown in the survey area and are best suited to the soils are identified, and the system of land capability classification used by the Soil Conservation Service is explained. The estimated yields of the main crops and hay and pasture plants are listed for each soil in table 6.

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 Soil Conservation Service or the Cooperative Extension Service.

Crops

Cropland is of minor extent in Madison County. In the 1940's and 1950's, a large part of the county was used for crops. Most of the cropland has been converted to pasture and hayland. The Ferguson Unit of the Texas Department of Corrections has approximately 1,900 acres of cropland. This is the largest area of cropland in the county. Crops grown in the county include corn, oats, grain sorghum, wheat, cotton, forage sorghum, watermelons, and other garden crops. The majority of the acreage used as cropland is planted to small grain for grazing by livestock.

Management is needed to control water erosion, to maintain tilth and fertility, and to drain excess water in some areas. The major management practices are conservation cropping sequences, crop residue management, conservation tillage, surface drainage systems, cover crops or mulching, and proper applications of fertilizer.

Soil erosion is the major problem on nearly all of the cropland where the slope exceeds 2 percent. Loss of the surface layer decreases productivity and is damaging to the environment. Fertility is progressively reduced in the root zone as erosion removes the topsoil and the less fertile subsoil is incorporated into the plow layer. Erosion also results in sediments entering streams. Controlling erosion minimizes the pollution of streams by sediments and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

Crop residue management helps to control erosion. A good cover of residue left on the surface minimizes compaction caused by heavy rainfall, slows runoff, increases the rate of water infiltration, and minimizes the formation of crusts and the evaporation of moisture from the soil. It shades the soil and thus reduces soil temperature. Also, it adds organic matter to the soil, improves tilth, and minimizes the compaction caused by farm machinery. Crop residue should not be excessively removed by livestock and tillage and should not be burned. A tillage system that leaves crop residue on the surface should be applied. Conservation tillage is effective in controlling erosion in sloping areas and can be adapted to most of the soils that are used as cropland in the county.

Most crops respond well to applications of commercial fertilizer. Most of the soils in the county require applications of fertilizer for optimum production. Soil fertility levels can be maintained by applying the proper amounts and kinds of fertilizer and by applying proper management practices.

Information about soil management practices can be obtained at the local office of the Soil Conservation Service.

Pasture and Hayland

Pasture and hayland are very important land uses in Madison County because raising livestock is the main agricultural enterprise. For many years the trend has been to convert land from other uses to pasture or hayland. Land used for pasture or hay mainly is planted to introduced grasses that respond well to good management. Areas planted to these grasses are used in combination with native range and supplemental pasture to provide year-round grazing.

Some of the pasture plants used in the county are common bermudagrass, improved bermudagrass, weeping lovegrass, bahiagrass, kleingrass, Johnsongrass, switchgrass, Dallisgrass, and fescue. Grazing programs commonly include bermudagrass overseeded with crimson clover, subterranean clover, arrowleaf clover, berseem clover, white clover, vetch, or singletary peas.

Programs that provide year-round forage can be developed by planning land use and the kinds of forage to be grown. Establishing a planned grazing system can increase production by providing for timely rest periods from grazing, for livestock management, and for a more efficient harvest.

Well managed pasture requires adequate fencing to allow for the rotation of grazing and the efficient harvest of forage. Proper use of forage ensures that plants retain vigor. In a well managed pasture, brush and weeds are controlled, fertilizer is applied at the proper time and in the proper amounts, and an adequate supply of water is available for livestock. In many areas used as pasture, applications of agricultural limestone are required to correct acidity problems and to help release fertilizer amendments for use by plants.

Good hay production requires the selection of the more productive kinds of grasses and the application of fertilizer at the correct time and in proper amounts. Forage must be cut at the proper time to provide high-quality hay, and the cutting height must be adequate to maintain plant vigor and to permit timely regrowth.

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 6. 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 6 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 Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for use as cropland *(27)*. 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. They are shown for each soil in table 6.

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

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

Rangeland

John C. Copeland, area plant scientist, Soil Conservation Service, helped prepare this section.

In areas of rangeland the native vegetation consists of a wide variety of grasses, grasslike plants, forbs, shrubs, and trees. Rangeland receives no regular or frequent cultural treatment. The composition and production of the plant community is determined by soil, climate, topography, overstory canopy, and grazing management. Management to conserve soil and water and to improve production is accomplished by balancing the number of livestock with forage production and rotating livestock to allow desirable plants to improve vigor, produce seed, and establish seedlings.

Rangeland is of minor importance in Madison County. It occurs in the Texas Claypan Area and Texas Blackland Prairie major land resource areas. Only general soil map units 1, 2, 3, 5, 8, and 10 have a significant acreage of rangeland.

When Madison County was first settled, the three types of rangeland were post oak-blackjack oak savannah; true blackland prairie of tall and mid grasses, legumes, and forbs; and bottom land along the Navasota and Trinity Rivers, having about a 40 percent canopy cover of hardwoods and underbrush. Originally, about 95 percent of the county was rangeland. Wildfire was a natural part of the rangeland ecosystem, repeatedly burning the area and controlling the spread and thickening of the oaks and underbrush and perpetuating the production of the tall grasses, legumes, and forbs.

After settlement a number of events affected the rangeland in the county. Most of the blackland area and some of the claypan area were plowed and planted to cotton and corn. Wildfires were suppressed, fences were constructed, and domestic livestock were confined at very heavy stocking rates. These factors resulted in overgrazing of the tall-growing productive grasses and led to a rapid increase in the canopy of oak and associated brush species on the claypan savannah and bottom-land sites. The shade from the canopy reduced the extent of sun-loving tall grasses and increased the extent of shade-tolerant forage plants, such as longleaf uniola, and cool-season plants, such as Texas wintergrass. Plant composition on all types of rangeland changed from tall, high-quality grasses to a mixture of mid and short grasses and low-quality forbs.

Remnants of the original plant species still grow in protected areas on most rangeland. Some native meadows and areas of rangeland are managed to maintain the native species.

Range Sites and Condition Classes

A *range site* is a distinctive kind of rangeland that produces a characteristic vegetation that differs from the climax vegetation on other range sites in kind, amount, and proportion of range plants. Soils that produce about the same kinds and amounts of forage make up a range site. Soil properties that affect moisture supply and plant nutrients have the most influence on productivity. Soil reaction, salt content, and a seasonal high water table also are important.

The climax vegetation on a range site is the stabilized plant community that reproduces itself and changes very little so long as the environment remains unchanged. Throughout the county the climax vegetation consists of the plants that grew in the area before settlement. The most productive combination of forage plants on a range site is generally the climax vegetation.

Range management requires a knowledge of the kinds of soil and of the climax vegetation. It also requires an evaluation of the present range condition.

Range condition is determined by comparing the present plant community with the climax vegetation on a particular range site. The more closely the existing community resembles the climax vegetation, the better the range condition.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. The classes show the present condition of the native vegetation on a range site in relation to the native vegetation in the climax community. A range is in excellent condition if 76 to 100 percent of the vegetation is of the same kind as that in the climax stand; in good condition if 51 to 75 percent; in fair condition if 26 to 50 percent; and in poor condition if 25 percent 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.

A primary objective of good range management is keeping the range in excellent or good condition and thus conserving water, improving yields, and protecting the soil. The main management concern is recognizing important changes that occur in the kind of cover on a range site. These changes take place gradually and can be misinterpreted or overlooked. Plant growth that occurs because of heavy rainfall can lead to the conclusion that the range is in good condition when the plant community actually has a large percentage of weeds and the long-term trend is toward lower production. On the other hand, some rangeland that has been closely grazed for short periods under careful supervision may have a degraded appearance that temporarily conceals its quality and ability to recover.

If range is subject to years of prolonged overuse, it loses the sources of seeds of desirable vegetation. Under these conditions, the vegetation must be reestablished before management can be effective. The condition of the range can be improved by controlling brush, range seeding, fencing, developing water sources, or applying other mechanical treatment 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.

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

Table 7 shows, for many of the soils, the range site and the potential annual production of vegetation in favorable, average, and unfavorable years. Only those soils that are suited to rangeland are listed.

Potential annual production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is in excellent condition. 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.

The 10 range sites in the county are Blackland, Clayey Bottomland, Clay Loam, Claypan Savannah, Claypan Prairie, Deep Sand, Eroded Blackland, Loamy Bottomland, Sandy, and Sandy Loam.

Blackland range site. The Burleson and Dimebox soils in map units BuA and DmA are in this site. The climax vegetation is a tall-grass prairie that has a few large live oak, elm, and hackberry trees along draws and in motts. The composition, by weight, is 85 percent grasses, 5 percent woody plants, and 10 percent forbs. This site has high natural fertility.

Little bluestem, indiangrass, and big bluestem produce 75 percent of the forage in areas where the site is in climax condition. Many other grasses make up another 10 percent. The most important of these are switchgrass, sideoats grama, Texas winter-grass, Texas cupgrass, tall dropseed, silver bluestem, longspike tridens, Florida paspalum, and Virginia wildrye. Woody species, such as live oak, elm, hackberry, bumelia, and coralberry, make up 5 percent. Approximately 34 species of forbs grow on this site and make up 10 percent.

Overgrazing eventually kills out the little bluestem, big bluestem, indiangrass, switchgrass, and eastern gamagrass. These grasses are replaced by silver bluestem, Texas winter-grass, sideoats grama, tall dropseed, and other mid grasses. If overgrazing continues, the site is dominated by buffalograss and annual forbs and invaded by mesquite, huisache, Osage-orange, winged elm, honey locust, Texas grama, and tumblegrass.

Clayey Bottomland range site. The Gladewater and Kaufman soils in map units Gg, Gh, Gn, Ka, and Kf are in this range site. The climax plant community is a tall-grass savannah that has a canopy of 30 percent. The canopy generally is heavier adjacent to the stream. Cool-season grasses and sedges grow under the canopy and warm-season grasses and forbs dominate the open areas. The composition, by weight, is 70 percent grasses, 25 percent woody plants, and 5 percent forbs.

Sedges, Virginia wildrye, Canada wildrye, and rustyseed paspalum make up 35 percent of the composition. Beaked panicum, switchgrass, indiangrass, little bluestem, big bluestem, eastern gamagrass, vine-mesquite, and Florida paspalum make up 25 percent. Buffalograss, longleaf uniola, knotroot bristlegrass, and other grasses make up 10 percent. Oaks, elm, cottonwood, hackberry, black willow, pecan, hawthorn, and woody vines make up 25 percent. Tickclover, snoutbean, lespedezas, and gayfeather make up 5 percent.

This range site is preferred by livestock. Heavy grazing and fire suppression reduce the extent of warm-season grasses and forbs and enable the brush to form a dense canopy. Shade-tolerant grasses then dominate the herbaceous production, drastically reducing total usable forage.

Clay Loam range site. The Benchley and Flatonia soils in map units BeB and FtB are in this range site. The climax plant community is a highly productive tall-grass prairie. The composition, by weight, is 90 percent grasses, 5 percent woody plants, and 5 percent forbs.

The climax plant community is about 70 percent little bluestem, indiangrass, big bluestem, and switchgrass; 15 percent sideoats grama, Florida paspalum, Canada wildrye, silver bluestem, tall dropseed, and Texas winter-grass; 5 percent other short grasses, such as buffalograss; 5 percent hackberry, elm, pecan, and oak; and 5 percent forbs, such as Maximilian sunflower, Engelmann daisy, and bundleflowers.

Overgrazing decreases the extent of big bluestem, little bluestem, indiangrass, switchgrass, Florida paspalum, and palatable forbs and results in an increase in the extent of sideoats grama, silver bluestem, Texas winter-grass, tall dropseeds, low panicums, and less palatable forbs. If overgrazing continues, the site is dominated by buffalograss, Texas winter-grass, Texas grama, hairy grama, threeawn, windmillgrass, tumblegrass, western ragweed, prairie coneflower, and woody plants, such as mesquite.

Claypan Savannah range site. The Derly, Gredge, Kurten, and Lufkin soils in map units DeA, GrC, GrD, KuC, LfA, and RbA are in this range site. The climax plant community is a post oak and blackjack oak savannah that has trees shading 20 to 25 percent of the ground. The composition, by weight, is about 75 percent grasses, 20 percent woody plants, and 5 percent forbs.

About 60 percent of the climax vegetation is made up of little bluestem, indiangrass, and brownseed paspalum. Other grasses, such as switchgrass, Florida paspalum, purpletop, low panicums, low paspalums, silver bluestem, tall dropseeds, and Texas winter-grass, make up about 15 percent. Woody plants make up 20 percent. They include post oak, blackjack oak, elm, yaupon, hawthorn, and American beautyberry. Forbs, such as dayflower, bundleflower, sensitive briar, tickclover, wildbean, and lespedezas, make up 5 percent.

Overgrazing and fire suppression decrease the extent of little bluestem, indiangrass, and switchgrass and result in an increase in the extent of brownseed paspalum, silver bluestem, arrowfeather threeawn, tall dropseeds, purpletop, and low panicums. The extent of woody plants, such as post oak, elm, yaupon, and hackberry, also increases, forming a dense canopy that suppresses grass and forb production.

Claypan Prairie range site. The Boonville, Bremond, Crockett, Mabank, Wilson, Zack, and Zulch soils in map units BoB, BrA, CrB, MaA, WcA, ZaB, ZaC2, ZaD, ZgC3, and ZuB are in this range site. The climax plant community is a tall-grass prairie or a very open savannah that has a few scattered live oak, elm, and hackberry trees along watercourses or in motts.

The climax plant community is 65 percent little bluestem and indiangrass; 15 percent switchgrass, big bluestem, Virginia wildrye, Canada wildrye, Florida paspalum, sideoats grama, meadow dropseed, Texas winter-grass, and vine-mesquite; 5 percent purpletop, brownseed paspalum, longspike tridens, buffalograss, low panicums, fall witchgrass, and sedges; 5 percent live oak, elm, hackberry, bumelia, coralberry, and post oak; and 10 percent forbs, such as Maximilian sunflower, Engelmann daisy, halfshrub sundrop, western indigo, and prairie clover.

Overgrazing decreases the extent of big bluestem, little bluestem, indiangrass, and switchgrass and results in an increase in the extent of meadow dropseed, silver bluestem, sideoats grama, and Texas winter-grass. If overgrazing continues, mesquite and pricklypear invade the site and buffalograss, Texas winter-grass, Texas grama, windmillgrass, and weedy forbs dominate the site.

Deep Sand range site. The Eufaula, Navasan, and Padina soils in map units EuB, EuE, NuB, and PaC are in this range site. The climax vegetation is a bluejack oak, blackjack oak, and post oak savannah that has a canopy of 20 to 25 percent. The composition, by weight, is 80 percent grasses, 5 percent forbs, and 15 percent woody plants.

About 65 percent of the composition is little bluestem, indiangrass, switchgrass, sand lovegrass, and purpletop. Other grasses, such as low panicums, low paspalums, purple lovegrass, sand dropseed, and splitbeard bluestem, make up 15 percent. Woody plants, such as bluejack oak, blackjack oak, and post oak, make up 10 percent of the composition. Shrubs, such as yaupon, hawthorn, and American beautyberry, make up 5 percent. Forbs, such as lespedezas, tickclover, wildbean, and partridge pea, make up 5 percent.

Overgrazing decreases the extent of little bluestem, sand lovegrass, indiangrass, and purpletop and results in an increase in the extent of low panicums, low paspalums, purple lovegrass, and woollysheath threeawn. Oak and yaupon increase in extent to form a dense canopy. If overgrazing continues, red lovegrass, tumble lovegrass, crabgrass, red sprangletop, sandbur, bracken-fern, pricklypear, and queen's delight dominate the site and production of forage species is reduced to nothing.

Eroded Blackland range site. The Ellis soil in map unit EcE is in this range site. The climax plant community has been destroyed by cultivation, and the natural productivity has been lowered by erosion. The potential plant community is a tall-grass prairie similar to that of the Blackland range site. A long time is needed for secondary plant succession to reestablish the plant community. The potential plant community, by weight, is 85 percent grasses, 5 percent woody plants, and 10 percent forbs.

The potential plant community is 70 percent little bluestem, indiangrass, and big bluestem; 15 percent Virginia wildrye, Canada wildrye, switchgrass, Florida paspalum, sideoats grama, tall dropseed, silver bluestem, Texas winter-grass, and vine-mesquite; 5 percent live oak, hackberry, elm, bumelia, and coralberry; and 10 percent forbs, such as Maximilian sunflower, Engelmann daisy, and bundleflowers.

Most of this site is in an intermediate stage of secondary plant succession. Silver bluestem, tall dropseeds, Texas winter-grass, sideoats grama, and buffalograss normally dominate this stage and respond as increasers. If heavy grazing is continuous, buffalograss or Texas winter-grass, or both, dominate the site.

Loamy Bottomland range site. The Gowker, Hatliff, and Nahatche soils in map units Go, Gn, Ha, and Na are in this range site. The climax plant community is a tall-grass savannah that has trees shading 30 percent of the ground. Cool-season grasses and sedges dominate the shaded areas. Warm-season plants dominate the open areas. The composition, by weight, is 70 percent grasses, 25 percent woody plants, and 5 percent forbs.

Virginia wildrye, sedges, and rustyseed paspalum grow in the shaded and wet areas and make up 25 percent of the production. Switchgrass, beaked panicum, indiangrass, big bluestem, little bluestem, eastern gamagrass, vine-mesquite, and purpletop grow in the open areas and make up 35 percent. Redtop panicum, gaping panicum, low panicums, uniolas, buffalograss, knotroot bristlegrass, Texas winter-grass, and other grasses make up 10 percent. Oaks, pecan, hackberry, elm, cottonwood, black willow, sycamore, hickory, ash, and many understory shrubs make up 25 percent. Tickclover, lespedezas, snoutbean, partridge pea, and gayfeather make up 5 percent.

This range site is preferred by livestock. Overgrazing and fire suppression reduce the extent of warm-season grasses and forbs and result in an increase in the extent of canopy. Shade-tolerant grasses and forbs then dominate the herbaceous production, drastically reducing forage production.

Sandy range site. The Dutek, Robco, and Silstid soils in map units DuC, RcB, and SdB are in this range site. The climax vegetation is an open savannah that has post oak and blackjack oak shading 25 to 30 percent of the ground. The open areas are dominated by tall grasses. The composition, by weight, is 75 percent grasses, 5 percent forbs, and 20 percent woody plants.

About 50 percent of the composition is little bluestem, and 10 percent is indiangrass. Switchgrass, beaked panicum, sand lovegrass, purpletop, and brownseed paspalum make up an additional 10 percent. Other grasses, such as fringeleaf paspalum, purple lovegrass, tall dropseeds, splitbeard bluestem, and low panicums, make up about 5 percent. Forbs, such as lespedezas, tickclover, sensitive briar, snoutbean, tephrosia, partridge pea, and western ragweed, make up 5 percent. Woody species make up about 20 percent. They include post oak and blackjack oak and an understory of hawthorn, American beautyberry, greenbrier, yaupon, and berry vines.

Overgrazing and fire suppression decrease the extent of little bluestem, indiangrass, and switchgrass and result in an increase in the extent of brownseed paspalum, tall dropseed, fall witchgrass, and other species. If overgrazing continues, red lovegrass, yankeeweed, bullnettle, snakecotton, and croton invade the site. Other invading plants are broomsedge bluestem, smutgrass, sandbur, pricklypear, queen's delight, beebalm, pricklepoppy, baccharis, and wax-myrtle. Woody species increase in extent and invade the site, forming dense thickets.

Sandy Loam range site. The Chazos, Gasil, Jedd, Rader, Rosanky, Silawa, Spiller, and Tabor soils in map units ChB, DeA, GaB, JeD, RaB, RbA, RoC, SaB, SpB, and TaB are in this range site. The climax vegetation is a post oak and blackjack oak savannah that has a canopy of 20 to 25 percent. Tall grasses are in the open areas. The composition, by weight, is 80 percent grasses, 5 percent forbs, and 15 percent woody plants.

Little bluestem makes up 50 percent of the composition, and indiangrass makes up about 10 percent. Eastern gamagrass, switchgrass, big bluestem, beaked panicum, and longleaf uniola make up an additional 10 percent. Numerous other grasses make up another 10 percent. Numerous forbs, such as Engelmann daisy, gayfeather, sensitive briar, and native legumes, make up 5 percent. Post oak and blackjack oak make up about 10 percent. Numerous other woody plants, such as elm, yaupon, greenbrier, American beautyberry, and berry vines, make up 5 percent.

Overgrazing and fire suppression result in an increase in the extent of the woody canopy and a decrease in the extent of tall grasses, such as little bluestem, indiangrass, big bluestem, and eastern gamagrass. These grasses are replaced by an increase in the extent of such plants as brownseed paspalum. If overgrazing continues, the sites deteriorate to thickets of oak, brush, annual grasses, forbs, and carpetgrass.

Woodland Management and Productivity

John Ross, forester, Soil Conservation Service, helped prepare this section.

Soils vary in their ability to produce trees. Depth of the root zone, fertility, texture, and the available water capacity influence tree growth. Soil permeability, drainage, and position of the soil on the landscape also are important.

This soil survey can be used by woodland managers planning ways to increase the productivity of forest land. Some soils respond better to applications of fertilizer than others, and some are more susceptible to erosion after roads are built and timber is harvested. Some soils require special reforestation efforts. In the section "Detailed Soil Map Units," the description of each map unit in the survey area suitable for timber includes information about productivity and major limitations in harvesting timber. The common forest understory plants also are listed. Table 8 summarizes this forestry information and rates the soils for a number of factors to be considered in management. *Slight, moderate*, and *severe* are used to indicate the degree of the major soil limitations to be considered in forest management.

Table 8 lists the *ordination symbol* for each soil. The first part of the ordination symbol, a number, indicates the potential productivity of a soil for the indicator species based on the site index. The larger the number, the greater the potential productivity.

Loblolly pine is the indicator species for soils that can produce pine in Madison County. Soils having a very high potential productivity for pine (site indices of 92 or above) have a number that is 10 or more as the first part of the ordination symbol. Soils that have a low potential productivity for pine (site indices of 70 or below) have a number that is 6 or less for the first part of the ordination symbol.

Water oak is the indicator species for soils that generally produce only hardwoods. Soils that have a very high potential productivity for hardwoods (site indices of 98 or above) have a number that is 7 or more as the first part of the ordination symbol. Soils with a low potential productivity for hardwoods (site indices below 63) have a number that is 3 or less as the first part of the ordination symbol.

The second part of the ordination symbol, a letter, indicates the major kind of soil limitation affecting use and management. The letter *R* indicates a soil that has a significant limitation because of steepness of slope. The letter *X* indicates that a soil has restrictions because of stones or rocks on the surface. The letter *W* indicates a soil in which excessive water, either seasonal or year-round, causes a significant limitation.

The letter *T* indicates a soil that has, within the root zone, excessive alkalinity or acidity, sodium salts, or other toxic substances that limit the development of desirable trees. The letter *D* indicates a soil that has a limitation because of a restricted rooting depth, such as a shallow soil that is underlain by hard bedrock, a hardpan, or other layers that restrict roots. The letter *C* indicates a soil that has a limitation because of the kind or amount of clay in the upper part of the profile. The letter *S* indicates a dry, sandy soil. The letter *F* indicates a soil that has a large amount of coarse fragments. The letter *A* indicates a soil having no significant limitations that affect forest use and management. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

Ratings of the *erosion hazard* indicate the probability that damage may occur if site preparation or harvesting activities expose the soil. The risk is *slight* if no particular preventive measures are needed under ordinary conditions; *moderate* if erosion-control measures are needed for particular silvicultural activities; and *severe* if special precautions are needed to control erosion for most silvicultural activities. Ratings of moderate or severe indicate the need for construction of higher standard roads, additional maintenance of roads, additional care in planning harvesting and reforestation activities, or the use of special equipment.

Ratings of *equipment limitation* indicate limits on the use of forest management equipment, year-round or seasonal, because of such soil characteristics as slope, wetness, or surface texture. As slope gradient and length increase, it becomes more difficult to use wheeled equipment. On the steeper slopes, tracked equipment may be needed. The rating is *slight* if equipment use is restricted by wetness for less than 2 months and if special equipment is not needed. The rating is *moderate* if slopes are so steep that wheeled equipment cannot be operated safely across the slope, if wetness restricts equipment use from 2 to 4 months per year, or if sandy or clayey extremes in surface texture restrict the use of ground-based equipment. The rating is *severe* if slopes are so steep that wheeled equipment cannot be operated safely across the slope, if wetness restricts equipment use for more than 4 months per year, or if the surface layer is loose sand that severely restricts the use of ground-based equipment. Ratings of moderate or severe indicate a need to choose the best suited equipment and to carefully plan the timing of harvesting and other management activities.

Ratings of *seedling mortality* refer to the probability of the death of naturally occurring or properly planted seedlings of good stock in periods of normal rainfall, as influenced by kinds of soil or topographic features. Seedling mortality is caused primarily by too much water or too little water. The factors used in rating a soil for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, and rooting depth. The mortality rate generally is highest on soils that have a sandy or clayey surface layer. The risk is *slight* if, after site preparation, expected mortality is less than 25 percent; *moderate* if expected mortality is between 25 and 50 percent; and *severe* if expected mortality exceeds 50 percent. Ratings of moderate or severe indicate that it may be necessary to increase the planting rate per acre, to use containerized or larger than usual planting stock, or to make special site preparations, such as bedding, furrowing, installing a surface drainage system, and providing artificial shade for seedlings. Reinforcement planting is often needed if the risk is moderate or severe.

Ratings of *plant competition* indicate the likelihood of the growth or invasion of undesirable plants. In Madison County plant competition is more severe on the more droughty soils and on poorly drained soils. The risk is *slight* if competition from undesirable plants hinders adequate natural or artificial reforestation but does not necessitate intensive site preparation and maintenance. The risk is *moderate* if competition from undesirable plants hinders natural or artificial reforestation to the extent that some type of site preparation and maintenance are needed. The risk is *severe* if competition from undesirable plants prevents adequate natural or artificial reforestation unless the site is intensively prepared and maintained. A moderate or severe rating indicates the need for site preparation to ensure the development of an adequately stocked stand. Managers must plan site preparation measures to ensure reforestation without delays.

The *potential productivity* of *common trees* on a soil is expressed as a *site index* and a *volume* number. Common trees that have commercial value are listed in the order of their observed general occurrence. Generally, only two or three tree species dominate. The first tree listed for each soil is the indicator species for that soil. An indicator species is a tree that is common in the area and that is generally the most productive on a given soil.

The *site index* is determined by taking height measurements and determining the age of dominant and codominant trees within stands of a given species. This index is the average height, in feet, that the trees attain in a period of 50 years. This index applies to fully stocked, even-aged, unmanaged stands. The estimates of the productivity of the soils in this survey are based on loblolly pine for all sites suited to pine and on water oak for bottom-land sites suitable only for hardwoods. The methods for determining site indices are based on published data *(11, 12, 13, 23, 29)*.

The *volume* is the yield likely to be produced by the most important species in fully stocked natural stands, expressed in board feet (Doyle rule) per acre per year over a 50-year period. Because this volume is based on trees in natural stands that have had no intermediate cutting management, the listed yields can be significantly increased by applying sound forestry practices, such as scheduled thinnings.

Trees to plant are those that are used for reforestation or, under suitable conditions, natural regeneration. They are suited to the soils and can produce a commercial wood crop. The desired product, topographic position (such as a low, wet area), and personal preference are three factors among many that can influence the choice of trees for use in reforestation.

Woodland Understory Vegetation

John C. Copeland, area plant specialist, Soil Conservation Service, helped prepare this section.

The woodland in Madison County originally had an open canopy of post oak, blackjack oak, red oak, water oak, green ash, and hickory and scattered stands of shortleaf pine and loblolly pine. The understory consisted of such plants as little bluestem, indiangrass, big bluestem, switchgrass, purpletop, longleaf uniola, American beautyberry, yaupon, dogwood, bracken-fern, and tickclover. Natural wildfires were a part of the woodland ecosystem and tended to keep the canopy and midcanopy more open than they are today. The canopy has closed as a result of fire suppression; concentrated, year-round overgrazing; and regeneration of pine. This closure has resulted in a decrease in the extent of tall, sun-loving grasses and an increase in the extent of shade-tolerant plants, such as longleaf uniola. Forage production has been reduced significantly.

Two practices are essential when managing woodland in the county for the production of timber and understory forage. First, the density of the overstory and midstory canopy should be reduced by harvesting trees or prescribed burning. This reduction in the density of canopy allows sunlight to penetrate to the woodland floor and perpetuates the growth of natural tall grasses under the overstory. Second, good grazing management is essential to allow these grasses to reestablish and reach their optimum potential. These two practices must be applied simultaneously to ensure maximum forage production.

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

The quantity and quality of understory vegetation vary with the kind of soil, the age and kind of trees in the canopy, the density of the canopy, and the depth and condition of the litter. The density of the canopy determines the amount of light that understory plants receive.

Table 9 shows, for each soil suitable for woodland, the potential for producing understory vegetation. The total production of understory vegetation includes the herbaceous plants and the leaves, twigs, and fruit of woody plants up to a height of 4½ feet. It is expressed in pounds per acre of air-dry vegetation in favorable, normal, and unfavorable years. In a favorable year, soil moisture is above average during the optimum part of the growing season; in a normal year, soil moisture is average; and in an unfavorable year, it is below average.

Table 9 also lists the common names of the *characteristic vegetation* on each soil and the *composition*, by percentage of air-dry weight, of each kind of plant. The table shows the kind and percentage of understory plants expected under a canopy density that is most nearly typical of woodland in which the production of wood crops is highest.

Recreation

Michael E. Zeman, area biologist, Soil Conservation Service, helped prepare this section.

Madison County is about 100 miles north-northwest of Houston. It is bisected by Interstate 45. The winters are mild, and average annual rainfall is 41.8 inches. The climate, the proximity of the county to a large number of people, and the soils in the county result in a high potential for development of recreational facilities. The largest recreational area in the county is Lake Madison Park, which is a 246-acre facility in Madisonville. The park contains tennis courts, picnic areas, baseball diamonds, playgrounds, and a 75-acre public fishing lake. Madisonville also has a nine-hole golf course.

Hunting and fishing are popular recreational activities in the county. Boat ramps have been installed along the Trinity River to improve public accessibility for fishing and boating. Rodeos are popular. Many thoroughbred horse ranches are in the county, and several horseracing tracks are planned.

The soils should be considered when evaluating a site for recreational use. Properties that limit the soil as a site for recreational facilities need to be evaluated. Methods to overcome these limitations, if any, can be incorporated in the planning process to achieve maximum success.

In table 10, the soils of the survey area are rated according to the 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 10, 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 by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

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 gentle 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, stones, or boulders that increase the cost of shaping sites or of building 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

Michael E. Zeman, area biologist, Soil Conservation Service, helped prepare this section.

Wildlife is a valuable resource in Madison County. Most of the larger farms and ranches lease hunting rights. The most popular game species is white-tailed deer. In 1984, trends in the deer population indicated the probability of an increase to a density of approximately one deer per 15 acres on the 166,000 acres of good deer range. The heaviest concentrations of deer are on the bottom land along the Navasota River, which borders the western edge of the county, and on the bottom land along Bedias Creek, which is in the southern part of the county. The deer population density in these areas may be as high as one deer per 5 acres. The areas of bottom land have the most productive vegetation in the county. The dominant vegetation is water oak, elm, and hackberry. Fox, gray squirrel, and waterfowl are abundant in these areas. A relatively high number of feral hogs are along the Navasota River and Caney Creek.

The three major vegetative types that make up the wildlife habitat in the county are the plant community of native or introduced grasses, the post oak savannah, and the pine-hardwood forest.

The plant community of native or introduced grasses is in areas that have been cleared of timber and are used mostly for pasture or rangeland. These areas are scattered throughout the county but are concentrated in the northeast corner. This habitat supports fair-sized populations of mourning dove and cottontail rabbit. The population of fox squirrel has increased considerably in the past several years as pecan orchards have matured.

The post oak savannah makes up most of the county. This habitat supports a good number of deer and a fair number of fox squirrels, mourning doves, feral hogs, and cottontail rabbits. If properly managed, it could support a fair number of bobwhite quails. If the habitat is not managed, however, quail populations tend to be low. Local landowners believe that the high number of fire ants is the reason the quail population is so low, but current research is inconclusive. Recently, Leon County to the north and Walker County to the south have been restocked with eastern wild turkey. If these restocking efforts are successful, eastern wild turkey also will be restocked in Madison County.

The pine-hardwood forest is in an extremely small area in the southeast corner of the county. Deer and fox squirrel can be found in fair numbers. Quail are in the open areas where native grasses occur.

Most wildlife habitat is created or managed by establishing, maintaining, or manipulating suitable vegetation in order to support desirable game species. Management for game species also generally benefits many nongame species. The nongame species in the county include fox, bobcat, coyote, raccoon, opossum, armadillo, several species of reptiles, amphibians, many kinds of songbirds, wading birds, hawks, and owls.

The county has many soils suitable for impounding water and consequently is dotted with ponds and small lakes, many of which are stocked with and managed for largemouth bass, bluegill, redear sunfish, and channel catfish. Other species found in streams and in many unmanaged ponds include green sunfish, bullhead catfish, white crappie, gar, grass pickerel, longear sunfish, carp, and various minnows. Both the Trinity and Navasota Rivers, which border the county, are renowned for their populations of flathead catfish and blue catfish and are extensively fished with trotlines. Lake Madison, which is a 75-acre lake, is stocked with bass, bluegill, channel catfish, and white crappie.

The water quality in most of the county is fair. It is determined by the soils on which the ponds are constructed. Most of the surface water is slightly acidic, resulting in low or medium fish production.

The county has very little aquaculture, and the potential for expansion is low. Competition is probably the factor that most limits the development of a facility because the counties surrounding Madison County have several major and a few minor freshwater operations that specialize in raising several species of fingerlings for stocking recreational ponds. Also, production costs are higher in Madison County because the major ground-water resource is the Carrizo-Wilcox aquifer, which is about 350 to 450 feet deep and contains water that is relatively low in hardness.

The physical conditions in Madison County are good for aquaculture. The county has a mean annual temperature of 67 degrees F, and as much as 95 percent of the soils are suitable for pond reservoir areas. The more extensively occurring suitable soils include Lufkin, Rader, Kurten, Zack, Zulch, and Wilson soils.

The species suitable for commercial culture include channel catfish, blue catfish, largemouth bass, bass forage, tilapia, crawfish, bait minnows, freshwater shrimp, and hybrid stripers.

The bottom land in the county consists primarily of hardwood forests and meadows along the Trinity and Navasota Rivers. Soils common on these alluvial flood plains include Gladewater, Kaufman, Nahatche, Hatliff, and Gowker soils. The bottom land includes some of the most productive wildlife areas in the county. It provides winter habitat for various waterfowl, including wood ducks, mallards, teal, widgeon, gadwall, pintail, and shoveler. It provides very important habitat for rearing wood ducks. It also provides habitat for many other wading birds and songbirds; furbearers, such as raccoon; reptiles; and amphibians.

The hardwood overstory in areas of the bottom land typically includes water oak, willow oak, pecan, water elm, and sugarberry. Understory species include yaupon, possumhaw, hawthorns, blackberries, waxmyrtle, and common persimmon. Ground cover species include wildrye, rushes, sedges, arrowheads, smartweeds, paspalums, and panicums.

Open bodies of water, such as farm ponds and small lakes, primarily provide resting and feeding areas for migrating waterfowl.

Some endangered or threatened species inhabit or may inhabit the county. The redcockaded woodpecker could be in the pine-hardwood area in the southeastern part of the county. Active colonies of the woodpecker are known to occur east of the Trinity River. The arctic peregrine falcon and the southern bald eagle both migrate through the area each fall and spring and would most likely be seen along the Trinity and Navasota Rivers. The eagle is known to nest along these rivers from late winter through early summer. The American alligator is common in Bedias Creek and in several private ponds and occurs in the Trinity River.

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

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

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

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

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, kleingrass, bahiagrass, 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, sunflowers, and partridge pea.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, hackberry, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and blueberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and rainbow wild plum.

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

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are yaupon, sparkleberry, American beautyberry, and wax-myrtle.

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

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

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

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

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

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

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include bobwhite quail, deer, bobcat, meadowlark, and lark bunting.

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 kind 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 12 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. Depth to a high water table, depth to bedrock or to a cemented pan, large stones, 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, depth to 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, 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, depth to 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 13 shows the degree and the 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 13 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 that 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, depth to 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 13 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, depth to 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 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, depth to a 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 type 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 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 14 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 14, 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 releases a variety of plant nutrients as it decomposes.

Water Management

Table 15 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; embankments, dikes, and levees; and aquifer-fed excavated ponds. 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 the restrictive features that affect each soil for drainage, irrigation, 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 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.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and the salinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; and susceptibility to flooding. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

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 or 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 21.

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 16 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 "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 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(3)* and the system adopted by the American Association of State Highway and Transportation Officials *(2)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

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 21.

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.

Physical and Chemical Properties

Table 17 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, or component, 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 the 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 ⅓-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 movement of water through the soil when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

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 in each major soil layer is stated in inches of water per inch of soil. 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.

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; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

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. Losses are expressed in tons per acre per year. These 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 0.69. 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 over a sustained period without affecting crop productivity. The rate is expressed 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 to wind erosion. Soils are grouped according to the following distinctions:

1. Coarse sands, sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to reestablish after cultivation.

2. Loamy coarse sands, loamy sands, loamy fine sands, loamy very fine sands, and sapric soil material. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Coarse sandy loams, sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, noncalcareous clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control wind erosion are used.

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 17, 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 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils are assigned to one of four groups. They are grouped according to the infiltration of water when the soils 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 high shrink-swell potential, soils that have a permanent 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 covering of the soil surface by flowing water, is caused by overflowing streams, by runoff from adjacent slopes, or by inflow from high tides. Shallow water standing or flowing for short periods after rainfall is not considered flooding.

Standing water in swamps and marshes or in a closed depression is considered ponding.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely to occur.

Frequency, duration, and probable dates of occurrence are estimated. Frequency generally is expressed as *none, rare, occasional,* or *frequent. None* means that flooding is not probable. *Rare* means that flooding is unlikely but possible under unusual weather conditions (the chance of flooding is nearly 0 to 5 percent in any year). *Occasional* means that flooding occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year). *Frequent* means that flooding occurs often under normal weather conditions (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* (less than 2 days), *brief* (2 to 7 days), *long* (7 days to 1 month), and *very long* (more than 1 month). The time of year that floods are most likely to occur is expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

The information on flooding 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 the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, *perched* or *apparent*; and the months of the year that the water table commonly is highest. A water table that is seasonally high for less than 1 month is not indicated in table 18.

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.

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. "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 specified as 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. In some areas in Madison County, steel pipe risers in ponds and steel culverts in road drainage ditches have failed because of corrosion. Special site examination and design may be needed if the combination of factors creates a severely corrosive environment. 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 the 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 19 and the results of chemical analysis in table 20. The data are for soils sampled at carefully selected sites. Most pedons are typical of the series and are described in the section "Soil Series and Their Morphology." Soil samples were analyzed by the Soil Characterization Laboratory, Texas A&M University, 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 oven-dry basis. The methods used in obtaining the data are indicated in the list that follows. The codes in parentheses refer to published methods *(30)*.

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 oven-dry weight of less than 2 mm material; ⅓-bar (4B1).
Bulk density—of less than 2 mm material, saran-coated clods field moist (4A1a), ⅓-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—ammonium acetate, pH 7.0, steam distillation (5A8b).
Base saturation—sum of cations, TEA, pH 8.2 (5C3).
Reaction (pH)—1:1 water dilution (8C1f).
Electrical conductivity—saturation extract (8A3a).
Exchangeable sodium percentage (5D2).

Engineering Index Test Data

Table 21 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil Series and Their Morphology." The soil samples were tested by the State Department of Highways and Public Transportation, Austin, 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); Plasticity index—T 90 (AASHTO), D 4318 (ASTM); Specific gravity—T 100 (AASHTO), D 854 (ASTM); and Shrinkage—T 92 (AASHTO), D 427 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(28)*. 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 on laboratory measurements. Table 22 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 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; 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 *ustalfs*, the suborder of the Alfisols that occurs in dry climates).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic 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 known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Ultic* identifies one subgroup of the great group. An example is Ultic 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 class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, siliceous, thermic Ultic Haplustalfs.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. There can be some variation in the texture of the surface layer or of the underlying material within a series.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

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" *(26)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(28)*. Unless otherwise stated, 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."

Arriola Series

The Arriola series consists of moderately deep, moderately sloping, moderately well drained, very slowly permeable soils on uplands. These soils formed in clayey material and in material weathered from siltstone and sandstone. Slopes range from 5 to 8 percent.

The soils of the Arriola series are fine, mixed, thermic Albaquultic Hapludalfs.

Typical pedon of Arriola fine sandy loam, 5 to 8 percent slopes; from the intersection of Texas Highway 21 and Farm Road 1428 about 3 miles east of Madisonville, 6.0 miles southeast on Farm Road 1428, about 0.2 mile southeast on county road, 2.2 miles south and east on woodland trail, and 20 feet north in an area of woodland:

A—0 to 4 inches; brown (10YR 5/3) fine sandy loam; weak fine granular structure; slightly hard, friable; many fine, medium, and coarse roots; many fine pores; slightly acid; clear smooth boundary.

E—4 to 8 inches; pale brown (10YR 6/3) fine sandy loam; weak fine granular structure; slightly hard, friable; many fine, medium, and coarse roots; many fine pores; strongly acid; abrupt wavy boundary.

Bt1—8 to 17 inches; dark red (2.5YR 3/6) clay; common medium prominent grayish brown (10YR 5/2) and few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; extremely hard, very firm; common medium and coarse roots; few fine pores; thin patchy clay films on faces of peds; very strongly acid; clear wavy boundary.

Bt2—17 to 27 inches; mottled red (2.5YR 4/6) and light brownish gray (10YR 6/2) clay; common medium prominent yellowish red (5YR 5/6) mottles; moderate coarse angular blocky structure; extremely hard, very firm; common medium and coarse roots; few fine pores; thin patchy clay films on faces of peds; very strongly acid; clear wavy boundary.

Bt3—27 to 36 inches; grayish brown (10YR 5/2) clay; common medium prominent dark red (2.5YR 3/6) and few fine prominent yellowish red (5YR 5/6) mottles; moderate coarse angular blocky structure; extremely hard, very firm; few fine and medium roots along faces of peds; thin patchy clay films on faces of peds; very strongly acid; abrupt wavy boundary.

Cr—36 to 50 inches; light gray (10YR 7/2), weakly cemented sandstone; grayish brown (10YR 5/2) clay films filling interstices in the upper 5 inches; very hard when dry and easily crushed when moist.

The thickness of the solum, or the depth to paralithic contact with sandstone or siltstone, ranges from 20 to 40 inches.

The A horizon is dark brown, brown, or yellowish brown. The E horizon is light yellowish brown, pale brown, or light brownish gray. The A horizon is very strongly acid to slightly acid. The E horizon is very strongly acid to medium acid.

The Bt1 horizon is dark red or red. It has no mottles or has few to many mottles in shades of brown. Reaction is very strongly acid to medium acid.

The Bt2 horizon is mottled in shades of red, light brownish gray, dark red, reddish brown, reddish gray, strong brown, or dark gray. Reaction is very strongly acid or strongly acid.

The Bt3 horizon is grayish brown, dark grayish brown, brown, or reddish gray. Reaction is very strongly acid or strongly acid.

The Cr layer is gray sandstone or siltstone or interbedded sandstone and siltstone.

Benchley Series

The Benchley series consists of very deep, gently sloping, moderately well drained, slowly permeable soils on uplands. These soils formed in clayey marine sediments. Slopes range from 1 to 5 percent.

The soils of the Benchley series are fine, montmorillonitic, thermic Udertic Argiustolls.

Typical pedon of Benchley clay loam, 1 to 5 percent slopes; from the intersection of Farm Road 39 and Old San Antonio Road in Normangee, 5.2 miles southwest on Old San Antonio Road and 350 feet south of Old San Antonio Road, in an area of native pasture:

A—0 to 12 inches; very dark gray (10YR 3/1) clay loam; moderate medium subangular blocky structure parting to moderate medium granular; hard, friable; many fine roots; many fine pores; about 2 percent, by volume, rounded ironstone fragments less than 5 millimeters in diameter; medium acid; clear wavy boundary.

Bt1—12 to 19 inches; very dark grayish brown (10YR 3/2) clay; common medium distinct very dark gray (10YR 3/1) mottles; moderate medium subangular blocky structure; hard, firm; common fine roots; few ironstone pebbles; common clay films on faces of peds; medium acid; gradual wavy boundary.

Bt2—19 to 29 inches; dark gray (10YR 4/1) clay; many medium and coarse prominent red (2.5YR 4/6) and common medium distinct brown (10YR 4/3) mottles; moderate medium angular blocky structure; very hard, very firm; common fine roots; common fine pores; few ironstone pebbles; common clay films on faces of peds; medium acid; gradual wavy boundary.

Bt3—29 to 55 inches; red (2.5YR 4/8) clay; many medium prominent dark gray (10YR 4/1) and yellowish brown (10YR 5/4) mottles; moderate medium angular blocky structure; very hard, very firm; few fine roots; common clay films on faces of peds; slightly acid; gradual wavy boundary.

BC—55 to 72 inches; yellowish brown (10YR 5/6) clay; common medium distinct dark gray (10YR 4/1) and few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few small slickensides; neutral; gradual wavy boundary.

C—72 to 80 inches; yellowish brown (10YR 5/4) clay; massive; slightly hard, friable; few concretions of calcium carbonate; mildly alkaline.

The thickness of the solum ranges from 60 to more than 80 inches. The content of ironstone pebbles ranges from 0 to 5 percent, by volume, in the upper part of the solum in some pedons. During extended dry periods, cracks ½ inch or more wide extend from the surface to a depth of at least 20 inches and are 20 inches long on the surface. The average content of clay in the upper 20 inches of the argillic horizon is 40 to 55 percent.

The A horizon is very dark gray, very dark grayish brown, or dark brown. Reaction is medium acid to neutral.

The Bt1 horizon is very dark gray, very dark grayish brown, or dark grayish brown. It is clay loam or clay. It has few or no small slickensides. Reaction is medium acid to neutral.

The lower part of the Bt horizon is red, reddish brown, or yellowish red. It has common or many mottles in shades of brown, gray, or red. It has few or common small slickensides. Reaction is strongly acid to neutral.

The BC horizon is yellowish brown, brownish yellow, or dark grayish brown. It has few or common mottles in shades of yellow, red, or brown. The texture is sandy clay, clay, or sandy clay loam. This horizon has few or common concretions and masses of calcium carbonate and few or common crystals of calcium sulfate. Reaction is strongly acid to moderately alkaline.

Bienville Series

The Bienville series consists of very deep, very gently sloping, somewhat excessively drained, moderately rapidly permeable soils on stream terraces. These soils formed in sandy alluvium (fig. 11). Slopes range from 0 to 3 percent.

The soils of the Bienville series are sandy, siliceous, thermic Psammentic Paleudalfs.

The Bienville soils in Madison County are taxadjuncts to the series because in most areas the subsoil does not increase in content of clay sufficiently to qualify as an argillic horizon. This difference, however, does not affect the use and management of the soils.

Typical pedon of Bienville loamy fine sand, 0 to 3 percent slopes; from the intersection of Farm Road 2548 and Texas Highway 21 at Midway, 4.4 miles northeast on Texas Highway 21, about 1.1 miles southeast on Farm Road 2548, and 150 feet west in a pastured area:

Ap—0 to 6 inches; yellowish brown (10YR 5/4) loamy fine sand; weak fine and medium granular structure; loose, very friable; many fine roots; slightly acid; gradual smooth boundary.

Bw—6 to 22 inches; dark brown (7.5YR 4/4) loamy fine sand; weak fine and medium subangular blocky structure; loose, very friable; common fine roots; slightly acid; clear wavy boundary.

Bw/E—22 to 42 inches; dark brown (7.5YR 4/4) loamy fine sand (Bw), which makes up about 65 percent of the matrix; many coarse distinct light yellowish brown (10YR 6/4) spots and streaks of (E) material, which makes up about 35 percent of the matrix; weak fine and medium subangular blocky structure; slightly hard, friable; few fine roots; medium acid; gradual smooth boundary.

E/Bw1—42 to 68 inches; brown (7.5YR 5/4) and light brown (7.5YR 6/4) loamy fine sand (E), which makes up about 55 percent of the matrix; many medium and coarse distinct spots and thin lamellae of dark brown (7.5YR 5/6) loamy fine sand (Bw); weak fine and medium subangular blocky structure; slightly hard, friable; few fine roots; medium acid; gradual smooth boundary.

E/Bw2—68 to 80 inches; light yellowish brown (10YR 6/4) loamy fine sand (E), which makes up about 65 percent of the matrix; brown (7.5YR 4/4) loamy fine sand (Bw), which makes up about 35 percent of the matrix; weak fine and medium subangular blocky structure; slightly hard, friable; few fine roots; medium acid.

The solum ranges from 60 to more than 80 inches in thickness.

The A horizon is yellowish brown, dark brown, dark yellowish brown, dark grayish brown, or brown. Reaction is strongly acid to slightly acid.

The E part of the E/B and B/E horizons is dark yellowish brown, brown, light yellowish brown, very pale brown, or light brown. The texture is loamy fine sand or fine sand. Reaction ranges from strongly acid to slightly acid.

The Bw horizon is brown, strong brown, or yellowish red. It is dominantly loamy fine sand or fine sand but is fine sandy loam in some lamellae. In some pedons the lamellae are below an argillic horizon. Reaction is strongly acid or medium acid.

Boonville Series

The Boonville series consists of very deep, very gently sloping, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in colluvium consisting of slightly weathered Yegua material (fig. 12). Slopes range from 1 to 3 percent.

The soils of the Boonville series are fine, montmorillonitic, thermic Mollic Albaqualfs.

Typical pedon of Boonville fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 21 and Farm Road 1428 about 3 miles east of Madisonville, 2.5 miles southeast on Farm Road 1428, about 0.7 mile north on county road to Little Rock Baptist Church, 0.25 mile southeast on county road, 180 feet east on county road, 110 feet south of road, in an area of native pasture:

A—0 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam; massive; very hard, friable; common fine roots; few fine siliceous pebbles; slightly acid; abrupt wavy boundary.

Btg1—15 to 24 inches; dark gray (10YR 4/1) clay; few fine prominent red (2.5YR 4/6) and few fine faint dark yellowish brown (10YR 4/6) mottles; strong medium angular and subangular blocky structure; very hard, very firm; common fine roots; common pressure faces; common clay films on faces of peds; few fine siliceous pebbles; medium acid; gradual wavy boundary.

Btg2—24 to 40 inches; dark grayish brown (10YR 4/2) clay; common fine faint very dark gray (10YR 3/1) and dark gray (10YR 4/1) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; common pressure faces; common clay films on faces of peds; few fine siliceous pebbles; mildly alkaline; gradual wavy boundary.

BC—40 to 72 inches; very pale brown (10YR 7/3) clay; few fine distinct reddish yellow (7.5YR 7/8) mottles; weak medium subangular blocky structure; very hard, very firm; few crystals of calcium sulfate; moderately alkaline; gradual wavy boundary.

C—72 to 80 inches; light gray (10YR 7/2), stratified, loamy and clayey material; common medium distinct reddish yellow (7.5YR 6/8) mottles; moderate thin platy structure; hard, firm; moderately alkaline.

The thickness of the solum ranges from 60 to more than 80 inches. Cracks are evident in the Bt horizon during portions of dry periods. The amplitude of the upper boundary of the subsoil is 8 to 20 inches between the subsoil crests and the subsoil troughs. The length of the cycle ranges from 3 to 8 feet.

The A horizon is very dark grayish brown or dark brown. Reaction ranges from strongly acid to slightly acid. The content of gravel ranges from 1 to about 5 percent, by volume.

Some pedons have an E horizon in the subsoil troughs. This horizon is light gray, light yellowish brown, very pale brown, or pale brown. Reaction is medium acid or slightly acid.

The Btg horizon is dark gray, dark grayish brown, or very dark grayish brown. It has few or common mottles in various shades of brown, yellow, gray, or red. The lower part of this horizon is clay, sandy clay loam, or clay loam. Reaction ranges from medium acid to mildly alkaline throughout the horizon.

The BC horizon is light gray, light brownish gray, very pale brown, grayish brown, brown, or pale olive. The texture is clay or clay loam. Reaction is mildly alkaline or moderately alkaline.

The C horizon is light gray, very pale brown, light olive gray, light brownish gray, or pale olive. It is clay loam or sandy clay loam that grades into stratified, loamy and clayey beds of the Yegua Formation. Reaction is mildly alkaline or moderately alkaline.

Bremond Series

The Bremond series consists of very deep, nearly level, moderately well drained, very slowly permeable soils on high terraces or remnants of terraces associated with erosional uplands. These soils formed in clayey sediments. Slopes range from 0 to 2 percent.

The soils of the Bremond series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Bremond loam, in an area of Bremond-Wilson complex, 0 to 2 percent slopes; from the intersection of Farm Road 39 and Old San Antonio Road in Normangee, 0.3 mile east on Old San Antonio Road, 900 feet southeast on city street, and 100 feet east in an area of cropland:

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam; massive; very hard, friable; common fine roots; few fine pores; few siliceous and ironstone pebbles; medium acid; abrupt smooth boundary.

Bt—8 to 18 inches; dark reddish brown (5YR 3/4) clay; common medium distinct dark red (2.5YR 3/6) mottles; moderate fine and medium angular blocky structure; extremely hard, very firm; common fine roots; few fine pores; few thin patchy clay films; common fine pressure faces; few fine black concretions; few siliceous and ironstone pebbles; few vertical cracks filled with loamy material; medium acid; gradual wavy boundary.

Btss—18 to 46 inches; light olive brown (2.5Y 5/4) clay; common medium distinct yellowish brown (10YR 5/6) and few fine prominent dark reddish brown

(5YR 3/4) mottles; moderate medium and coarse angular blocky structure; extremely hard, very firm; few fine roots; few fine pores; few thin patchy clay films; common fine pressure faces and few slickensides as much as 4 inches across; few fine black concretions; few siliceous and ironstone pebbles; neutral; gradual smooth boundary.

Btssy—46 to 68 inches; yellowish brown (10YR 5/4) clay; common medium distinct brownish yellow (10YR 6/8) and few fine prominent dark reddish brown (5YR 3/4) mottles; moderate medium prismatic structure parting to weak medium angular blocky; extremely hard, very firm; few fine roots; few thin patchy clay films; common pressure faces and intersecting slickensides; about 3 percent, by volume, crystals of calcium sulfate; few fine black concretions; few siliceous and ironstone pebbles; moderately alkaline; gradual smooth boundary.

Btssky—68 to 80 inches; yellowish brown (10YR 5/6) clay loam; common medium faint brownish yellow (10YR 6/8) and few fine prominent dark reddish brown (5YR 3/4) mottles; moderate medium prismatic structure parting to weak coarse angular blocky; extremely hard, very firm; common patchy clay films; common pressure faces and intersecting slickensides; about 4 percent, by volume, crystals of calcium sulfate; about 3 percent, by volume, concretions and soft masses of calcium carbonate; few fine black concretions; few siliceous and ironstone pebbles; moderately alkaline.

The thickness of the solum ranges from 60 to more than 80 inches. The depth to secondary carbonates and gypsum crystals ranges from 40 to 70 inches. Some pedons, however, do not have visible carbonates and crystals. The base saturation ranges from 80 to 100 percent by sum of the cations throughout the argillic horizon. The solum commonly has few to about 5 percent, by volume, siliceous and ironstone pebbles. The content of clay in the control section ranges from 38 to 50 percent. The coefficient of linear extensibility ranges from 0.07 to 0.10 in the upper 20 inches of the Bt horizon, and the potential linear extensibility is 2.5 to 4.5 inches in the upper 50 inches of the profile. During dry periods cracks ½ inch to 2 inches wide extend from the surface to a depth of more than 3 feet. The subsoil has few or common pressure faces throughout. Few or common intersecting slickensides are in the lower horizons.

The A horizon is brown, dark brown, very dark grayish brown, or dark grayish brown. Reaction ranges from strongly acid to neutral.

The Bt horizon is reddish brown, dark reddish brown, or dark yellowish brown. It has common or many mottles in shades of red, olive, yellow, or brown. Reaction ranges from medium acid to neutral.

The Bt and Btssy horizons are brown, yellowish brown, pale brown, light yellowish brown, light olive brown, or olive. They are mottled mainly in shades of brown, yellow, gray, or red. They are slightly acid to moderately alkaline and typically are noncalcareous. The number of calcium sulfate crystals ranges from none to common in the lower part of the Bt horizon.

The Btssky horizon has colors similar to those of the Btss and Btssy horizons, or the matrix is mottled with these colors. The texture is clay loam or clay. Reaction ranges from neutral to moderately alkaline. All or some part of the horizon is calcareous in most pedons. This horizon has very few to many concretions and masses of calcium carbonate and few to many crystals of calcium sulfate.

Burleson Series

The Burleson series consists of very deep, nearly level, moderately well drained, very slowly permeable soils on high stream terraces. These soils formed in alkaline, clayey sediments. Slopes are 0 to 1 percent.

The soils of the Burleson series are fine, montmorillonitic Udic Pellusterts.

Typical pedon of Burleson clay, 0 to 1 percent slopes; from the intersection of Farm Roads 1428 and 247 at Ferguson State Prison Farm, south on Farm Road 247 for 1.2 miles, east 0.9 mile along private ranch road, and 1,300 feet north of ranch road, in a pastured area:

Ap—0 to 10 inches; black (10YR 2/1) clay; strong medium angular blocky structure; extremely hard, very firm; shiny pressure faces on peds; slightly acid; clear smooth boundary.

Bss1—10 to 40 inches; black (10YR 2/1) clay; strong medium angular blocky structure; distinct intersecting slickensides tilted 30 to 60 degrees from the horizontal; extremely hard, very firm; shiny pressure faces on peds; few very dark brown strongly cemented concretions of iron and manganese oxide 1 to 3 millimeters in diameter; neutral; gradual wavy boundary.

Bss2—40 to 52 inches; very dark gray (10YR 3/1) clay; few medium distinct grayish brown (10YR 5/2) mottles; moderate medium angular blocky structure; distinct slickensides and parallelepipeds; extremely hard, very firm; few concretions of iron and manganese oxide; moderately alkaline; gradual wavy boundary.

Bkss—52 to 80 inches; dark gray (10YR 4/1) clay; few medium faint grayish brown (10YR 5/2) mottles; moderate medium angular blocky structure; few distinct slickensides and parallelepipeds; extremely hard, very firm; few concretions of iron and manganese oxide; about 2 percent, by volume, cemented concretions and soft masses of calcium carbonate; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness. The control section averages 45 to 60 percent clay. Undisturbed areas have gilgai microrelief. The distance from the center of a microknoll to the center of a microhigh is 5 to 15 feet. The difference between the high and low points is 3 to 10 inches. The depth to intersecting slickensides ranges from 10 to 30 inches.

The combined thickness of the A and Bss horizons ranges from 10 inches on the microknolls to 54 inches in the microdepressions. The thickness averages about 25 inches in most of the pedon. These horizons are black or very dark gray. Reaction ranges from medium acid to neutral.

The Bkss horizon is dark gray, gray, light brownish gray, or grayish brown. It has few or common mottles in shades of brown, yellow, or olive. The number of concretions and soft masses of calcium carbonate ranges from none to common. Intersecting slickensides are a few inches to several feet across. Reaction is mildly alkaline or moderately alkaline. Most pedons are calcareous in the lower part.

Chazos Series

The Chazos series consists of very deep, gently sloping, moderately well drained, slowly permeable soils on high stream terraces. These soils formed in clayey alluvium. Slopes range from 1 to 5 percent.

The soils of the Chazos series are fine, mixed, thermic Aquic Paleustalfs.

Typical pedon of Chazos loamy fine sand, 1 to 5 percent slopes; from the intersection of Old San Antonio Road and Farm Road 1119 at Elwood, 2.0 miles north along Farm Road 1119 and about 0.75 mile east and northeast in a pastured area, 0.5 mile northeast of Tan Yard Cemetery:

A—0 to 4 inches; brown (10YR 5/3) loamy fine sand; weak fine granular structure; slightly hard, very friable; common fine roots; slightly acid; clear smooth boundary.

E—4 to 14 inches; very pale brown (10YR 7/4) loamy fine sand; weak fine granular structure; slightly hard, very friable; common fine roots; few fine pores; medium acid; clear smooth boundary.

Bt1—14 to 23 inches; yellowish brown (10YR 5/4) clay; common medium prominent red (2.5YR 4/6) and few medium distinct grayish brown (10YR 5/2) mottles; moderate medium angular blocky structure; hard, firm; few fine roots; few fine pores; many clay films; medium acid; gradual smooth boundary.

Bt2—23 to 46 inches; grayish brown (10YR 5/2) sandy clay; many medium prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few fine pores; many clay films; medium acid; gradual smooth boundary.

Bt3—46 to 63 inches; light brownish gray (10YR 6/2) sandy clay; common coarse prominent red (2.5YR 4/8) mottles; weak medium subangular blocky structure; hard, firm; few fine pores; common clay films; medium acid; gradual smooth boundary.

BC—63 to 80 inches; light gray (10YR 7/2) sandy clay loam; few coarse prominent yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; hard, firm; few pockets of clean sand grains; slightly acid.

The thickness of the solum ranges from 60 to more than 80 inches. The content of rounded quartz pebbles ranges from 0 to about 10 percent, by volume, throughout the solum.

The A horizon is brown, pale brown, or dark brown. The E horizon is pale brown, light yellowish brown, or very pale brown. These horizons are medium acid to neutral.

The Bt horizon is grayish brown, light brownish gray, yellowish brown, brownish yellow, or red. It has prominent or distinct mottles in shades of red, yellow, brown, or gray. The texture is clay or sandy clay. The content of clay ranges from 35 to 50 percent. Reaction is medium acid or slightly acid in the Bt1 horizon and medium acid to neutral in the lower part of the Bt horizon.

The BC horizon is mainly in shades of gray or brown. It has mottles in shades of red or yellow. It ranges from sandy clay loam to clay. Reaction is slightly acid to moderately alkaline.

Crockett Series

The Crockett series consists of very deep, very gently sloping, moderately well drained, very slowly permeable soils on uplands. These soils formed in clayey material interbedded with shale (fig. 13). Slopes range from 1 to 3 percent.

The soils of the Crockett series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Crockett loam, 1 to 3 percent slopes; from the intersection of Farm Road 2289 and Old San Antonio Road about 3 miles east of Normangee, 0.5 mile east on Old San Antonio Road and 60 feet south of Old San Antonio Road, in an area of improved bermudagrass pasture:

Ap—0 to 6 inches; brown (10YR 4/3) loam; weak fine granular structure; very hard, friable; many fine roots; common ironstone pebbles; few fine black concretions; medium acid; abrupt wavy boundary.

Bt—6 to 17 inches; dark yellowish brown (10YR 3/4) clay; common medium prominent dark red (2.5YR 3/6) mottles; moderate medium subangular blocky structure; extremely hard, very firm; few fine pores; few ironstone pebbles; many clay films; few fine black concretions; vertical cracks partially filled with brown loam; slightly acid; gradual wavy boundary.

Btss1—17 to 37 inches; olive brown (2.5Y 4/4) clay; moderate medium subangular blocky structure; extremely hard, very firm; many clay films; common slickensides; many ironstone pebbles; few fine black concretions; neutral; gradual wavy boundary.

Btss2—37 to 45 inches; olive brown (2.5Y 4/4) clay; moderate medium subangular blocky structure; extremely hard, very firm; common clay films; common slickensides and pressure faces; common ironstone pebbles; few fine black concretions; neutral; gradual wavy boundary.

BCy—45 to 59 inches; light olive brown (2.5Y 5/4) clay; common medium distinct yellowish red (5YR 5/6) and few fine distinct pinkish gray (5YR 6/2) mottles; moderate medium subangular blocky structure; extremely hard, very firm; few concretions of calcium carbonate; common crystals of calcium sulfate; few thin clay films; moderately alkaline; gradual wavy boundary.

Ck—59 to 80 inches; light brownish gray (2.5YR 6/2), interbedded clay and shale; common medium prominent reddish yellow (5YR 5/6) mottles; massive; extremely hard, very firm; few concretions of calcium carbonate; few crystals of calcium sulfate; moderately alkaline.

The solum ranges from 40 to about 60 inches in thickness. The content of clay in the upper 20 inches of the argillic horizon ranges from 40 to 60 percent. The depth to secondary carbonates ranges from 30 to 60 inches.

The A horizon is brown or very dark grayish brown. The content of ironstone and siliceous pebbles ranges from 1 to 10 percent, by volume. Reaction is medium acid to neutral.

The Bt horizon is reddish brown, dark reddish brown, or dark yellowish brown. It has common or many mottles in shades of red, olive, yellow, or brown. The content of ironstone and siliceous pebbles ranges from 1 to 10 percent, by volume. Reaction ranges from medium acid to neutral.

The Btss horizon is olive brown, dark grayish brown, dark olive gray, or light yellowish brown. It has few or common mottles in shades of red, yellow, or brown. It has few or no concretions and soft bodies of calcium carbonate. Reaction ranges from slightly acid to moderately alkaline.

The BC and C horizons have matrix colors of brown or gray. They have mottles in shades of olive, gray, or yellow. The texture is clay, sandy clay, or clay loam. Some pedons have thin fragments of interbedded shale. The number of calcium sulfate crystals and calcium carbonate concretions ranges from none to common. Reaction ranges from neutral to moderately alkaline.

Derly Series

The Derly series consists of very deep, nearly level, poorly drained, very slowly permeable soils on old terraces. These soils formed in clayey sediments in depressions (fig. 14). Slopes are 0 to 1 percent.

The soils of the Derly series are fine, montmorillonitic, thermic Typic Glossaqualfs.

Typical pedon of Derly silt loam, 0 to 1 percent slopes; from the intersection of Farm Roads 247 and 1428 at Ferguson State Prison Farm, 2.0 miles southwest on Farm Road 1428, about 600 feet south on ranch road, and 50 feet west in a pastured area:

A—0 to 4 inches; grayish brown (10YR 5/2) silt loam; common medium faint brown (10YR 4/3) mottles; weak medium subangular blocky structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.

Eg—4 to 7 inches; light brownish gray (10YR 6/2) silt loam; few medium faint brown (10YR 4/3) mottles; weak fine subangular blocky structure; slightly hard, friable; common fine roots; medium acid; clear wavy boundary.

Btg/E—7 to 23 inches; dark grayish brown (10YR 4/2) clay (Btg); grayish brown (10YR 5/2) tongues and streaks of silt loam (E), which makes up about 20 percent of the horizon; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few thin clay films; medium acid; gradual smooth boundary.

Btg1—23 to 36 inches; dark gray (10YR 4/1) clay; moderate coarse blocky structure parting to moderate medium subangular blocky; very hard, very firm; few fine roots; few thin clay films; few thin streaks of uncoated sand and silt; medium acid; gradual smooth boundary.

Btg2—36 to 52 inches; grayish brown (10YR 5/2) clay; common medium faint pale brown (10YR 6/3) mottles; moderate coarse blocky structure parting to moderate medium subangular blocky; very hard, very firm; few fine roots; few thin clay films; few black concretions; neutral; gradual wavy boundary.

Btg3—52 to 71 inches; light gray (10YR 7/2) clay loam; common medium distinct strong brown (7.5YR 5/8) mottles; weak medium subangular blocky structure; very hard, very firm; few fine roots; few thin clay films; few black concretions; common fine crystals of barium sulfate salts; neutral; gradual smooth boundary.

BCg—71 to 80 inches; light gray (10YR 7/2), stratified loam, clay loam, and clay; common coarse distinct brownish yellow (10YR 6/8) mottles; weak coarse subangular blocky structure; hard, firm; neutral.

The solum is more than 60 inches thick.

The A horizon is dark grayish brown, brown, or grayish brown. It has few or common dark grayish brown, brown, grayish brown, or gray mottles in most pedons. Reaction ranges from strongly acid to slightly acid.

The Eg horizon is grayish brown, light brownish gray, or light gray. It has few or common grayish brown, light brownish gray, light gray, or brown mottles in some pedons. Reaction ranges from very strongly acid to medium acid.

The Bt part of the Bt/E horizon is dark brown, brown, dark grayish brown, or light brownish gray. The texture is clay or clay loam. The E part is grayish brown, light brownish gray, light gray, or pinkish white. In some pedons it has few or common yellowish brown and strong brown mottles. The texture is silt loam or very fine sandy loam. Tongues and interfingering of E material make up 15 to 30 percent of this horizon. Reaction ranges from very strongly acid to medium acid.

The Btg horizon is dark gray, dark grayish brown, or grayish brown. It has few or common mottles in shades of red or brown in some pedons. Reaction generally is strongly acid or medium acid but ranges to neutral in the lower part of the horizon.

The BC horizon is grayish brown, light brownish gray, or light gray. In some pedons it has mottles in shades of red, yellow, or brown. In some pedons it has barium sulfate salts, concretions of calcium carbonate, or gypsum crystals. Reaction is slightly acid or neutral.

Dimebox Series

The Dimebox series consists of very deep, nearly level, moderately well drained, very slowly permeable soils that formed in clayey marine sediments. These soils are on nearly level uplands. Slopes are 0 to 1 percent.

The soils of the Dimebox series are fine, montmorillonitic, thermic Udic Pellusterts.

Typical pedon of Dimebox silty clay, 0 to 1 percent slopes; from the intersection of Farm Road 2289 and Old San Antonio Road about 3 miles east of Normangee, 1.6 miles east on Old San Antonio Road and 200 feet south of Old San Antonio Road, in an area of native pasture:

A—0 to 6 inches; very dark gray (10YR 3/1) silty clay; strong fine angular blocky structure parting to strong fine granular; extremely hard, very firm; many fine and medium roots; cracks, ¼ inch to 2 inches wide, extending from the surface to a depth of 40 inches; slightly acid; gradual wavy boundary.

Bss1—6 to 21 inches; black (10YR 2.5/1) clay; moderate medium angular blocky structure parting to moderate medium granular; few slickensides; extremely hard, very firm; many fine and medium roots; about 1 percent, by volume, ironstone pebbles; slightly acid; gradual wavy boundary.

Bss2—21 to 52 inches; black (10YR 2.5/1) clay; strong medium angular blocky structure; extremely hard, very firm; intersecting slickensides tilted from the horizontal; common parallelepiped aggregates; about 5 percent, by volume, ironstone pebbles 3 to 10 millimeters in size; few nodules of calcium carbonate; noncalcareous; neutral; gradual wavy boundary.

Byss—52 to 73 inches; dark gray (10YR 4/1) clay; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; extremely hard, very firm; common intersecting slickensides; common fine and medium crystals of calcium sulfate; neutral; gradual wavy boundary.

BC—73 to 91 inches; yellowish brown (10YR 5/6) clay; many medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; extremely hard, very firm; cracks filled with material from the upper horizons; moderately alkaline.

The A and B horizons are cyclic, ranging from 40 to 90 inches in thickness. The solum has a few to about 5 percent rounded ironstone pebbles. Some pedons have rounded quartz pebbles. In more than 50 percent of the pedon, horizons that have chroma of less than 1.5 and value of less than 5.5 range from 12 to 65 inches in thickness. Undisturbed areas have gilgai microrelief. The microhighs are 6 to 16 inches higher than the microlows. The distance between the center of the high and low points is 5 to 18 feet. During dry periods cracks ¼ inch to 2 inches wide extend from the surface to a depth of 40 inches or more. The depth to intersecting slickensides ranges from 15 to 36 inches.

The A and Bss horizons are black, very dark brown, or very dark gray. They are strongly acid to neutral.

The Byss and BC horizons are dark gray, gray, yellowish brown, or brownish yellow. They have few to many mottles in shades of yellow, brown, gray, or olive. Some parts of the matrix are calcareous. The number of pitted calcium carbonate concretions generally ranges from none to common, but some pockets have many of these concretions. The number of calcium sulfate crystals is few or common. Intersecting slickensides are a few inches to several feet across. The texture is clay or silty clay. Reaction ranges from strongly acid to moderately alkaline.

Dutek Series

The Dutek series consists of very deep, gently sloping, well drained, moderately permeable soils on high terraces in the uplands. These soils formed in loamy and sandy material. Slopes range from 1 to 5 percent.

The soils of the Dutek series are loamy, siliceous, thermic Arenic Haplustalfs.

Typical pedon of Dutek loamy fine sand, 1 to 5 percent slopes; from the intersection of Interstate 45 and Old San Antonio Road 0.7 mile west on Old San Antonio Road, 0.9 mile south on county road, and 100 feet east in a pastured area:

A—0 to 7 inches; brown (7.5YR 4/4) loamy fine sand; weak fine granular structure; loose, very friable; many fine roots; medium acid; clear smooth boundary.

E—7 to 26 inches; strong brown (7.5YR 5/6) loamy fine sand; single grained; loose, friable; few fine roots; medium acid; clear smooth boundary.

Bt1—26 to 45 inches; red (2.5YR 4/6) sandy clay loam; weak coarse prismatic structure parting to moderate medium subangular blocky; hard, friable; few patchy clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt2—45 to 65 inches; red (2.5YR 4/6) fine sandy loam; weak medium subangular blocky structure; slightly hard, friable; few patchy clay films; strongly acid; gradual wavy boundary.

BCt—65 to 80 inches; yellowish red (5YR 5/8) fine sandy loam; weak fine and medium subangular blocky structure; soft, very friable; few patchy clay films; very strongly acid.

The thickness of the solum ranges from 60 to more than 80 inches.

The combined thickness of the A and E horizons is 20 to 40 inches. These horizons are medium acid or slightly acid. The A horizon is brown or pale brown. The E horizon is light yellowish brown, strong brown, or reddish yellow.

The Bt horizon is yellowish red or red. The texture is sandy clay loam or fine sandy loam. Reaction is strongly acid or medium acid.

The BC horizon is red, reddish yellow, or yellowish red. The texture is fine sandy loam or sandy clay loam. Reaction is very strongly acid to medium acid.

Ellis Series

The Ellis series consists of moderately deep, strongly sloping to moderately steep, well drained, very slowly permeable soils on uplands. These soils formed in weakly consolidated clayey material and in material weathered from shale. Slopes range from 5 to 15 percent.

The soils of the Ellis series are fine, montmorillonitic, thermic Udertic Ustochrepts.

Typical pedon of Ellis clay, 5 to 15 percent slopes; from the intersection of Texas Highway 21 and Farm Road 2548 in Midway, 2.9 miles northeast on Texas Highway 21 and 1,100 feet southeast in a pastured area, 300 feet south of a farm pond:

A—0 to 3 inches; brown (10YR 4/3) clay; moderate medium subangular and angular blocky structure; very hard, very firm; few fine roots; neutral; clear smooth boundary.

Bw—3 to 25 inches; olive brown (2.5Y 4/4) clay; moderate medium angular blocky structure; very hard, very firm; few fine roots; about 3 percent, by volume, concretions of calcium carbonate; calcareous in the lower part; moderately alkaline; gradual smooth boundary.

C—25 to 80 inches; light yellowish brown (10YR 6/4) shale that has a texture of clay; common medium faint brownish yellow (10YR 6/8), common medium distinct light gray (10YR 7/2), and few fine distinct strong brown (7.5YR 5/6) mottles; massive but natural cleavage of shale is coarse angular blocky; extremely hard, very firm; few slickensides; calcareous; moderately alkaline.

The solum ranges from 20 to 40 inches in thickness. The content of clay throughout the solum ranges from 40 to 60 percent.

The A horizon is brown or dark grayish brown. It is neutral to moderately alkaline. In some pedons it is calcareous.

The Bw horizon is olive brown or light yellowish brown. In some pedons it has mottles in shades of gray or yellow. It is mildly alkaline or moderately alkaline. In some pedons it is calcareous and has as much as 3 percent, by volume, cemented concretions of calcium carbonate.

The C horizon is light olive brown or light yellowish brown and is mottled in shades of gray, yellow, and brown. It is shale or clay. In some pedons it has black stains on cleavage planes. Reaction is mildly alkaline or moderately alkaline.

Elmina Series

The Elmina series consists of deep, very gently sloping, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in sandy and clayey deposits. Slopes range from 1 to 3 percent.

The soils of the Elmina series are clayey, montmorillonitic, thermic Aquic Arenic Hapludalfs.

Typical pedon of Elmina loamy fine sand, 1 to 3 percent slopes; from the intersection of Texas Highway 21 and Farm Road 1428 about 3 miles east of Madisonville, 6.0 miles southeast on Farm Road 1428, about 0.2 mile southeast on county road to a metal gate, 1.1 miles south on woodland trail, and 20 feet east in an area of woodland:

A—0 to 5 inches; brown (10YR 5/3) loamy fine sand; single grained; very friable, soft; many fine to coarse roots; strongly acid; clear smooth boundary.

E—5 to 25 inches; pale brown (10YR 6/3) loamy fine sand; weak fine subangular blocky structure; very friable, soft; common medium and coarse roots; common fine pores; strongly acid; clear wavy boundary.

Btg1—25 to 35 inches; grayish brown (10YR 5/2) clay; common medium prominent dark red (2.5YR 3/6) mottles; moderate medium angular blocky structure; very hard, very firm; few medium and coarse roots; few fine pores; common thin clay films; few fine black concretions; very strongly acid; gradual wavy boundary.

Btg2—35 to 47 inches; light brownish gray (10YR 6/2) clay; many medium prominent strong brown (7.5YR 5/8) and common medium distinct red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few medium and coarse roots; few fine pores; common thin clay films; very strongly acid; gradual wavy boundary.

Btg3—47 to 58 inches; light brownish gray (10YR 6/2) sandy clay; common fine distinct brownish yellow (10YR 6/6) mottles; few fine very pale brown (10YR 7/4) sandstone fragments; moderate medium subangular blocky structure; hard, firm; few fine roots; few fine pores; common thin clay films; very strongly acid; abrupt wavy boundary.

Cr—58 to 60 inches; very pale brown (10YR 7/3), weakly cemented sandstone; very strongly acid.

The thickness of the solum, or the depth to paralithic contact with sandstone or siltstone, ranges from 40 to 60 inches.

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

The E horizon is pale brown, light yellowish brown, or very pale brown. It is very strongly acid to slightly acid.

The Btg1 horizon is grayish brown, light gray, or light brownish gray. It has yellow, brown, strong brown, reddish brown, or red mottles. It is clay or sandy clay. The Btg2 horizon is light brownish gray, light gray, or gray. It has mottles in shades of red, brown, or yellow. It ranges from clay to sandy clay. The Btg3 horizon is light brownish gray, dark grayish brown, or grayish brown. These horizons are extremely acid to medium acid.

The Cr horizon is weakly cemented to strongly cemented sandstone grading to tuffaceous clay that has rock structure.

Eufaula Series

The Eufaula series consists of very deep, gently sloping to strongly sloping, somewhat excessively drained, rapidly permeable soils on terraces. These soils formed in sandy sediments along the Navasota River and its tributaries. Slopes range from 1 to 15 percent.

The soils of the Eufaula series are sandy, siliceous, thermic Psammentic Paleustalfs.

Typical pedon of Eufaula loamy fine sand, 5 to 15 percent slopes; from the intersection of Texas Highway 21 and Farm Road 1428 about 2.5 miles east of Madisonville, 3.4 miles southeast on Farm Road 1428, about 2.6 miles northeast on Farm Road 2158, and 700 feet east along a road in a pastured area, 250 feet north of Larrison Creek:

A—0 to 5 inches; dark grayish brown (10YR 4/2) loamy fine sand; single grained; loose, very friable; common fine roots; slightly acid; clear smooth boundary.

E—5 to 48 inches; pale brown (10YR 6/3) loamy fine sand; single grained; loose, very friable; few fine roots; slightly acid; gradual smooth boundary.

E/Bt—48 to 80 inches; pale brown (10YR 6/3) loamy fine sand (E); single grained; lamellae of strong brown (7.5YR 4/6) fine sandy loam (Bt) ⅛ to 1 inch thick and ½ inch to 3 inches apart; massive; slightly hard, friable; wavy and discontinuous; clay bridges between the sand grains in the lamellae; neutral.

The solum is more than 80 inches thick.

The combined thickness of the A and E horizons is 40 to 50 inches. The A horizon is dark grayish brown,

brown, or dark yellowish brown. The E horizon is mainly loamy fine sand, but the range includes fine sand. The E horizon is pale brown or light yellowish brown. These horizons are medium acid or slightly acid.

The E/Bt horizon is mainly loamy fine sand, but the range includes fine sand. The E material makes up 55 to 75 percent of the horizon. It is light yellowish brown, very pale brown, or pale brown. The Bt material is strong brown or reddish yellow. Reaction ranges from strongly acid to neutral.

Flatonia Series

The Flatonia series consists of deep, very gently sloping, moderately well drained, slowly permeable soils on uplands. These soils formed in neutral or alkaline, clayey sediments and mudstones. Slopes range from 1 to 3 percent.

The soils of the Flatonia series are fine, montmorillonitic, thermic Udertic Argiustolls.

The Flatonia soils in Madison County are taxadjuncts to the series because in most areas the A horizon is hard and massive when dry and therefore does not qualify as a mollic epipedon. This difference, however, does not affect the use and management of the soils.

Typical pedon of Flatonia clay loam, 1 to 3 percent slopes; from the intersection of Texas Highway 21 and Farm Road 39 in North Zulch, 1.3 miles north on Farm Road 39, about 0.3 mile east and north and 0.3 mile east on county road, and 150 feet north in a pastured area:

A—0 to 7 inches; very dark gray (10YR 3/1) clay loam; weak coarse angular blocky structure, massive when dry; very hard, very firm; common fine roots; few siliceous pebbles; slightly acid; clear smooth boundary.

Bt1—7 to 30 inches; black (10YR 2/1) clay; weak medium prismatic structure parting to moderate medium angular blocky; extremely hard, very firm; few fine roots; about 3 percent, by volume, ironstone fragments; few pressure faces; few thin clay films; neutral; gradual smooth boundary.

Bt2—30 to 40 inches; black (10YR 2/1) clay; few medium faint very dark gray (10YR 3/1) and dark gray (10YR 4/1) mottles; weak medium prismatic structure parting to moderate medium angular blocky; extremely hard, very firm; few fine roots; few ironstone fragments; few pressure faces; few thin clay films; moderately alkaline; gradual smooth boundary.

BC—40 to 48 inches; gray (10YR 5/1) clay; few medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium angular blocky structure; very hard, very firm; few fine roots; few ironstone fragments; moderately alkaline; clear smooth boundary.

Cr—48 to 80 inches; pale olive (5Y 6/3), weakly cemented shale; massive with thinly bedded rock structure; very hard, very firm; few films and threads of calcium carbonate in upper part; moderately alkaline.

The thickness of the solum ranges from 40 to about 60 inches. During dry periods cracks ½ inch to 2 inches wide extend from the surface to the C horizon. Most pedons have a few siliceous pebbles in the A and Bt horizons.

The A horizon is very dark gray, very dark grayish brown, dark grayish brown, or dark gray. It is slightly acid or neutral.

The Bt horizon is black, very dark gray, dark gray, dark grayish brown, very dark grayish brown, or very dark brown. The average content of clay in the upper 20 inches of this horizon ranges from 40 to 50 percent. In some pedons this horizon has a few ironstone fragments and a few siliceous pebbles. Reaction ranges from slightly acid to moderately alkaline.

The BC horizon is mostly gray or brown. The texture is clay loam, silty clay, or clay. The number of concretions, films, threads, and soft masses of calcium carbonate ranges from none to common. Reaction is mildly alkaline or moderately alkaline.

The Cr horizon is mostly in colors of gray, brown, or olive. It is weakly cemented shale that crushes to silty clay loam, silt loam, or silty clay and has thin seams and strata of fine sand. In the upper part it has few or common concretions, films, threads, and soft masses of calcium carbonate. In some pedons it has soft masses of gypsum or barium salts.

Gasil Series

The Gasil series consists of very deep, gently sloping, well drained, moderately permeable soils on uplands. These soils formed in weathered loamy sediments. Slopes range from 1 to 5 percent.

The soils of the Gasil series are fine-loamy, siliceous, thermic Ultic Paleustalfs.

The Gasil soils in Madison County are taxadjuncts to the series because in most areas they decrease in content of clay by 20 percent or more of the maximum within 60 inches of the surface and qualify as Haplustalfs. This difference, however, does not affect the use and management of the soils.

Typical pedon of Gasil fine sandy loam, 1 to 5 percent slopes; from the intersection of Farm Roads 39 and 1452 at the community of George, 4.0 miles west on Farm Road 1452 and 1,200 feet northwest in an area of improved pasture:

A—0 to 4 inches; brown (10YR 4/3) fine sandy loam; weak fine granular structure; soft, very friable; common fine roots; medium acid; clear smooth boundary.

E—4 to 8 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak medium subangular blocky structure parting to weak fine granular; soft, very friable; common fine roots; medium acid; clear smooth boundary.

Bt1—8 to 17 inches; strong brown (7.5YR 5/8) sandy clay loam; common fine distinct yellowish red (5YR 4/8) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films; strongly acid; gradual wavy boundary.

Bt2—17 to 42 inches; yellowish brown (10YR 5/8) sandy clay loam; weak medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films; strongly acid; gradual wavy boundary.

Bt3—42 to 62 inches; yellow (10YR 7/8) sandy clay loam; weak fine subangular blocky structure; hard, firm; few fine roots; few patchy clay films; medium acid; clear wavy boundary.

BC—62 to 80 inches; mottled very pale brown (10YR 8/3) and yellow (10YR 7/8) fine sandy loam; weak fine subangular blocky structure; soft, friable; neutral.

The solum ranges from 60 to more than 80 inches in thickness. The control section ranges from 18 to 35 percent clay. The content of fine ironstone pebbles ranges from 0 to about 5 percent throughout the solum.

The combined thickness of the A and E horizons is 5 to 20 inches. The A horizon is brown or dark yellowish brown. The E horizon is light yellowish brown, pale brown, brown, or yellowish brown. These horizons are medium acid or slightly acid.

The Bt horizon is strong brown, yellowish brown, or brownish yellow. It has few or common mottles in shades of red or yellow. The texture is sandy clay loam or loam. Reaction ranges from strongly acid to slightly acid.

The BC horizon is yellow, brownish yellow, or yellowish brown. It has few or common mottles in shades of red, yellow, or gray. The texture is sandy clay loam or loam. Reaction ranges from strongly acid to neutral.

Gladewater Series

The Gladewater series consists of very deep, nearly level, poorly drained, very slowly permeable soils on bottom land. These soils formed in clayey alluvium. They are subject to flooding. Slopes are less than 1 percent.

The soils of the Gladewater series are fine, montmorillonitic, nonacid, thermic Vertic Haplaquepts.

Typical pedon of Gladewater clay, frequently flooded; from the intersection of Old San Antonio Road and Farm Road 1452 about 6 miles southwest of Normangee, 0.6 mile south on Farm Road 1452, about 1.0 mile south and west on county road, 1.3 miles west on ranch road, and 300 feet north of ranch road, in an area of bottom land:

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) clay; moderate medium angular blocky structure; extremely hard, very firm; many fine roots; medium acid; gradual wavy boundary.

Bgss1—7 to 26 inches; dark gray (10YR 4/1) clay; common medium prominent reddish brown (5YR 4/4) mottles; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; few medium intersecting slickensides; few pressure faces; medium acid; gradual wavy boundary.

Bgss2—26 to 47 inches; dark gray (10YR 4/1) clay; moderate medium angular blocky structure; extremely hard, very firm; few intersecting slickensides; many fine pressure faces; strongly acid; gradual wavy boundary.

Cg—47 to 80 inches; gray (10YR 5/1) clay; common medium distinct yellowish brown (10YR 5/6) mottles; massive; extremely hard, very firm; strongly acid.

The solum ranges from 20 to 50 inches in thickness. The content of clay ranges from 40 to 55 percent.

The Ap horizon is very dark grayish brown or dark grayish brown. It has few or common mottles in shades of brown or gray. Reaction is medium acid or slightly acid.

The Bgss horizon is dark gray, dark grayish brown, gray, or grayish brown. It has few or common mottles in shades of brown. The texture is clay or silty clay. Reaction ranges from very strongly acid to neutral. It is medium acid or slightly acid in some subhorizons within a depth of 40 inches.

The C horizon is gray, grayish brown, or dark grayish brown. Reaction ranges from strongly acid to moderately alkaline.

Gowker Series

The Gowker series consists of very deep, nearly level, moderately well drained, slowly permeable soils on flood plains. These soils formed in loamy and clayey sediments. They are subject to flooding. Slopes are 0 to 1 percent.

The soils of the Gowker series are fine-loamy, siliceous, thermic Cumulic Hapludolls.

Typical pedon of Gowker clay loam, frequently flooded; from the intersection of Farm Roads 39

Figure 11.—Profile of a Bienville loamy fine sand. The lower part of the soil has spots and streaks of uncoated sand grains.

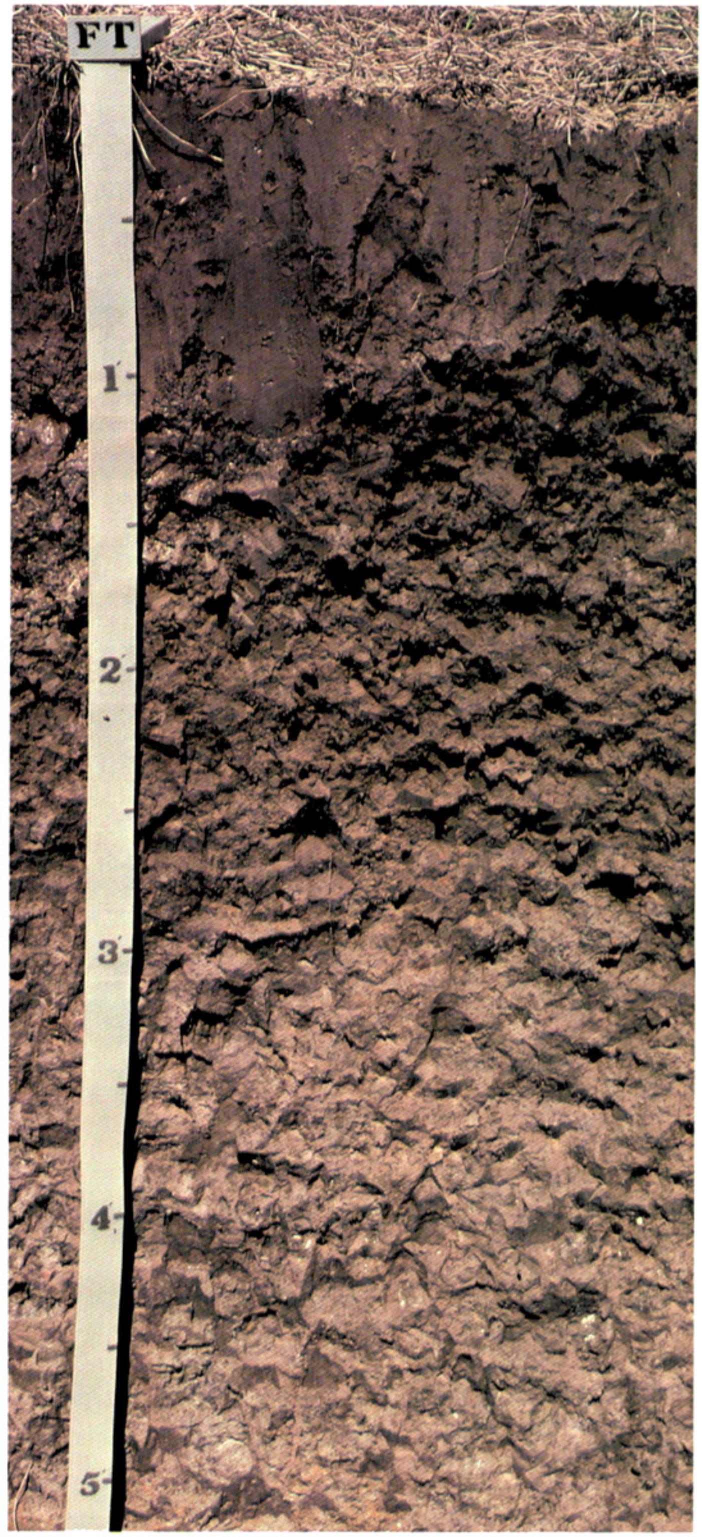

Figure 12.—Profile of a Boonville fine sandy loam. An abrupt wavy boundary is between the surface layer and the subsoil.

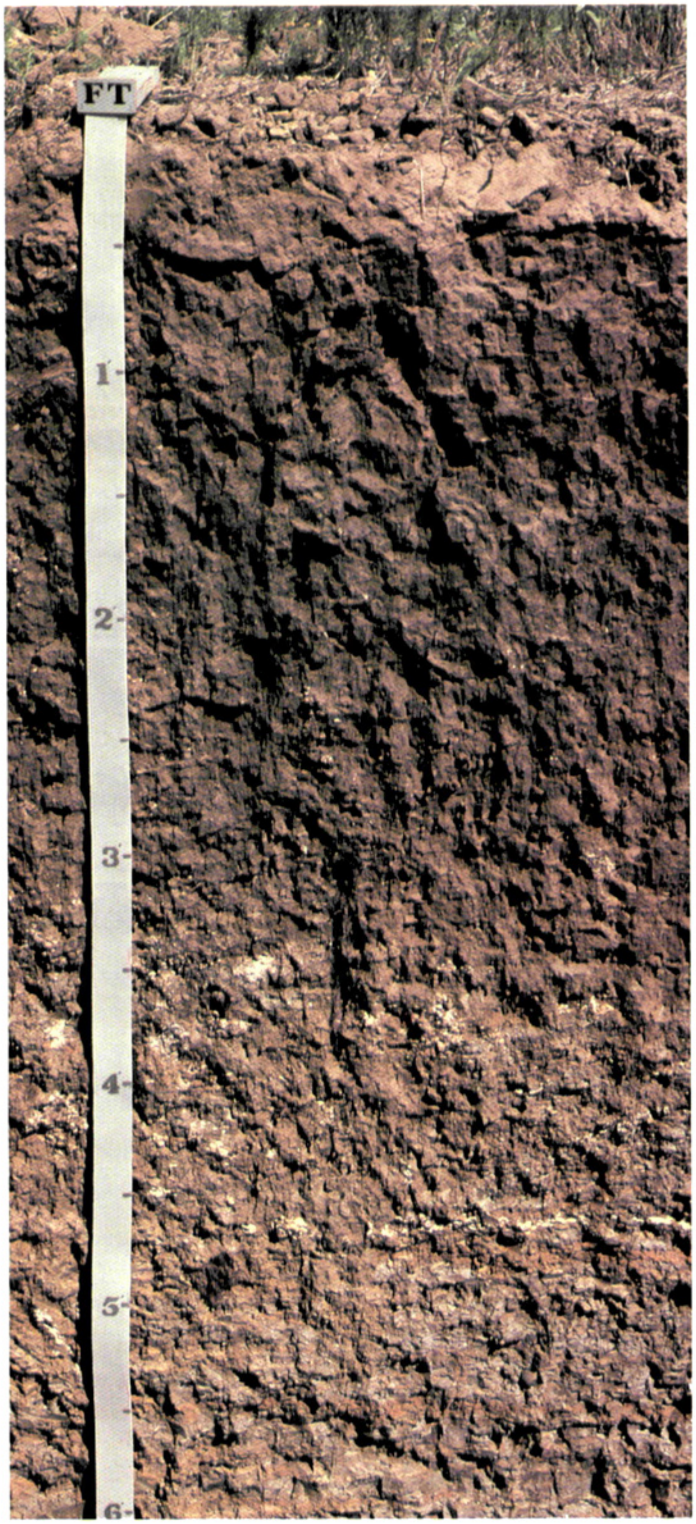

Figure 13.—Profile of a Crockett loam. This very slowly permeable soil formed in clayey material interbedded with shale.

Figure 14.—Profile of a Derly silt loam. The upper part of the subsoil is clay that has tongues and streaks of silt loam.

Figure 15.—Profile of a Gredge fine sandy loam. The subsoil is red clay in the upper part and grayish sandy clay loam in the lower part.

Figure 16.—Profile of a Lufkin fine sandy loam. The subsoil is dense clay that is very slowly permeable.

Figure 17.—Profile of a Rader fine sandy loam. This soil formed in clayey sediments interbedded with loamy material.

Figure 18.—Profile of a Zulch fine sandy loam. The dark, dense subsoil is underlain by grayish and olive, weakly consolidated shale.

and 1452 at the community of George, 5.2 miles west on Farm Road 1452 and 300 feet south in an area of bottom land near West Caney Creek:

A1—0 to 8 inches; dark brown (10YR 3/3) clay loam; weak medium granular structure; hard, friable; common fine roots; medium acid; gradual smooth boundary.

A2—8 to 20 inches; very dark grayish brown (10YR 3/2) clay loam; moderate medium subangular blocky structure; hard, friable; common fine roots; medium acid; gradual smooth boundary.

A3—20 to 31 inches; very dark gray (10YR 3/1) clay loam; common medium distinct yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; hard, friable; few fine roots; medium acid; gradual smooth boundary.

A4—31 to 45 inches; very dark grayish brown (10YR 3/2) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; very hard, firm; common crystals of calcium sulfate; medium acid; gradual smooth boundary.

Bw1—45 to 60 inches; dark grayish brown (10YR 4/2) clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very hard, firm; neutral; gradual smooth boundary.

Bw2—60 to 80 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct strong brown (7.5YR 5/6 and 4/6) mottles; weak medium subangular blocky structure; very hard, firm; few fine dark concretions and stains; mildly alkaline.

The A horizon ranges from 24 to 50 inches in thickness. It is clay loam or sandy clay loam. It is medium acid or slightly acid. The A1 horizon is very dark grayish brown, very dark gray, or dark brown. The A2, A3, and A4 horizons are very dark grayish brown, very dark gray, brown, dark brown, or dark grayish brown. In some pedons the lower part of the A horizon has few or common crystals of calcium sulfate.

The B horizon is very dark gray, very dark grayish brown, dark gray, or grayish brown. It has few or common mottles in shades of yellow or brown. The texture is clay loam, clay, or sandy clay loam. Reaction ranges from medium acid to neutral. In some pedons the B horizon has few or common crystals of calcium sulfate.

The C horizon, if it occurs, is brown, light brownish gray, dark grayish brown, or very dark grayish brown. The texture is sandy clay loam, clay, or clay loam. Reaction ranges from medium acid to moderately alkaline.

Gredge Series

The Gredge series consists of very deep, gently sloping to moderately sloping, moderately well drained, very slowly permeable soils on terraces and uplands (fig. 15). These soils formed in clayey and loamy sediments. Slopes range from 1 to 8 percent.

The soils of the Gredge series are fine, montmorillonitic, thermic Aquic Paleustalfs.

Typical pedon of Gredge fine sandy loam, 1 to 5 percent slopes; from the intersection of Texas Highway 21 and Texas Highway 75 in Madisonville, 1.1 miles north on Texas Highway 75, about 0.6 mile east and northeast on county road, and 300 feet east in a pastured area:

A—0 to 7 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak coarse subangular blocky structure; hard, friable; many fine roots; common fine pores; few quartz pebbles; very strongly acid; abrupt smooth boundary.

Bt—7 to 21 inches; red (2.5YR 4/8) clay; few medium distinct light brownish gray (10YR 6/2) mottles; moderate medium angular blocky structure; very hard, very firm; common fine roots; continuous clay films on faces of peds; few quartz pebbles; very strongly acid; clear wavy boundary.

Btg1—21 to 32 inches; light brownish gray (10YR 6/2) clay; common medium distinct yellowish red (5YR 5/6) mottles; moderate medium angular blocky structure; very hard, very firm; few fine roots; continuous clay films on faces of peds; few quartz pebbles; strongly acid; gradual wavy boundary.

Btg2—32 to 45 inches; light brownish gray (10YR 6/2) sandy clay loam; common medium distinct yellowish red (5YR 5/6) mottles; weak medium subangular blocky structure; very hard, very firm; few fine roots; patchy clay films on faces of peds; few fine barite crystals; few quartz pebbles; slightly acid; gradual wavy boundary.

BCg—45 to 63 inches; light brownish gray (2.5Y 6/2) sandy clay loam; common coarse distinct yellowish brown (10YR 5/8) mottles; weak medium subangular blocky structure; hard, firm; few patchy clay films on faces of peds; few mica flakes in the lower part; few quartz pebbles; mildly alkaline; clear smooth boundary.

2C—63 to 80 inches; light brownish gray (2.5YR 6/2) clay loam stratified with clay and fine sandy loam; massive; hard, firm; moderately alkaline.

The thickness of the solum ranges from 60 to 80 inches. Some pedons have calcium carbonate and other salts in the lower part of the Bt horizon and in the BC and C horizons. Siliceous pebbles 2 millimeters to 1 inch in size are throughout most pedons. They make up 1 to 10 percent of the volume.

The A horizon is dark grayish brown, grayish brown, brown, and pale brown. The E horizon is brown, pale brown, light brownish gray, light yellowish brown, and very pale brown. The content of siliceous gravel in the A and E horizons ranges from 0 to 5 percent, by volume. Reaction is very strongly acid to slightly acid in unlimed areas.

The upper part of the Bt horizon is dark red, reddish brown, red, yellowish red, brown, strong brown, and dark yellowish brown or is mottled with these colors and has mottles in shades of yellow, gray, or red. Reaction is very strongly acid to medium acid.

The lower part of the Bt horizon is dark grayish brown, grayish brown, light brownish gray, dark brown, or brown. It has mottles in shades of brown, red, yellow, or gray. The texture ranges from clay to sandy clay loam. Reaction ranges from strongly acid to moderately alkaline.

The BC horizon is mostly in shades of gray and brown and generally is mottled with shades of red, yellow, or gray. The texture is sandy clay loam or clay loam. Reaction ranges from strongly acid to moderately alkaline.

The C horizon is light gray, light brownish gray, brown, and pale brown, or is mottled in shades of red, brown, yellow, and gray. The texture is loamy fine sand, fine sandy loam, sandy clay loam, or clay loam or is stratified with these textures. Reaction is strongly acid to moderately alkaline.

Hatliff Series

The Hatliff series consists of very deep, nearly level, moderately well drained, moderately rapidly permeable soils on flood plains. These soils formed in loamy and sandy alluvial sediments. Slopes are 0 to 1 percent.

The soils of the Hatliff series are coarse-loamy, siliceous, nonacid, thermic Aquic Udifluvents.

Typical pedon of Hatliff fine sandy loam, frequently flooded; from the intersection of Texas Highway 21 and Farm Road 1428 about 2.5 miles east of Madisonville, 5.9 miles southeast on Farm Road 1428, about 1.4 miles northeast on ranch road, and 0.6 mile northeast in an area of bottom land:

A—0 to 9 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; slightly hard, friable; common fine roots; slightly acid; abrupt smooth boundary.

Bw1—9 to 22 inches; brown (10YR 4/3) fine sandy loam; many fine faint light brownish gray (10YR 6/2) and grayish brown (10YR 5/2) mottles; common strata 1 to 4 centimeters in thickness of loamy fine sand; bedding planes evident; weak coarse subangular blocky structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.

Bw2—22 to 62 inches; brown (10YR 5/3) fine sandy loam; common medium distinct yellow (10YR 6/6) mottles; few strata 1 to 4 centimeters in thickness of loamy fine sand and silt loam; weak coarse subangular blocky structure; slightly hard, friable; strongly acid; gradual smooth boundary.

Cg—62 to 80 inches; grayish brown (10YR 5/2) fine sandy loam; few fine distinct yellowish brown (10YR 5/4) mottles; few thin strata of loamy fine sand; massive; slightly hard, friable; neutral.

Bedding planes are evident and strata of contrasting textures are throughout the profile.

The A horizon is brown, dark brown, or grayish brown. Reaction ranges from strongly acid to slightly acid.

The Bw horizon is dark brown, brown, or yellowish brown. It has mottles in shades of brown or gray. It is fine sandy loam, sandy loam, or loamy fine sand. Reaction ranges from strongly acid to slightly acid.

The Cg horizon is light yellowish brown, yellowish brown, pale brown, or grayish brown. It has few or common fine mottles in shades of brown, yellow, or gray. It is dominantly fine sandy loam or loamy fine sand, but it has strata of fine sand in some pedons. Reaction ranges from strongly acid to neutral.

Huntsburg Series

The Huntsburg series consists of very deep, gently sloping, moderately well drained, very slowly permeable soils on uplands. These soils formed in clayey and loamy sediments. Slopes range from 1 to 5 percent.

The soils of the Huntsburg series are fine, mixed, thermic Plinthaquic Paleudalfs.

Typical pedon of Huntsburg loamy fine sand, 1 to 5 percent slopes; from the intersection of Texas Highway 75 and Spur 67 about 6 miles southeast of Madisonville, 1.4 miles east on county road to entrance of rural subdivision, 1.2 miles southeast on county road, 0.9 mile east on subdivision road, and 300 feet south in a forested area:

A—0 to 7 inches; brown (10YR 5/3) loamy fine sand; weak fine granular structure; loose, very friable; many fine roots; slightly acid; clear smooth boundary.

E—7 to 18 inches; light yellowish brown (10YR 6/4) loamy fine sand; weak fine granular structure; loose, very friable; many fine roots; slightly acid; clear smooth boundary.

Bt—18 to 25 inches; yellowish brown (10YR 5/6) sandy clay; many medium prominent red (2.5YR 4/8) and few fine distinct light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; hard, friable; few fine roots; thin patchy clay films on faces of peds; medium acid; gradual smooth boundary.

Btv—25 to 58 inches; mottled dark red (10R 3/6) and gray (10YR 5/1) clay; few fine distinct brownish yellow (10YR 6/8) mottles; weak medium subangular blocky structure; very hard, very firm; about 5 percent, by volume, nodular plinthite and 5 percent, by volume, soft red aggregates grading towards plinthite; thin patchy clay films on faces of peds; few fine roots; very strongly acid; gradual smooth boundary.

BCt—58 to 74 inches; light brownish gray (2.5Y 6/2) clay loam; common medium prominent yellowish red (2.5YR 5/6), few medium prominent light reddish brown (10YR 6/4), and few fine distinct gray (5Y 6/1) mottles; weak medium subangular blocky structure; hard, firm; thin patchy clay films on faces of peds; very strongly acid; gradual smooth boundary.

2C—74 to 80 inches; light olive gray (5Y 6/2) stratified shale and sandstone; massive; very hard, very firm; very strongly acid.

The thickness of the solum ranges from 60 to more than 80 inches. The average content of clay in the upper 20 inches of the argillic horizon is 35 to 45 percent.

The combined thickness of the A and E horizons ranges from 12 to 20 inches. These horizons are medium acid or slightly acid. The E horizon is light yellowish brown, pale brown, or very pale brown.

The Bt horizon is brownish yellow, yellowish brown, or strong brown. It has few to many mottles in shades of red, yellow, brown, or gray, or the matrix is mottled in shades of red, gray, and yellow. The texture is clay loam, sandy clay, or clay. Reaction is very strongly acid or strongly acid.

The Btv horizon is reticulately mottled dark red, red, gray, light gray, light brownish gray, or grayish brown. It has few to many mottles in shades of red, gray, yellow, or brown, or the matrix is mottled in shades of red, gray, and yellow. The texture is clay, sandy clay, or sandy clay loam. The content of plinthite ranges from 5 to 8 percent, by volume. The content of soft red masses ranges from 5 to 20 percent, by volume. Reaction is very strongly acid or strongly acid.

The BC horizon is light gray, light brownish gray, dark grayish brown, light brownish gray, gray, or grayish brown. It has few to many mottles in shades of red, gray, yellow, or brown. The texture is sandy clay loam, sandy clay, or clay loam. Reaction is very strongly acid or strongly acid.

The 2C horizon is light olive gray, olive gray, light gray, very pale brown, strong brown, or dark grayish brown. It has few to many mottles in shades of red, gray, or yellow. It is clay, sandy clay loam, or stratified shale and sandstone. Reaction is very strongly acid or strongly acid.

Jedd Series

The Jedd series consists of moderately deep, strongly sloping, well drained, moderately slowly permeable soils on uplands. These soils formed in weakly cemented sandstone. Slopes range from 5 to 12 percent.

The soils of the Jedd series are fine, mixed, thermic Ultic Paleustalfs.

Typical pedon of Jedd fine sandy loam, 5 to 12 percent slopes; from the intersection of Farm Roads 39 and 1452 at the community of George, 4.8 miles west on Farm Road 1452, about 0.2 mile south on county road, and 60 feet west in an area of native pasture:

A—0 to 5 inches; brown (10YR 5/3) fine sandy loam; weak fine granular structure; slightly hard, friable; common fine roots; about 2 percent, by volume, rounded ironstone pebbles; slightly acid; clear smooth boundary.

Bt—5 to 15 inches; yellowish red (5YR 5/8) clay; moderate medium subangular blocky structure; very hard, very firm; few fine roots; about 2 percent, by volume, rounded ironstone pebbles; continuous clay films on faces of peds; strongly acid; gradual smooth boundary.

BCt—15 to 25 inches; yellowish red (5YR 5/8) sandy clay loam; moderate medium subangular blocky structure; very hard, very firm; patchy clay films on faces of peds; very strongly acid; gradual smooth boundary.

Cr—25 to 60 inches; reddish yellow (7.5YR 6/6) and yellowish red (5YR 5/8), stratified, weakly cemented sandstone; massive; very hard, very firm; few mica flakes; very strongly acid.

The solum ranges from 20 to 40 inches in thickness. The A horizon is brown, pale brown, or yellowish brown. The content of fragments of ironstone ranges from 1 to 5 percent. Reaction ranges from strongly acid to slightly acid. Some pedons have an E horizon, which is thin and discontinuous and has value and chroma slightly higher than in the A horizon.

The Bt horizon is yellowish red, reddish yellow, or red. It has mottles in shades of brown, red, yellow, or gray. The texture is clay or sandy clay. The content of clay ranges from 35 to 50 percent. The content of ironstone fragments is 1 to 3 percent, by volume. Reaction is very strongly acid or strongly acid.

The BC horizon is yellowish red, reddish yellow, or strong brown. It has mottles in shades of red, yellow, or gray. The texture is sandy clay loam or clay loam. Reaction is very strongly acid or strongly acid.

The Cr horizon is reddish yellow, yellowish red, or reddish brown. It is stratified shale and weakly cemented sandstone. The shale has a texture of clay. Few or common flakes of mica are visible mainly along cleavage planes between strata. Reaction is very strongly acid or strongly acid.

Kaufman Series

The Kaufman series consists of very deep, nearly level, somewhat poorly drained, very slowly permeable soils on bottom land. These soils formed in clayey alluvium. Slopes generally are less than 1 percent.

The soils of the Kaufman series are very-fine, montmorillonitic, thermic Typic Pelluderts.

Typical pedon of Kaufman clay, occasionally flooded; from the intersection of Texas Highway 21 and Farm Road 2548 at Midway, 3.9 miles east on Farm Road 2548, about 2.6 miles east on ranch road, and 90 feet south in a pastured area:

Ap—0 to 6 inches; black (10YR 2/1) clay; moderate medium angular blocky and fine subangular blocky structure; very hard, very firm; common fine roots; medium acid; clear smooth boundary.

A—6 to 24 inches; black (10YR 2/1) clay; moderate medium angular blocky structure; very hard, very firm; common fine roots; few fine black ferromanganese concretions; many pressure faces; common very fine reddish iron segregations; neutral; gradual smooth boundary.

Bss1—24 to 41 inches; black (10YR 2/1) clay; common coarse faint very dark gray (10YR 3/1) mottles; strong medium angular blocky structure; very hard, very firm; few fine roots; common fine black ferromanganese concretions and very fine reddish iron segregations; common intersecting slickensides and many shiny pressure faces; neutral; diffuse smooth boundary.

Bss2—41 to 58 inches; black (10YR 2/1) clay; common coarse faint very dark gray (10YR 3/1) mottles; strong medium angular blocky structure; very hard, very firm; few fine roots; common fine black ferromanganese concretions; common intersecting slickensides and many shiny pressure faces; neutral; gradual smooth boundary.

BC—58 to 80 inches; dark brown (10YR 4/3) clay; weak medium angular blocky structure; very hard, very firm; few fine black ferromanganese concretions; very few fine roots; moderately alkaline.

The soil is medium acid to moderately alkaline and is calcareous below a depth of 50 inches in some pedons. Undisturbed areas have gilgai microrelief. Microhighs are 4 to 8 inches higher than microlows. The content of clay in the 10- to 40-inch control section ranges from 60 to 80 percent. Intersecting slickensides begin about 20 inches below the surface. During dry periods cracks 1 to 4 inches wide extend from the surface to a depth of 40 inches or more.

The A horizon is black or very dark gray. In some pedons it has few or common mottles in shades of brown.

The B and BC horizons are black, very dark gray, dark gray, grayish brown, dark grayish brown, very dark grayish brown, or dark brown. They have mottles in shades of brown, yellow, or gray. In some pedons they have few or common concretions of calcium carbonate. Some pedons have sandy clay loam or fine sandy loam below a depth of 80 inches.

Kurten Series

The Kurten series consists of deep, gently sloping, moderately well drained, very slowly permeable soils on uplands. These soils formed in shale and clayey sediments. Slopes range from 1 to 5 percent.

The soils of the Kurten series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Kurten fine sandy loam, 1 to 5 percent slopes; from the intersection of Interstate 45 and Old San Antonio Road about 10 miles north of Madisonville, 1 mile west on Old San Antonio Road, 0.4 mile south on private ranch road, and 1,100 feet southwest in a pastured area:

A—0 to 4 inches; dark brown (10YR 4/3) fine sandy loam; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; medium acid; clear smooth boundary.

E—4 to 8 inches; brown (10YR 5/3) fine sandy loam; weak fine subangular blocky structure; slightly hard, very friable; common fine roots; medium acid; abrupt wavy boundary.

Bt1—8 to 24 inches; dark reddish brown (2.5YR 3/4) clay; few fine prominent light brownish gray (10YR 6/2) mottles; moderate medium angular blocky structure; very hard, very firm; common fine roots; common distinct pressure faces; thin continuous clay films; strongly acid; gradual wavy boundary.

Bt2—24 to 36 inches; red (2.5YR 4/6) clay; common medium distinct light brownish gray (10YR 6/2) and brownish yellow (10YR 6/6) mottles; moderate medium and coarse angular blocky structure; very hard, very firm; few fine roots; few distinct slickensides and common distinct pressure faces; thin continuous clay films; very strongly acid; gradual wavy boundary.

Btss—36 to 51 inches; light brownish gray (10YR 6/2) clay; many medium prominent red (2.5YR 4/6) mottles; weak medium and coarse angular blocky structure; very hard, very firm; few fine roots; few distinct slickensides and pressure faces; thin continuous clay films; very strongly acid; gradual smooth boundary.

BCt—51 to 58 inches; weak red (2.5YR 5/2) clay and stratified shale; thin strata of light brownish gray (10YR 6/2) and brownish yellow (10YR 6/8) shale ¼ to ½ inch thick; weak coarse angular blocky structure; very hard, very firm; thin patchy clay films; strongly acid; clear smooth boundary.

C—58 to 80 inches; stratified reddish brown (2.5YR 5/4) shale that has a texture of clay and light gray (10YR 7/2) very fine sandy loam; massive; strongly acid.

The thickness of the solum ranges from 45 to 60 inches. The boundary between the E and Bt horizons is abrupt over the subsoil crests and clear over the subsoil troughs. The content of clay in the control section ranges from 40 to 60 percent in most pedons.

The combined thickness of the A and E horizons averages less than 10 inches in more than 50 percent of the pedon, but it can be slightly more than 10 inches in subsoil troughs. The A horizon is dark brown, dark grayish brown, brown, or pale brown. It has a few siliceous pebbles in some pedons. It is strongly acid to neutral.

The E horizon is brown, yellowish brown, pale brown, or very pale brown. In some pedons it has been mixed with the A horizon by cultivation. Reaction ranges from strongly acid to slightly acid.

The Bt1 horizon is dark reddish brown, dark red, red, yellowish red, or brown. It has mottles in shades of red, brown, gray, or yellow in some pedons. Reaction is very strongly acid to slightly acid.

The Bt2 and Bt3 horizons have matrix colors in shades of red, brown, yellow, or gray, or they are mottled with these colors. Reaction ranges from very strongly acid to neutral. The number of gypsum crystals ranges from none to common.

The BC horizon is mottled in shades of red, brown, yellow, or gray. The texture is clay or clay loam. Reaction ranges from strongly acid to neutral. The number of gypsum crystals ranges from none to common.

The C horizon is in shades of red, brown, yellow, or gray. It is mostly shale that has a texture of clay but is stratified with silt loam or very fine sandy loam in some pedons. Reaction ranges from strongly acid to mildly alkaline. The number of gypsum crystals ranges from none to common. In a few pedons this horizon has a few concretions of calcium carbonate.

Lufkin Series

The Lufkin series consists of very deep, nearly level, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in clayey terrace sediments (fig. 16). Slopes are 0 to 1 percent.

The soils of the Lufkin series are fine, montmorillonitic, thermic Vertic Albaqualfs.

Typical pedon of Lufkin fine sandy loam, 0 to 1 percent slopes; from the intersection of Texas Highway 21 and Texas Highway 75 in Madisonville, 6.9 miles west on Texas Highway 21, about 0.8 mile south on county road, and 600 feet east in a pastured area:

A—0 to 5 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; hard, friable; common fine roots; few siliceous pebbles; slightly acid; clear smooth boundary.

E—5 to 9 inches; grayish brown (10YR 5/2) fine sandy loam; weak fine granular structure; hard, friable; common fine roots; few siliceous pebbles; medium acid; abrupt wavy boundary.

Btg1—9 to 20 inches; grayish brown (10YR 5/2) clay; common fine distinct light yellowish brown (10YR 6/4) and strong brown (7.5YR 5/6) and few fine prominent red (2.5YR 4/6) mottles; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; common pressure faces; few siliceous pebbles; thin patchy clay films; slightly acid; gradual wavy boundary.

Btg2—20 to 44 inches; gray (10YR 5/1) clay; common coarse faint dark gray (10YR 4/1) mottles; weak medium subangular blocky structure; very hard, very firm; few fine roots; common pressure faces; few siliceous pebbles; thin patchy clay films; strongly acid; gradual wavy boundary.

BCg—44 to 56 inches; light brownish gray (10YR 6/2) clay; weak medium subangular blocky structure and massive; very hard, firm; few pressure faces; few siliceous pebbles; few gypsum crystals; few soft masses of barium salts; moderately alkaline; diffuse smooth boundary.

Cg—56 to 80 inches; light brownish gray (2.5YR 6/2) clay; massive; very hard, very firm; strata of clay loam and thin lenses of very fine sand; few siliceous pebbles; few soft masses of barium salts; few black concretions; moderately alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. Some pedons have a few pebbles throughout.

The A horizon is dark grayish brown, very dark grayish brown, grayish brown, or gray. The E horizon is gray, grayish brown, light gray, or light brownish gray. These horizons are massive and hard when dry but have weak granular structure when moist. Reaction ranges from strongly acid to slightly acid.

The Btg horizon is dark gray, gray, dark grayish brown, grayish brown, or light brownish gray. It has mottles in shades of brown, olive, yellow, or red in most pedons. The content of clay ranges from 35 to 45 percent. Reaction is very strongly acid to mildly alkaline.

The BCg and Cg horizons are in shades of gray and may have mottles in shades of red, yellow, brown, or olive. In most pedons they have concretions of calcium carbonate, gypsum crystals, soft masses of barium salts, or ferromanganese concretions. Reaction ranges from medium acid to moderately alkaline.

Mabank Series

The Mabank series consists of very deep, nearly level, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in alkaline, clayey marine material and in material weathered from shale. Slopes are 0 to 1 percent.

The soils of the Mabank series are fine, montmorillonitic, thermic Vertic Albaqualfs.

Typical pedon of Mabank fine sandy loam, 0 to 1 percent slopes; from the intersection of Texas Highway 21 and Farm Road 1428 about 2.5 miles east of Madisonville, 6.4 miles southeast on Farm Road 1428 and 50 feet south in a pastured area, 150 feet north of a water tank:

A—0 to 10 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

Btg1—10 to 33 inches; black (10YR 2/1) clay; strong medium angular blocky structure; extremely hard, very firm; few fine roots; common siliceous pebbles; few pressure faces; thin patchy clay films; slightly acid; gradual smooth boundary.

Btg2—33 to 45 inches; very dark gray (10YR 3/1) clay; moderate medium angular blocky structure; extremely hard, very firm; few siliceous pebbles; few pressure faces; common thin patchy clay films; neutral; gradual smooth boundary.

BC—45 to 65 inches; dark gray (10YR 4/1) sandy clay loam; common medium faint olive yellow (2.5YR 6/6) mottles; moderate medium subangular blocky structure; very hard, firm; few siliceous pebbles; neutral; gradual smooth boundary.

2C—65 to 80 inches; light brownish gray (2.5Y 6/2), stratified clay and pale yellow (5Y 7/4), weakly cemented sandstone; few barium sulfate crystals; massive; very hard, firm; neutral.

The thickness of the solum ranges from 60 to more than 80 inches. The number of siliceous pebbles is few or common throughout the profile.

The A horizon is very dark grayish brown, dark grayish brown, grayish brown, brown, or very dark gray. Reaction is medium acid or slightly acid.

The Btg horizon is black or very dark gray. Reaction ranges from medium acid to neutral. In some pedons the lower part of this horizon has gypsum crystals.

The BC horizon is dark gray, dark grayish brown, brown, grayish brown, or very dark grayish brown. It has few or common mottles in shades of yellow or brown. It is clay or sandy clay loam. Reaction ranges from medium acid to moderately alkaline.

The 2C horizon is light brownish gray, light gray, or olive yellow. It is clay, or it is shale interbedded with weakly cemented sandstone. Reaction ranges from slightly acid to moderately alkaline.

Nahatche Series

The Nahatche series consists of very deep, nearly level, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in loamy alluvial sediments. They are subject to flooding at least once every 2 years. Slopes are 0 to 1 percent.

The soils of the Nahatche series are fine-loamy, siliceous, nonacid, thermic Aeric Fluvaquents.

Typical pedon of Nahatche loam, frequently flooded; from the intersection of Texas Highway 21 and Farm Road 2346 about 1.5 miles east of Madisonville; 4 miles north on Farm Road 2346; about 0.5 mile east, north, and east on winding county road; and 50 feet north of county road, in an area of hardwoods adjacent to a stream:

A—0 to 8 inches; dark brown (10YR 4/3) loam; weak fine granular structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.

Bg1—8 to 17 inches; dark grayish brown (10YR 4/2) clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; thin strata of fine sandy loam; moderate medium subangular blocky structure; very hard, very firm; common fine roots; slightly acid; clear smooth boundary.

Bg2—17 to 39 inches; dark grayish brown (10YR 4/2) loam; few fine distinct yellowish brown (10YR 5/4) mottles; thin strata of fine sandy loam; weak fine subangular blocky structure; slightly hard, firm; few fine roots; few black spots; few dark concretions; slightly acid; abrupt smooth boundary.

Bg3—39 to 60 inches; grayish brown (10YR 5/2) loam; common medium distinct dark yellowish brown (10YR 4/4) and common medium distinct light brownish gray (10YR 6/2) mottles; weak fine granular structure; slightly hard, firm; slightly acid.

The A horizon is dark brown, brown, or grayish brown. In some pedons it has mottles in shades of brown or yellow. The texture is loam or clay loam. Reaction ranges from strongly acid to neutral.

The Bg horizon is dark grayish brown, grayish brown, light brownish gray, light gray, or dark gray. It has mottles in shades of red, yellow, or brown. Stratified layers of loam, silt loam, sandy clay loam, clay loam, or silty clay loam are common. Thin layers of sandier material also are common. Buried horizons below a depth of 40 inches also are common. Reaction ranges from strongly acid to mildly alkaline. A fluctuating water table is usually encountered in this horizon.

Navasan Series

The Navasan series consists of very deep, very gently sloping, moderately well drained, moderately slowly permeable soils on low terraces. These soils formed in thick beds of sandy material. Slopes range from 1 to 3 percent.

The soils of the Navasan series are loamy, siliceous, thermic Grossarenic Paleustalfs.

Typical pedon of Navasan loamy fine sand, 1 to 3 percent slopes; from the intersection of Texas Highway 21 and Farm Road 2865 about 4 miles west of North Zulch; 2.5 miles north on Farm Road 2865; about 1.1 miles west on county road; 2.5 miles south, west, southwest, southeast, and east on winding ranch road; and 50 feet north of the road:

A—0 to 8 inches; brown (10YR 4/3) loamy fine sand; weak fine granular structure; soft, very friable; common fine and medium roots; slightly acid; clear smooth boundary.

E1—8 to 20 inches; brown (10YR 5/3) loamy fine sand; weak fine granular structure; soft, very friable; few fine and medium roots; medium acid; gradual smooth boundary.

E2—20 to 45 inches; very pale brown (10YR 7/3) loamy fine sand; weak fine granular structure; soft, very friable; few fine roots in the upper part; medium acid; gradual smooth boundary.

Bt/E—45 to 55 inches; yellowish brown (10YR 5/6) fine sandy loam (Bt); about 10 percent, by volume, pockets and tongues about ½ inch to 2 inches wide of grayish brown (10YR 5/2) loamy fine sand (E); weak medium subangular blocky structure; hard, very friable; thin patchy clay films; medium acid; gradual wavy boundary.

Btg—55 to 65 inches; grayish brown (10YR 5/2) sandy clay loam; common medium distinct yellowish brown (10YR 5/8) and common medium prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm; common thin clay films; medium acid; gradual wavy boundary.

BC—65 to 75 inches; mottled yellowish brown (10YR 5/8), light gray (10YR 7/2), and yellowish red (5YR 5/6) fine sandy loam; moderate weak subangular blocky structure; slightly hard, friable; slightly acid.

The solum is more than 80 inches thick. A perched water table is at a depth of 36 to 60 inches during most seasons.

The combined thickness of the A and E horizons is 40 to 60 inches. These horizons are strongly acid to neutral. The E horizon is brown, very pale brown, or light yellowish brown.

The Bt/E horizon is yellowish brown, light yellowish brown, or brownish yellow in the Bt part and grayish brown, light brownish gray, or pale brown in the E part. Reaction is strongly acid or medium acid.

The Bt horizon, if it occurs, is yellowish brown or brownish yellow. The Btg horizon is grayish brown, light gray, or light brownish gray. It has mottles in shades of red, yellow, or gray. It is sandy loam or sandy clay loam. Reaction is strongly acid or medium acid.

The BC horizon is mottled yellowish brown, light gray, yellowish red, or yellow. In some pedons it has very pale brown mottles. Reaction is strongly acid to slightly acid.

Padina Series

The Padina series consists of very deep, gently sloping, well drained, moderately slowly permeable soils on uplands. These soils formed in thick beds of sandy material. Slopes range from 1 to 5 percent.

The 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 Old San Antonio Road and Farm Road 1119 at Elwood, 2.8 miles north on Farm Road 1119 to Tan Yard Community, 1.1 miles southwest and 0.2 mile north along subdivision road, and 50 feet east in a wooded area:

A—0 to 5 inches; brown (10YR 5/3) loamy fine sand; weak fine granular structure; soft, loose; common fine and few medium roots; medium acid; clear smooth boundary.

E—5 to 52 inches; light yellowish brown (10YR 6/4) loamy fine sand; single grained; loose; few fine and medium roots in upper part; medium acid; clear wavy boundary.

Bt1—52 to 62 inches; yellowish red (5YR 5/6) sandy clay loam; many medium distinct red (2.5YR 4/8) and few fine prominent light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; hard, firm; thin patchy clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt2—62 to 80 inches; strong brown (7.5YR 5/6) sandy clay loam; common medium distinct yellowish red (5YR 5/6) and common medium prominent light gray (10YR 7/2) mottles; weak medium subangular blocky structure; hard, firm; few thin patchy clay films; strongly acid.

The solum ranges from 70 to more than 80 inches in thickness.

The combined thickness of the A and E horizons is 40 to 75 inches. These horizons are medium acid to neutral. The A horizon is pale brown, brown, yellowish brown, or dark brown. The E horizon is brownish yellow, very pale brown, or light yellowish brown.

The Bt horizon is sandy clay loam. The content of clay ranges from 20 to 30 percent. This horizon is yellowish brown, brownish yellow, strong brown, reddish yellow, yellowish red, red, or light gray. It has mottles in shades of red, yellow, or gray. Reaction ranges from strongly acid to slightly acid.

Portersprings Series

The Portersprings series consists of very deep, nearly level, moderately well drained, moderately slowly permeable soils on stream terraces. These soils are on the first terrace level along the Trinity River. They formed in loamy alluvial sediments. They are subject to flooding by runoff from higher elevations and to rare flooding by overflow from the Trinity River. Slopes range from 0 to 2 percent.

The soils of the Portersprings series are fine-loamy, siliceous, thermic Aquic Argiudolls.

Typical pedon of Portersprings fine sandy loam, in an area of Gowker-Portersprings complex, 0 to 2 percent slopes; from the intersection of Texas Highway 21 and Farm Road 2548 at Midway, 3.9 miles east on Farm Road 2548, about 0.3 mile east on ranch road, and 1,320 feet southeast of ranch headquarters, in an area of open pasture:

A—0 to 15 inches; very dark grayish brown (10YR 3/2) fine sandy loam; common medium faint brown (10YR 4/3) mottles; weak fine subangular blocky structure parting to weak fine granular; hard, friable; common fine roots; slightly acid; gradual smooth boundary.

Bt1—15 to 34 inches; dark brown (10YR 4/3) sandy clay loam; common medium distinct yellowish brown (10YR 5/6) and few fine prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few thin patchy clay films; slightly acid; gradual smooth boundary.

Bt2—34 to 58 inches; brownish yellow (10YR 6/8) sandy clay loam; common medium distinct red (2.5YR 4/8) and few fine distinct light brownish gray (10YR 6/2) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; few thin patchy clay films; medium acid; gradual smooth boundary.

BC—58 to 80 inches; very pale brown (10YR 7/3) fine sandy loam; common medium distinct yellowish brown (10YR 5/4) and common medium distinct strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; slightly hard, very friable; medium acid.

The thickness of the solum ranges from 60 to 80 inches. The mollic epipedon is 10 to 20 inches thick. The content of clay in the control section ranges from 20 to 35 percent.

The A horizon is dark brown or very dark grayish brown. It has no mottles or few mottles in shades of brown. Reaction is slightly acid to mildly alkaline.

The Bt1 horizon is dark grayish brown, brown, grayish brown, or yellowish brown. It has few or common mottles in shades of brown or red. It has mottles with chroma of 2 or less at a depth of 15 to 30 inches, or it has a matrix with chroma of 2 and has red, yellow, or brown mottles. The texture is loam, sandy clay loam, or clay loam. Reaction ranges from slightly acid to mildly alkaline.

The Bt2 horizon is brownish yellow, yellowish brown, or strong brown. It has few or common mottles in shades of brown or gray. The texture is sandy clay loam or clay loam. This horizon has 0 to 5 percent, by volume, threads and concretions of calcium carbonate in some pedons. Reaction ranges from medium acid to mildly alkaline.

The BC horizon is yellowish brown, brownish yellow, yellow, brown, pale brown, or very pale brown. It has few or common mottles in shades of brown or yellow. The texture is fine sandy loam or loam. Reaction ranges from medium acid to mildly alkaline.

Some pedons have a C horizon. This horizon is loamy fine sand or loamy sand. It has the same colors and reaction as the BC horizon.

Rader Series

The Rader series consists of very deep, very gently sloping, moderately well drained, very slowly permeable soils on terraces and uplands. These soils formed in clayey sediments interbedded with loamy material (fig. 17). Slopes range from 1 to 3 percent.

The soils of the Rader series are fine-loamy, mixed, thermic Aquic Paleustalfs.

Typical pedon of Rader very fine sandy loam, in an area of Rader-Derly complex, 0 to 2 percent slopes; from the junction of Farm Road 2548 and Texas Highway 21 in Midway, 2.3 miles northeast on Texas Highway 21, about 0.3 mile north on an oil well road, and 250 feet east in a pastured area:

A—0 to 6 inches; brown (10YR 4/3) very fine sandy loam; weak fine granular structure; slightly hard, friable; many fine and medium roots; slightly acid; clear smooth boundary.

E—6 to 24 inches; yellowish brown (10YR 5/4) very fine sandy loam; weak fine granular structure; slightly hard, friable; common fine and medium roots; strongly acid; clear smooth boundary.

Bt/E1—24 to 29 inches; strong brown (7.5YR 5/6) very fine sandy loam; weak fine and medium subangular blocky structure; hard, firm; common fine roots; about 45 percent, by volume, light yellowish brown (10YR 6/4) E material; very strongly acid; clear smooth boundary.

Bt/E2—29 to 33 inches; yellow (10YR 7/6) loam; common fine prominent red (2.5YR 4/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; hard, firm; common fine roots; about 30 percent, by volume, very pale brown (10YR 7/4) E material; very strongly acid; clear smooth boundary.

Btg—33 to 45 inches; grayish brown (10YR 5/2) clay; many medium distinct yellowish brown (10YR 5/6) and common fine prominent red (2.5YR 4/8) mottles; moderate medium subangular blocky and angular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; very strongly acid; clear smooth boundary.

Btss—45 to 61 inches; yellowish brown (10YR 5/4) clay loam; many medium distinct grayish brown (10YR 5/2) and few fine distinct reddish yellow (7.5YR 6/8) mottles; moderate medium subangular blocky and angular blocky structure; very hard, very firm; few fine roots; few thin patchy clay films on faces of peds; common slickensides; medium acid; gradual wavy boundary.

BCg—61 to 80 inches; light gray (10YR 7/2) clay loam; many medium distinct strong brown (7.5YR 5/6) and common fine prominent red (2.5YR 4/8) mottles; weak coarse prismatic structure parting to weak medium subangular blocky; very hard, very firm; common brown (10YR 5/3) clay films on vertical faces of peds; moderately alkaline.

The thickness of the solum is 60 to more than 80 inches. The content of clay in the control section ranges from 28 to 35 percent.

The A horizon is brown, dark brown, pale brown, or very pale brown. The texture is fine sandy loam or very fine sandy loam. Reaction ranges from very strongly acid to slightly acid.

The E horizon is light yellowish brown, yellowish brown, brown, very pale brown, or dark yellowish brown. The texture is fine sandy loam or very fine sandy loam. Reaction ranges from very strongly acid to slightly acid.

The Bt/E horizon is 70 to 85 percent Bt material. The Bt part is yellow, yellowish brown, dark yellowish brown, or brownish yellow. It is sandy clay loam or loam. The E part is light yellowish brown, yellowish brown, pale brown, or very pale brown. In some pedons it has few or common mottles in shades of red, brown, or yellow. It is fine sandy loam, very fine sandy loam, or loam. It occurs as coatings on peds and pockets. The amount of E material decreases with increasing depth. Reaction is strongly acid or slightly acid.

The Bt horizon is grayish brown, light brownish gray, gray, yellowish brown, brownish yellow, light olive gray, or light gray. It has few to many mottles in shades of red, gray, brown, or yellow. The texture is clay, sandy clay, or clay loam. The content of clay ranges from 35 to 50 percent. Reaction is very strongly acid or strongly acid.

The BC horizon is light brownish gray, pale brown, grayish brown, light brownish gray, very pale brown, or light gray. It is sandy clay loam, sandy clay, or clay loam. Reaction ranges from strongly acid to moderately alkaline.

Robco Series

The Robco series consists of very deep, very gently sloping, moderately well drained, slowly permeable soils on uplands. These soils formed in loamy and clayey deposits. Slopes range from 1 to 3 percent.

The soils of the Robco series are loamy, mixed, thermic Aquic Arenic Paleustalfs.

Typical pedon of Robco loamy fine sand, 1 to 3 percent slopes; from the intersection of Old San Antonio

Road and Farm Road 1119 at Elwood, about 2.0 miles north on Farm Road 1119 and 0.5 mile east in a pastured area:

A—0 to 8 inches; brown (10YR 5/3) loamy fine sand; weak fine granular structure; soft, very friable; many fine roots; strongly acid; clear smooth boundary.

E—8 to 24 inches; very pale brown (10YR 7/4) loamy fine sand; single grained; loose, very friable; many fine roots; medium acid; clear smooth boundary.

Bt/E—24 to 28 inches; brownish yellow (10YR 6/6) loam (Bt); pockets and streaks of very pale brown (10YR 7/3) loamy fine sand (E); weak fine granular structure; slightly hard, friable; common fine roots; medium acid; diffuse irregular boundary.

Btg—28 to 45 inches; grayish brown (10YR 5/2) sandy clay loam; common medium distinct reddish yellow (7.5YR 6/6) and few medium prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; few fine pores; continuous clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt—45 to 73 inches; pale brown (10YR 6/3) sandy clay loam; common medium faint light gray (10YR 6/1) and few coarse prominent red (2.5YR 5/8) mottles; weak medium subangular blocky structure; hard, firm; few fine pores; continuous clay films on faces of peds; few crystals of calcium sulfate; very strongly acid; clear smooth boundary.

BC—73 to 80 inches; white (10YR 8/2) sandy clay loam; few coarse distinct yellow (10YR 7/6) mottles; weak coarse prismatic structure; slightly hard, friable; neutral.

The thickness of the solum ranges from 60 to more than 80 inches. The average content of clay in the upper 20 inches of the argillic horizon is 35 to 60 percent.

The combined thickness of the A and E horizons ranges from 20 to 40 inches. These horizons are strongly acid to slightly acid. The A horizon is brown, pale brown, light yellowish brown, or dark yellowish brown. The E horizon is very pale brown, yellowish brown, light yellowish brown, or pale brown. It has few or common mottles in shades of brown.

The Bt/E horizon is 60 to 90 percent, by volume, Bt material. The Bt part is sandy clay loam, loam, or clay loam. It is brownish yellow or yellowish brown. The E part is loamy fine sand or fine sand. The tongues and interfingers of E material are very pale brown, light gray, or pale brown. The mottles in this horizon are in shades of gray, yellow, or red. Reaction is very strongly acid to medium acid.

The Bt horizon is grayish brown, brown, pale brown, light gray, light brownish gray, or gray. It has few to many mottles in shades of red, yellow, brown, or gray, or the matrix is mottled in shades of red, gray, and yellow. The content of clay ranges from 25 to 35 percent in the upper 20 inches of the argillic horizon. The texture is loam or sandy clay loam in the upper part of the argillic horizon and loam, sandy clay loam, or clay loam in the lower part. In some pedons the lower part of the horizon has interfingering and tonguing of E material. Reaction ranges from very strongly acid to slightly acid.

The BC horizon is grayish brown, brown, pale brown, light brownish gray, or light gray. It has few to many mottles in shades of red, gray, yellow, or brown. The texture is sandy clay loam, clay loam, clay, or sandy loam. Reaction ranges from very strongly acid to neutral.

Rosanky Series

The Rosanky series consists of very deep, gently sloping, well drained, slowly permeable soils on uplands. These soils formed in stratified, loamy and clayey coastal plain deposits. Slopes range from 1 to 5 percent.

The soils of the Rosanky series are fine, mixed, thermic Ultic Paleustalfs.

Typical pedon of Rosanky fine sandy loam, 1 to 5 percent slopes; from the intersection of Texas Highway 75 and Old San Antonio Road at Cross Roads, 3.7 miles east on Old San Antonio Road and 100 feet north in a pastured area:

A—0 to 5 inches; dark brown (7.5YR 4/4) fine sandy loam; weak fine granular structure; slightly hard, very friable; common fine roots; about 6 percent, by volume, ironstone pebbles; medium acid; clear smooth boundary.

Bt1—5 to 20 inches; red (2.5YR 4/6) clay; few fine distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; continuous thin clay films; strongly acid; gradual smooth boundary.

Bt2—20 to 39 inches; red (2.5YR 4/6) clay; common medium prominent brown (10YR 5/3) mottles; moderate medium subangular blocky structure; very hard, very firm; few fine roots; continuous thin clay films; very strongly acid; gradual smooth boundary.

BCt—39 to 50 inches; red (2.5YR 4/6) clay loam; common medium prominent grayish brown (10YR 5/2) and common medium distinct brownish yellow (10YR 6/6) mottles; weak medium subangular blocky structure; hard, firm; few fine roots; common thin clay films; very strongly acid; gradual smooth boundary.

C—50 to 64 inches; red (2.5YR 4/6) clay loam stratified with thin layers of fine sandy loam; common medium prominent grayish brown (10YR 5/2) and few medium distinct brownish yellow (10YR 6/6) mottles; hard, very firm; few thin clay films in fractures; very strongly acid; clear smooth boundary.

Cr—64 to 80 inches; very pale brown (10YR 7/3) and red (2.5YR 4/6), stratified, weakly consolidated, cemented sandstone; very hard, very firm; few flakes of mica; strongly acid.

The solum ranges from 40 to 60 inches in thickness.

The A horizon is fine sandy loam or gravelly fine sandy loam. The content of gravel ranges from less than 1 percent to as much as 35 percent. The A horizon is dark brown or brown. Reaction ranges from strongly acid to slightly acid.

The Bt horizon is red or yellowish red. It has few or common mottles in shades of yellow, gray, brown, or red. The texture is clay, sandy clay, or clay loam. Reaction is strongly acid or medium acid.

The BC and C horizons are light gray, light brownish gray, very pale brown, red, yellowish brown, or yellowish red. The texture is fine sandy loam, sandy clay loam, or clay loam. Reaction is strongly acid or medium acid.

The Cr horizon is weakly consolidated to strongly consolidated, cemented sandstone. It is in shades of brown, red, or gray. The texture is fine sandy loam or sandy clay loam. This horizon is extremely hard when dry. Reaction is strongly acid or medium acid.

Silawa Series

The Silawa series consists of very deep, gently sloping, well drained, moderately permeable soils on stream terraces. These soils formed in sandy and loamy deposits. Slopes range from 1 to 5 percent.

The soils of the Silawa series are fine-loamy, siliceous, thermic Ultic Haplustalfs.

Typical pedon of Silawa fine sandy loam, 1 to 5 percent slopes; from the intersection of Texas Highway 21 and Farm Road 1452 about 1 mile west of Madisonville, 0.5 mile south on Farm Road 1452, about 1.3 miles east on ranch road, and 600 feet north in a pastured area:

A—0 to 5 inches; brown (7.5YR 5/4) fine sandy loam; weak fine granular structure; slightly hard, very friable; many fine roots; medium acid; clear smooth boundary.

E—5 to 10 inches; strong brown (7.5YR 5/6) fine sandy loam; weak fine granular structure; slightly hard, very friable; many fine roots; medium acid; clear smooth boundary.

Bt1—10 to 24 inches; red (2.5YR 4/6) sandy clay loam; moderate medium subangular blocky structure; very hard, firm; common fine roots; common fine pores; common thin clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt2—24 to 41 inches; red (2.5YR 4/8) sandy clay loam; moderate medium subangular blocky structure; hard, firm; common fine roots; common fine pores; common thin clay films on faces of peds; very strongly acid; gradual smooth boundary.

BC—41 to 57 inches; red (2.5YR 5/8) sandy clay loam; weak coarse prismatic structure parting to weak medium subangular; hard, firm; few fine roots; very strongly acid; gradual smooth boundary.

C—57 to 80 inches; yellowish red (5YR 5/8) fine sandy loam; common medium distinct reddish yellow (7.5YR 6/6) mottles; massive; slightly hard, very friable; strongly acid.

The thickness of the solum ranges from 50 to more than 65 inches. Some pedons have a few siliceous pebbles throughout.

The A horizon is brown or dark yellowish brown. The E horizon is strong brown, reddish yellow, or light yellowish brown. These horizons are strongly acid to slightly acid.

The content of clay in the control section, or the upper 20 inches of the Bt horizon, ranges from 18 to 35 percent. This horizon is very strongly acid to medium acid.

The BC and C horizons have colors similar to those of the Bt horizon. The texture is sandy clay loam, sandy loam, fine sandy loam, or loamy fine sand. Reaction is strongly acid or medium acid.

Silstid Series

The Silstid series consists of very deep, gently sloping, well drained, moderately permeable soils on uplands. These soils formed in beds of sandy or loamy material and interbedded sandstones. Slopes range from 1 to 5 percent.

The soils of the Silstid series are loamy, siliceous, thermic Arenic Paleustalfs.

Typical pedon of Silstid loamy fine sand, 1 to 5 percent slopes; from the intersection of Farm Road 39 and Old San Antonio Road in Normangee, 0.1 mile east on Old San Antonio Road, 1.3 miles east and south on county road, 800 feet west on private road, and 300 feet south in a pastured area:

A—0 to 8 inches; brown (10YR 4/3) loamy fine sand; weak fine granular structure; soft, very friable; common fine roots; medium acid; clear smooth boundary.

E—8 to 32 inches; light yellowish brown (10YR 6/4) loamy fine sand; weak fine granular structure; soft, very friable; common fine roots; medium acid; clear smooth boundary.

Bt1—32 to 52 inches; yellowish brown (10YR 5/6) sandy clay loam; few medium distinct yellowish red (5YR 4/6) and common medium faint brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; very hard, friable; few fine roots; common thin clay films on faces of peds; medium acid; gradual wavy boundary.

Bt2—52 to 60 inches; brownish yellow (10YR 6/6) sandy clay loam; common medium prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; very hard, friable; common medium very pale brown (10YR 7/3) pockets of uncoated sand; few fine roots; thin patchy clay films on faces of peds; medium acid; gradual wavy boundary.

Bt3—60 to 80 inches; mottled brownish yellow (10YR 6/8), red (2.5YR 4/8), and light gray (10YR 7/2) sandy clay loam; weak fine subangular blocky structure; slightly hard, friable; thin patchy clay films on faces of peds; medium acid.

The thickness of the solum ranges from 60 to more than 80 inches.

The combined thickness of the A and E horizons ranges from 20 to 40 inches. These horizons are medium acid to neutral. The A horizon is dark brown, brown, or yellowish brown. The E horizon is light yellowish brown, very pale brown, or pale brown.

The Bt horizon is brownish yellow, yellowish brown, light yellowish brown, or strong brown. It has mottles in shades of red throughout. In a few pedons it has mottles in shades of gray in the lower part. In some pedons it has streaks or pockets of uncoated sand in the lower part. The texture is sandy clay loam, loam, or fine sandy loam. The content of clay ranges from 18 to 32 percent. Reaction ranges from strongly acid to slightly acid.

Some pedons have a C horizon below a depth of 60 inches. This horizon is fine sandy loam.

Spiller Series

The Spiller series consists of very deep, very gently sloping, moderately well drained, slowly permeable soils on uplands. These soils formed in thinly stratified, loamy and shaly deposits. Slopes range from 1 to 3 percent.

The soils of the Spiller series are fine, mixed, thermic Ultic Paleustalfs.

Typical pedon of Spiller fine sandy loam, 1 to 3 percent slopes; from the intersection of Texas Highway 75 and Interstate 45 about 4 miles north of Madisonville, 1.9 miles northwest on west access road of Interstate 45, about 0.9 mile west and northwest on county road to ranch headquarters, 3.7 miles west and north on private ranch road, and 950 feet north in an area of improved pasture:

A—0 to 7 inches; dark brown (10YR 4/3) fine sandy loam; weak fine and medium subangular blocky structure; slightly hard, very friable; common fine and medium roots; neutral; clear smooth boundary.

E—7 to 14 inches; brown (10YR 5/3) fine sandy loam; weak fine and medium subangular blocky structure; slightly hard, very friable; common fine and medium roots; neutral; clear smooth boundary.

Bt1—14 to 22 inches; yellowish brown (10YR 5/6) clay loam; common medium distinct reddish brown (5YR 4/4) mottles; moderate medium subangular blocky structure; hard, friable; common fine roots; many thin continuous clay films; strongly acid; gradual smooth boundary.

Bt2—22 to 39 inches; yellowish brown (10YR 5/8) clay; common medium distinct red (2.5YR 4/6) mottles; strong fine and medium subangular blocky structure; hard, very firm; few fine roots; common thin continuous clay films; medium acid; gradual smooth boundary.

BC—39 to 56 inches; yellowish brown (10YR 5/4) clay; few fine distinct grayish brown (10YR 5/2) and few fine distinct yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; hard, firm; few hard black concretions; neutral; gradual smooth boundary.

C—56 to 80 inches; weakly consolidated, 1- to 2-inch-thick strata of yellowish brown (10YR 5/8) clay loam and light gray (10YR 7/2 and 6/1) shale that has a texture of clay; massive; neutral.

The thickness of the solum ranges from 40 to more than 60 inches. The content of clay in the control section ranges from 35 to 45 percent.

The combined thickness of the A and E horizons is 10 to 20 inches. These horizons are medium acid to neutral. The A horizon is brown or yellowish brown. The E horizon is brown, pale brown, or light yellowish brown.

The Bt horizon is yellowish brown or brownish yellow. It has few to many mottles in shades of red, yellow, or brown. In some pedons it has mottles in shades of gray in the lower part. The texture is clay loam or clay. Reaction is strongly acid or medium acid.

The C horizon is olive brown, yellowish brown, light yellowish brown, very pale brown, light gray, light brownish gray, or pale brown. It is dominantly loam, sandy clay loam, or clay loam but has strata of gray shale that has a texture of clay. The strata are 1 to 5 inches thick. Reaction is strongly acid to moderately alkaline.

Tabor Series

The Tabor series consists of very deep, very gently sloping, moderately well drained, very slowly permeable soils on uplands. These soils formed in interbedded clayey and loamy material. Slopes range from 1 to 3 percent.

The soils of the Tabor series are fine, montmorillonitic, thermic Udertic Paleustalfs.

Typical pedon of Tabor fine sandy loam, 1 to 3 percent slopes; from intersection of Farm Roads 1428 and 247 at the Ferguson State Prison Farm, 2.1 miles northwest on Farm Road 247, about 1.3 miles south and west on county road, and 100 feet south in a wooded area:

A—0 to 7 inches; brown (10YR 4/3) fine sandy loam; weak fine granular structure; hard, very friable; many fine roots; medium acid; clear smooth boundary.

E—7 to 14 inches; light yellowish brown (10YR 6/4) fine sandy loam; weak fine granular structure; hard, very friable; common fine roots; few fine pores; medium acid; abrupt wavy boundary.

Bt1—14 to 20 inches; yellowish brown (10YR 5/6) clay; many medium prominent red (2.5YR 4/6) and few fine distinct grayish brown (10YR 5/2) mottles; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; few fine pores; common pressure faces; continuous clay films on faces of peds; strongly acid; gradual wavy boundary.

Bt2—20 to 43 inches; yellowish brown (10YR 5/6) clay; common medium distinct light brownish gray (10YR 6/2) mottles; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; common pressure faces; continuous clay films on faces of peds; slightly acid; gradual wavy boundary.

Bt3—43 to 58 inches; light olive brown (2.5Y 5/4) clay; moderate medium angular blocky structure; extremely hard, very firm; few fine roots; few fine pores; few black stains on faces of peds; common pressure faces; continuous clay films on faces of peds; moderately alkaline; gradual wavy boundary.

BCt—58 to 70 inches; light yellowish brown (2.5Y 6/4) sandy clay loam; common medium distinct brownish yellow (10YR 6/6) mottles; moderate medium angular blocky structure; very hard, very firm; few pressure faces; thin patchy clay films on faces of peds; moderately alkaline; gradual wavy boundary.

C—70 to 80 inches; light brownish gray (2.5Y 6/2) clay; massive; extremely hard, very firm; common white salts and concretions of calcium carbonate in the upper part; moderately alkaline.

The thickness of the solum ranges from 40 to 70 inches. Base saturation is more than 75 percent in some part of the Bt horizon.

The combined thickness of the A and E horizons is more than 10 inches. These horizons are strongly acid to slightly acid. The A horizon is dark brown or brown. The E horizon is brown, pale brown, or light yellowish brown. In some pedons these horizons have rounded siliceous pebbles.

The Bt horizon is light yellowish brown, brownish yellow, or yellowish brown. It has many mottles in shades of red, yellow, brown, or gray. The lower part of this horizon is mottled in shades of brown, yellow, or gray. The upper part is very strongly acid or strongly acid and has 40 to 55 percent clay. The lower part is slightly acid to moderately alkaline and has 35 to 50 percent clay.

The BC and C horizons are strongly acid to mildly alkaline. Some pedons have gypsum crystals and concretions of calcium carbonate in the lower part. The C horizon is clay, clay loam, or sandy clay. In some pedons it has thin strata of shale and weakly cemented sandstone. It has concretions of calcium carbonate in the upper part in some pedons.

Tonkavar Series

The Tonkavar series consists of very deep, gently sloping to moderately sloping, well drained, moderately permeable soils on uplands. These soils formed in sandy marine deposits. Slopes range from 1 to 8 percent.

The soils of the Tonkavar series are loamy, siliceous, thermic Grossarenic Paleudalfs.

Typical pedon of Tonkavar loamy fine sand, 1 to 8 percent slopes; from the intersection of Texas Highway 75 and Spur 67 about 6 miles southeast of Madisonville, 4.5 miles east and south on county road and 150 feet south in an area of woodland:

A—0 to 6 inches; brown (10YR 4/3) loamy fine sand; single grained; soft, very friable; common fine roots; few siliceous pebbles; slightly acid; clear smooth boundary.

E—6 to 48 inches; pale brown (10YR 6/3) loamy fine sand; single grained; soft, very friable; common fine and medium roots; few siliceous pebbles; strongly acid; abrupt smooth boundary.

Bt1—48 to 54 inches; strong brown (7.5YR 5/8) sandy clay loam; common medium distinct grayish brown (10YR 5/2) and common fine distinct brownish yellow (10YR 6/6) mottles; moderate medium subangular blocky structure; hard, firm; few fine roots; few patchy clay films; very strongly acid; gradual wavy boundary.

Bt2—54 to 60 inches; strong brown (7.5YR 5/6) sandy clay loam; common medium distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; few fine roots; few patchy clay films; thin reddish films along old root channels; very strongly acid; gradual wavy boundary.

BC—60 to 72 inches; strong brown (7.5YR 5/6) sandy loam; weak fine granular structure; hard, friable; few fine roots; thin reddish clay films along old root channels; very strongly acid; abrupt smooth boundary.

Cr—72 to 80 inches; reddish yellow (7.5YR 7/6), weakly cemented sandstone; extremely firm; few fine roots along fractures; very strongly acid.

The thickness of the solum, or the depth to paralithic contact with weakly cemented sandstone, ranges from 60 to 80 inches.

The A horizon is brown or pale brown. Reaction is medium acid to neutral.

The E horizon is pale brown, very pale brown, pinkish gray, or pinkish white. It has a few thin lamellae of fine sandy loam in the lower part of most pedons. Reaction is strongly acid to slightly acid.

The Bt horizon is strong brown or yellowish brown. It has few to many mottles in shades of red, gray, brown, or yellow. The texture is sandy clay loam or clay loam. Reaction is very strongly acid to medium acid.

The BC horizon, if it occurs, is strong brown or yellowish brown. It is sandy loam or loamy sand. It is very strongly acid or strongly acid.

The Cr horizon is reddish yellow, very pale brown, yellow, or brownish yellow. It is weakly cemented to strongly cemented, fractured sandstone. It can be dug with a hand auger when moist, but it is hard when dry. Roots are only in the fractures. This horizon is very strongly acid or strongly acid.

Wilson Series

The Wilson series consists of very deep, nearly level, somewhat poorly drained, very slowly permeable soils on ancient terraces and uplands. These soils formed in clayey deposits. Slopes are 0 to 1 percent.

The soils of the Wilson series are fine, montmorillonitic, thermic Vertic Ochraqualfs.

Typical pedon of Wilson loam, 0 to 1 percent slopes; from the intersection of Texas Highway 21 and Farm Road 2548 in Midway, 2.8 miles northeast on Texas Highway 21 and 200 feet southeast in a pastured area:

A—0 to 6 inches; very dark gray (10YR 3/1) loam; weak fine granular structure, massive when dry; very hard, firm; common fine roots; medium acid; clear smooth boundary.

Bt—6 to 21 inches; black (10YR 2/1) clay; few fine faint reddish brown (5YR 4/3) mottles; strong medium angular blocky structure; extremely hard, very firm; few fine roots; common pressure faces; thin continuous clay films on peds; slightly acid; gradual wavy boundary.

Btg1—21 to 43 inches; very dark gray (5Y 3/1) clay; few fine faint reddish brown (5YR 4/3) mottles; strong medium angular blocky structure; very hard, very firm; few fine roots; common pressure faces; thin continuous clay films on peds; neutral; gradual wavy boundary.

Btg2—43 to 58 inches; dark grayish brown (2.5Y 4/2) clay; few medium distinct light yellowish brown (2.5Y 6/4) mottles; moderate medium angular blocky structure; very hard, very firm; few fine roots; patchy clay films on peds; moderately alkaline; gradual wavy boundary.

BC—58 to 80 inches; light olive brown (2.5YR 5/4) clay; common medium distinct grayish brown (10YR 5/2) mottles; massive; very hard, very firm; about 1 percent, by volume, concretions of calcium carbonate; noncalcareous matrix; moderately alkaline.

The thickness of the solum ranges from 60 to 80 inches.

The A horizon is black, very dark gray, or dark gray. It is hard or very hard when dry. Reaction ranges from medium acid to neutral.

The Bt horizon is very dark gray, black, or dark gray. In some pedons it has a few mottles in shades of brown or yellow. The texture is clay or clay loam. The content of clay ranges from 35 to 60 percent. Reaction ranges from medium acid to moderately alkaline.

The Btg1 and Btg2 horizons are dark gray, light brownish gray, gray, very dark gray, or dark grayish brown. In some pedons they have mottles in shades of olive, brown, or yellow. In some pedons they have gypsum crystals and concretions of calcium carbonate in the lower part. Reaction ranges from neutral to moderately alkaline.

The BC horizon is in shades of gray or brown. It has few to many mottles in shades of brown, yellow, red, or olive. Reaction ranges from neutral to moderately alkaline. In some pedons this horizon has concretions and soft masses of calcium carbonate and gypsum.

Zack Series

The Zack series consists of moderately deep, gently sloping and moderately sloping, moderately well drained, very slowly permeable soils on uplands. These soils formed in clayey and loamy, shaly deposits. Slopes are dominantly 1 to 5 percent, but range from 1 to 8 percent.

The soils of the Zack series are fine, montmorillonitic, thermic Aquic Paleustalfs.

Typical pedon of Zack fine sandy loam, 1 to 5 percent slopes; from the intersection of Farm Road 1428 and Texas Highway 21 about 2.5 miles east of Madisonville, 5.6 miles southeast on Farm Road 1428, about 300 feet east on an oil well road, and 20 feet south, next to a fence in a pastured area:

A—0 to 7 inches; yellowish brown (10YR 5/4) fine sandy loam; weak fine granular structure; slightly hard, friable; common fine roots; common fine pores; few siliceous pebbles; medium acid; abrupt wavy boundary.

Bt1—7 to 24 inches; yellowish red (5YR 5/6) clay; common medium distinct olive yellow (2.5Y 6/6) mottles; moderate medium angular blocky structure; extremely hard, very firm; common fine roots; common fine pores; common thin clay films; few siliceous pebbles; strongly acid; gradual wavy boundary.

Bt2—24 to 30 inches; light olive brown (2.5Y 5/4) clay; few fine distinct grayish brown (10YR 5/2) and few common prominent yellowish red (5YR 5/6) mottles; moderate medium angular blocky structure; extremely hard, very firm; few fine pores; common thin clay films; medium acid; gradual wavy boundary.

BC—30 to 36 inches; light yellowish brown (2.5Y 6/4) clay; few fine prominent yellowish red (5YR 5/6) and few fine distinct brown (10YR 5/2) mottles; weak medium subangular blocky structure; extremely hard, very firm; moderately alkaline; clear wavy boundary.

C—36 to 80 inches; light gray (5Y 7/2), stratified shale that has a texture of clay; massive; hard, firm; moderately alkaline.

The thickness of the solum ranges from 25 to 40 inches.

The A horizon is yellowish brown, brown, dark brown, grayish brown, dark grayish brown, or very dark grayish brown. It has few or common siliceous pebbles in most pedons. Reaction is strongly acid or medium acid.

The Bt1 horizon is yellowish red, red, reddish brown, dark red, or dark reddish brown. In some pedons the matrix is mottled in these colors. This horizon has few to many mottles in shades of gray, yellow, or brown. The content of clay ranges from 40 to 55 percent. The number of small slickensides or pressure faces ranges from none to common. This horizon has few or common siliceous pebbles in some pedons. Reaction ranges from strongly acid to neutral.

The Bt2 horizon is light olive brown, dark grayish brown, very dark grayish brown, dark gray, gray, light yellowish brown, light gray, pale olive, or light olive gray. It has few or common mottles in shades of brown, gray, or red. The texture is clay, silty clay, or clay loam. This horizon has few or no concretions of calcium carbonate. Reaction ranges from medium acid to moderately alkaline.

The BC horizon is light yellowish brown, olive yellow, grayish brown, light olive brown, light brownish gray, pale olive, pale yellow, olive, light gray, or olive yellow. It has few or common mottles in shades of brown, gray, or yellow. The number of calcium carbonate concretions ranges from none to common. The texture is silty clay loam, clay loam, or sandy clay loam. This horizon has few or no threads and masses of salts. Reaction ranges from neutral to moderately alkaline.

The C horizon is light gray, pale olive, grayish brown, olive, light brownish gray, light gray, light yellowish brown, or yellow. The parent material is mainly weakly consolidated shale that has a texture of clay loam, silty clay loam, or clay. Reaction is neutral to moderately alkaline.

Zulch Series

The Zulch series consists of moderately deep, very gently sloping, somewhat poorly drained, very slowly permeable soils that formed in clayey deposits (fig. 18). These soils are on plane to slightly convex uplands. Slopes are 1 to 3 percent.

The soils of the Zulch series are fine, montmorillonitic, thermic Vertic Albaqualfs.

Typical pedon of Zulch fine sandy loam, 1 to 3 percent slopes; from the intersection of Farm Roads 1428 and 247 at the Ferguson State Prison Farm, 1.8 miles north on Farm Road 247 and 90 feet west of a boundary fence, in a pastured area:

Ap—0 to 9 inches; brown (10YR 5/3) fine sandy loam; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable; many fine roots; few siliceous pebbles; medium acid; abrupt smooth boundary.

Btg1—9 to 18 inches; very dark gray (10YR 3/1) clay loam; moderate medium angular blocky structure; extremely hard, very firm; many fine roots; few siliceous pebbles; common pressure faces; many pores; few thin patchy clay films; neutral; gradual wavy boundary.

Btg2—18 to 35 inches; dark gray (10YR 4/1) clay loam; moderate coarse angular blocky structure; extremely hard, very firm; common fine roots; common pressure faces; few thin patchy clay films; few siliceous pebbles; moderately alkaline; gradual smooth boundary.

Bt/C—35 to 41 inches; very dark gray (10YR 3/1) clay (Bt); weak medium angular blocky structure; very hard, very firm; few fine roots; few fine concretions of calcium carbonate; few thin patchy clay films; about 40 percent, by volume, light brownish gray (2.5Y 6/2) fragments (C); moderately alkaline; gradual smooth boundary.

C/B—41 to 47 inches; light brownish gray (2.5Y 6/2) clay (C); few medium distinct brownish yellow (10YR 6/8) mottles; weak medium angular blocky and subangular blocky structure; very hard, very firm; few fine segregations of calcium carbonate along cracks; about 30 percent, by volume, dark gray (10YR 4/1) material (B); moderately alkaline; clear smooth boundary.

C—47 to 60 inches; pale olive (5Y 6/3), weakly consolidated shale that has a texture of clay; few fine segregations of calcium carbonate along cracks; moderately alkaline.

The thickness of the solum ranges from 30 to 50 inches. The number of masses of salts and carbonate concretions is common or many at the contact with the C horizon. Cracks are evident in the Bt horizon during the major part of dry periods. The soil has few or no siliceous pebbles throughout.

The A horizon is brown, very dark grayish brown, very pale brown, or dark brown. Reaction ranges from medium acid to neutral.

The Btg1 horizon is very dark gray, very dark brown, dark gray, very dark grayish brown, or dark grayish brown. It has few or common mottles in shades of brown or red. The texture is clay or clay loam. Reaction ranges from medium acid to neutral.

The Btg2 horizon is dark gray, black, dark grayish brown, very dark gray, or very dark grayish brown. It has no mottles or few or common mottles in shades of brown or red. The texture is clay or clay loam. Reaction ranges from slightly acid to moderately alkaline.

The B/C or C/B horizon is very dark gray, light brownish gray, dark gray, grayish brown, light yellowish brown, or dark grayish brown. It has no mottles or few or common mottles in shades of brown or yellow. It is clay or clay loam. It has few or no masses of salts and calcium carbonate. Reaction ranges from neutral to moderately alkaline.

The C horizon is soft shale having a texture of clay or clay loam and thinly bedded, weakly cemented siltstone. It is pale olive, light olive gray, light olive brown, olive, light brownish gray, grayish brown, or light yellowish brown. It has no mottles or few or common mottles in shades of brown, yellow, olive, or gray. It has few or common crystals of gypsum, barite, and calcium carbonate. Reaction ranges from neutral to moderately alkaline.

Formation of the Soils

In this section the factors of soil formation are related to the formation of soils in Madison County. Also, processes of horizon differentiation and the surface geology of the county are described.

Factors of Soil Formation

Soil is formed by the action of soil-forming processes on material deposited or accumulated by geological forces. The characteristics of a soil depend on the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the forces of soil development have acted on the soil material.

All five of these factors are important in the genesis of each soil. Some, however, have had more influence than others on a given soil.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It affects the chemical and mineral composition of the soil. In Madison County it consists of unconsolidated, sandy, loamy, and clayey sediments deposited by water during the Eocene, Pleistocene, and Holocene ages. The deposits of Eocene age are the Cook Mountain and Yegua Formations. Soils in the uplands formed in material from these formations. The deposits of Pleistocene age are sediments on the different fluviatile terrace levels along the Trinity and Navasota Rivers. The deposits of Holocene age include the recent alluvial deposits on bottom land along the Trinity and Navasota Rivers and the many smaller streams in the county.

The relationship between parent material and the different soils in the county is described in detail under the heading "Surface Geology."

Climate

The climate of the county is warm and humid. Rainfall, evaporation, and temperature are the main climatic factors influencing soil formation. Because of differences in rainfall and evaporation, the soils in the county are divided into two groups. The transition between the two groups occurs in the southeastern part of the county and zigzags from the northeast to the southwest. The soils in most of the county are in the drier or subhumid group. The soils in the southeastern part of the county are in the moister or humid group. This difference in moisture content over a short distance results in soils that have similar physical features and chemical properties but that formed under different vegetation. Because of the climatic changes, the natural vegetation changes gradually from east to west throughout the county. Also, the effects of rainfall are modified locally by runoff caused by slope.

Plant and Animal Life

Plants, insects, earthworms, animals, micro-organisms, and other living organisms, including humans, have contributed to the formation of the soils. Gains in content of organic matter and nitrogen in the soil, gains and losses in content of plant nutrients, and changes in structure and porosity are caused by plants, animals, and humans.

Tall grasses have had more influence on soil formation than other plants in the prairies of Madison County. They provide litter that protects the surface and adds organic matter to dark soils. The roots of grasses reach deeply into the soil to utilize nutrients and moisture. Minerals and organic matter are distributed throughout the soil as plants die and decompose. The decomposed plants leave pores and channels that increase the rate of water intake and the extent of aeration of the soil. Earthworms and other soil organisms feed on the decomposed roots. The borings of the earthworms also help channel air and water through the soil.

Pines, hardwoods, grasses, and shrubs have played a major role in soil formation in the areas of post oak savannah and post oak forest. Organic matter accumulates in the upper several inches of the soil. It is quickly destroyed if the soil is cultivated. The soils in the areas of post oak savannah and post oak forest have a light colored surface layer and are acid in the upper part of the subsoil.

Human activities, such as tillage, and livestock grazing have influenced soil formation. Much of the acreage of the savannahs and the prairies has been cultivated. Tillage practices that provided inadequate soil protection have increased the rate of runoff and the amount of erosion and reduced the content of organic matter. Tillage and continuous grazing have compacted clayey soils and reduced the degree of aeration and the rate of water infiltration and the permeability. All of these changes have affected the productivity of the soils and can have some affect on the future development of the soils.

Relief

Relief, or topography, influences soil formation through its effect on drainage, runoff, and depth of penetration by soil moisture.

The topography of the county ranges from nearly level to moderately steep. The nearly level areas consist of flood plains throughout the county and terraces in the eastern and western parts. The more sloping areas are mostly higher on the landscape than the nearly level areas.

If other factors are equal, the degree of soil profile development depends on the amount and depth of penetration by soil moisture. The more often a soil passes through a wetting and drying cycle, the greater and more distinct is the soil development.

Soils on a nearly level landscape tend to have marked differences in soil development. Soils in nearly level areas that are poorly drained and that remain saturated much of the time generally do not have pronounced horizonation. For example, the Gladewater and Derly soils are nearly level and have gray colors throughout the subsoil. These soils are generally not well developed below a depth of 60 inches. Nearly level soils that are well drained generally are distinctly developed to a depth of more than 80 inches.

Most of the gently sloping and sloping soils are developed to a depth of more than 60 inches. Generally as the slope increases above 8 percent, the depth of water penetration decreases. Because much of the water is removed by runoff, the soils in the more sloping areas tend to be shallower. For example, Jedd fine sandy loam, 5 to 12 percent slopes, is strongly sloping and has a moderately deep solum over marine sediments.

Time

A great length of time is required for the formation of soils that have distinct horizons. Differences in the length of time that the parent material has been in place commonly are reflected in the degree of development of soil horizons. Young soils have very little horizon development, and old soils have well expressed horizons.

Nahatche and Hatliff soils are young soils. They form on flood plains in sediments that are continuously being added. They have little horizon development.

Silawa soils are of intermediate age. Because they are on terraces of fluviatile sediments that have not been in place as long as most of the parent material on other landforms in the area, they have not undergone maximum development.

Advanced stages of development are evident in the Huntsburg soils. These soils have distinct horizons, having been leached of most bases.

Processes of Horizon Differentiation

The formation of horizons in soils involves several processes, including accumulation of organic matter, leaching of carbonates and other bases, reduction and transfer of iron, 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 upper part of a profile forms a distinct, dark surface layer. The content of organic matter in the soils in Madison County ranges from low to moderate. Benchley, Dimebox, Gowker, and Portersprings soils have accumulated sufficient organic matter to form a dark surface layer.

Carbonates have been completely leached out of most of the soils in the county. Some soils, such as Burleson, Dimebox, and Wilson soils, still have carbonates in the lower part of the solum.

The reduction and transfer of iron, a process called gleying, is evident in the poorly drained and somewhat poorly drained soils. Gray colors in the lower layers of Derly and Lufkin soils indicate reduction and loss of iron. The presence of yellowish brown, strong brown, and reddish mottles and concretions in some horizons indicate segregation of iron. Elmina, Huntsburg, and Silstid soils have this characteristic.

The translocation of clay minerals has contributed to horizon development in most of the soils in the county. These minerals are the product of weathering of primary minerals. The subsoil in most of the soils in the county has accumulations of clay or clay films in pores and on surfaces of peds. These soils were probably leached of carbonates and bases before the silicate clay was translocated. A horizon with accumulations of translocated clay is called an argillic horizon.

Surface Geology

Saul Aronow, Department of Geology, Lamar University, Beaumont, Texas, prepared this section.

Madison County lies in the West Gulf Coastal Plain geomorphic unit *(15)*. The formations in the unit dip toward the gulf at an angle of less than 2 degrees. They are exposed at the surface in long, narrow bands that parallel the gulf coast.

The oldest surface rocks in the county belong to the Cook Mountain Formation, which is of Eocene age. The youngest sediments are the Holocene alluvial deposits along the Trinity and Navasota Rivers and their tributaries.

Most of the county is drained by tributaries of the Trinity River. The largest tributaries are Bedias, Caney, Iron, Larrison, Mustang, and Pools Creeks. A small part of the county, west of Farm Road 39, drains into the Navasota River, mainly through Shepherd and West Caney Creeks.

The general soil map in this survey can be used to correlate the occurrence of the soils in the county with the surface outcrops of the geologic formations. The general northeast-southwest trend of the soil map units corresponds with the trend of outcrops of the major geologic units.

The formation names used in this section follow those in a geologic atlas of Texas. Parts of Madison County are located on four sheets of the atlas *(31, 32, 33, 34)*.

The major geologic units that are important to the distribution of the soils are the Cook Mountain Formation; the Yegua Formation; a small, post-Yegua Tertiary outlier, possibly the Caddell Formation with a very thin cap of the Plio-Pleistocene Willis Formation; the late Pleistocene to early Holocene Deweyville terraces; and Holocene alluvium. A sixth unit, named FCE, occupies much of the upland area. It is an informal unit and is a poorly defined, partly fluvial, partly colluvial, and partly eolian cover or drape of areally diverse ages and thicknesses. In some areas it constitutes the entire solum and C horizon of the soils. In other areas it appears to terminate within the solum or at the base of the solum.

Cook Mountain Formation

The Cook Mountain Formation and the overlying Yegua Formation are the two uppermost formations in the Claiborne Group, which is a geologic unit that is about 2,600 feet thick in the Brazos Valley *(9)*. In broad terms the Claiborne rocks represent a major cycle of deposition that begins with a marine transgression and is characterized by repeated regressions and transgressions. Claiborne deposition ended with a major regressive cycle *(9)*. Although advances and retreats of the shorelines of ancient seas are not of major interest in considering soil genesis, the kinds of sediments deposited help to explain the varieties and juxtapositions of the parent material.

The Cook Mountain Formation is about 300 to 370 feet thick and is largely shallow-water, nearshore marine in origin *(8, 9, 31, 33, 34)*.

The Old San Antonio Road, which forms the northwestern boundary of the county, lies within the outcrop area of the Cook Mountain Formation and parallels the strike of the formation. The outcrop area, part of which is in Leon County, is about 20 miles wide.

The formation has been divided into four members. From top to base (youngest to oldest), the members are Mount Tabor, Spiller, Landrum, and Wheelock. All four of these members probably crop out in the northwestern part of Madison County *(24)*. The Mount Tabor Member is clay and marl with marine megafossils. The Spiller Member is argillaceous lignitic sand. The Landrum and Wheelock Members are marls and marly clays with glauconitic, ironstone concretions and many marine megafossils *(31, 33, 34)*.

The major general soil map unit in the uplands in northwestern Madison County is the Rader-Gredge-Chazos unit, which straddles the geologic contact of the Cook Mountain Formation with the overlying, younger Yegua Formation. The boundary between the Rader-Gredge-Chazos unit and the Zack-Zulch-Boonville unit, which is to the southeast, does not correspond to the contact between the Cook Mountain Formation and the Yegua Formation even though most of the Yegua Formation is topped with soils of the Zack-Zulch-Boonville unit.

Other units on uplands and stream terraces within the outcrop areas of the Cook Mountain Formation are the Rader-Derly, Robco-Padina-Silstid, Crockett-Benchley-Dimebox, and Jedd-Gasil units. The Crockett-Benchley-Dimebox and Jedd-Gasil units are restricted to the Cook Mountain Formation. The other units occur in the outcrop areas of both the Cook Mountain and Yegua Formations.

The general northeasterly trend of the Rader-Gredge-Chazos, Crockett-Benchley-Dimebox, and Jedd-Gasil units in the outcrop area of the Cook Mountain Formation contrasts with the southeasterly trend of the Rader-Derly unit. The trend of the Rader-Derly unit parallels the overall southeasterly pattern of the tributaries of the Trinity River. The soils of this unit can be found mostly on well defined to poorly defined terraces flanking East Caney Creek and Riley Creek. The parent materials of this unit are fluvial deposits of late Pleistocene to early Holocene age.

On uplands, the Rader-Gredge-Chazos, Robco-

Padina-Silstid, Crockett-Benchley-Dimebox, and Jedd-Gasil units occupy a moderately dissected topography of flat-topped to gently rounded hills that have broad slopes. The soils of the Rader-Gredge-Chazos unit on these sites can be considered as isolated, relict fluvial deposits. The presence of fluvial soils in upland positions suggests that the parent materials of some upland soils are relict from a major drainage system. This system would have paralleled the strike of the local formations and been active in the late Pliocene to possibly early Pleistocene periods. It would have been functioning prior to the formation of the terraces flanking the Trinity and Navasota Rivers and their tributaries. It would possibly have been part of the stream system that deposited the Plio-Pleistocene Willis Formation, which is in counties to the south *(4, 5)*.

The dissected complex of relict fluvial materials is more than 8 miles wide. Before it was abandoned, it included channel and overbank deposits and flanking alluvial and strath terraces. These scattered upland deposits of varying thickness are included in the components of the FCE unit.

Crockett, Ellis, Jedd, Kurten, Mabank, Rosanky, Silstid, Spiller, and Tabor soils have parent materials derived from clays, shales, sandstones, and limestones that are interbedded or interlaminated. Perhaps the entire solum of the Ellis soil, which is an Inceptisol, formed in parent material from the Cook Mountain Formation. The loamy or sandy A or the A and E horizons of the Jedd, Silstid, and Spiller soils may contain residuum from the fluvial cover. The solum of the Kurten, Mabank, Rosanky, and Tabor soils contains siliceous pebbles. These pebbles are not evident in the underlying Cook Mountain Formation and thus must have been derived from the fluvial cover, which has almost vanished.

The other 14 soils that formed in areas of the Cook Mountain Formation seem to have formed in a fluvial cover so thick as to preclude bedrock involvement, or they developed in deeply weathered bedrock that has lost diagnostic stratification or lithology. Bremond, Chazos, Derly, Gredge, Lufkin, Rader, Robco, Silawa, and Wilson soils are on clearly defined terraces along existing flood plains and on the eroded surface of the Cook Mountain Formation. Bremond, Chazos, Gredge, Lufkin, Silawa, and Wilson soils have siliceous pebbles in the solum or C horizon. Benchley, Bremond, Crockett, Dimebox, Dutek, Gasil, Kurten, and Padina soils are restricted to the outcrop areas of the Cook Mountain Formation.

The A and E horizons of the Dutek, Padina, Robco, and Silstid soils do not have pebbles. They are loamy fine sand and have a maximum thickness of 40 to 80 inches. These soils probably had eolian reworking of the surface and would contribute to the eolian part of the poorly defined, surface FCE unit. Other soils containing pebbles that occur on the Cook Mountain Formation would belong to the fluvial or colluvial components of the FCE.

Yegua Formation

The Yegua Formation of Eocene age is the second oldest formation in Madison County and is the uppermost, or youngest, part of the Claiborne Group *(25)*. Its area of outcrop underlies the southern part of the Rader-Gredge-Chazos general soil map unit and all of the Zack-Zulch-Boonville unit.

The Yegua Formation ranges from about 600 to 1,000 feet in thickness *(31, 32, 33, 34)*. It is mainly deltaic in origin and is a product of a marine regression, which is the seaward advance of the shoreline, over the previously deposited, largely marine Cook Mountain Formation *(16, 17, 18)*. The dominant components of the Yegua Formation are clays, claystones, shales, siltstones, sandstones, and lignites *(8, 9, 17, 18, 31, 32, 33, 34)*. In deltaic environments, the finer sediments are deposited in prodelta, delta-front, interdistributary, and crevasse-splay environments. The coarser sediments are deposited in distributary and delta-front environments. Lignitic materials are in abandoned distributary channels, in interdistributary swamps and marshes, and on the broad surfaces of inactive, abandoned, subsiding deltas. Thin, reworked strata of pyroclastics (volcanic ash or tuff) are interbedded with the finer deposits. Commonly, the volcanic ash has weathered to smectites.

The northwest contact of the Yegua Formation with the underlying Cook Mountain Formation passes under the northeastward trending Rader-Gredge-Chazos unit. The origin of the Rader-Gredge-Chazos unit and its relationship to the local bedrock is described under the heading "Cook Mountain Formation."

The Zack-Zulch-Boonville unit is largely confined to the area of outcrop of the Yegua Formation. The C horizon of the major soils of this unit consists of shales, clays, and loams of the finer grained deltaic facies of the Yegua Formation. In some places the Tabor soil, which is a minor soil in this unit, has a coarser grained C horizon. The solum of this soil contains siliceous pebbles, which are not found in the Yegua Formation. This soil probably represents a thin part of the poorly defined FCE unit. The other soils of minor extent, except those on well defined fluvial terraces, probably formed in materials from the FCE unit of post-Yegua, possibly late Tertiary to even Holocene age. These soils include the Chazos, Gredge, Rader, and Robco soils.

Caddell and Willis Formations

A small area of the Elmina-Huntsburg general soil map unit is in the southeastern part of the county near the confluence of Bedias Creek and Trinity River. It may be developed on an outlier of one or more formations overlying, or younger than, the Yegua Formation. These formations include those of the Jackson Group and the Catahoula and Willis Formations. None of these are known to crop out in Madison County. They crop out in Grimes and Walker Counties to the south *(31, 32, 33, 34)*. Most of the topography is moderately dissected and similar to that of the outcrop areas of the Cook Mountain and Yegua Formations.

The Elmina soils in Walker and Grimes Counties occur principally on formations of the Jackson Group, which includes the Whitsett, Manning, Wellborn, and Caddell Formations, and on the Catahoula Formation *(4, 5)*. In Madison County, they are probably on the Caddell Formation, which has an outcrop in Walker County. This outcrop is very close to the area where the Elmina-Huntsburg unit occurs. The Elmina soils make up about 39 percent of the unit.

The Huntsburg soils make up about 19 percent of the Elmina-Huntsburg unit in Madison County. In Walker and Grimes Counties, they occur mostly on the Willis Formation *(4, 5, 19)*. These soils contain as much as 20 percent plinthite and have a reticulate mottling pattern. They are characteristic of soils on the Willis Formation, which is not, however, known to outcrop in Madison County *(31, 32, 33, 34)*. The Huntsburg soils in the county probably formed in thin, colluvial residuum from the Willis Formation resting upon a Cr horizon, which is probably the Caddell Formation of the Jackson Group. The Willis Formation is a fluvial deposit, probably of Plio-Pleistocene age. The remaining 42 percent of the soils in the Elmina-Huntsburg unit mainly are on Pleistocene and Holocene sediments on small terraces and narrow flood plains.

The FCE Drape on the Tertiary Sediments

The FCE unit, which is a local, informal geologic designation, was devised to describe the widespread occurrence of surface materials that might not be pedogenically related to the underlying Tertiary bedrock.

The most extensive occurrence of the FCE is the surface materials of the Rader-Gredge-Chazos general soil map unit astride the contact between the Yegua and Cook Mountain Formations. A comparatively high proportion of these soils, about 56 percent of the surface, has no apparent bedrock involvement. This suggests a major relict fluvial drainageway that flowed to the southwest. The range in texture of the C horizons in the Rader soils (sandy clay loam, sandy loam, and clay loam) and the Chazos soils (sandy clay loam to clay) suggests an overbank origin, either a levee, crevasse-splay, or flood basin or a combination of these. The coarser C horizon in the Gredge soils (loamy fine sand, fine sandy loam, sandy clay loam, or clay loam) suggests a point-bar origin. The scattering of siliceous pebbles in the profiles of the Chazos and Gredge soils may indicate a lateral or even vertical colluvial origin derived from a vanished channel site that was higher on the landscape.

The soils in the Zack-Zulch-Boonville unit make up about 66 percent of the unit. They have an A horizon of fine sandy loam to loam that ranges from 7 to 15 inches in thickness and contains scattered siliceous pebbles. They have a B horizon of clay to clay loam that contains siliceous pebbles to a depth of 40 inches *(22)*. The bedrock involvement of the profiles of these soils indicates a thinning of any previous fluvial cover. The pebbly, loamy A horizons may be the last remnants of such a cover modified by pedogenic processes. The pebbly Bt horizons may be colluvial mixtures of bedrock materials and relict fluvial deposits that have been both vertically and laterally displaced. Some of the pebbles in the Bt horizons may be present as a result of descent along desiccation cracks.

The contrast in the relative thicknesses of relict fluvial covers in the Rader-Gredge-Chazos unit compared to those in the Zack-Zulch-Boonville unit opens the possibility of several successive Tertiary to early Pleistocene fluvial covers. The thin layers of residuum, which may be of the Willis Formation, in the solum of the Huntsburg soil might be considered part of the FCE drape.

The major eolian component of the FCE drape is probably the A or A and E horizons in the Dutek, Padina, Robco, and Silstid soils in the uplands. These horizons are 40 to 80 inches of loamy fine sand and do not have pebbles.

The original relict fluvial cover materials of the FCE drape were deposited between the deposition of the Cook Mountain and Yegua Formations and the late Tertiary or the early Pleistocene. The thick, probably eolian A or A and E horizons most likely were deposited after the deposition of the Plio-Pleistocene Willis Formation. Some of this material was probably partly blown in from nearby Pleistocene terraces. The time of profile development of the soils was probably late Pleistocene to Holocene.

About the only place the FCE drape seems to have been recognized is on the Austin sheet of a geologic atlas of Texas *(34)*. In western Madison County, west and southwest of North Zulch, and in the upland areas flanking the Navasota River, small areas of high terraces are shown to be more or less continuous with adjacent upland areas. The major soils on these high terraces are Boonville, Zack, and Zulch soils. These soils may represent the thinnest parts of the FCE drape. Part of the solum and all of the C horizon of these soils developed in the Yegua Formation.

Late Pleistocene to Early Holocene Terrace Deposits

Terraces Along the Navasota River

The main soils on the stream terraces along the Navasota River are in the Bienville and Rader-Derly general soil map units. The Rader-Derly unit is on a terrace at an elevation of about 250 feet to 300 feet or more above sea level. In the lowest areas, the edge of the terrace is less than 10 feet above the Holocene flood plain. These areas probably have more than one terrace level. One area of the Bienville unit is on a small terrace about 10 feet above the flood plain and is separated by a well defined scarp from the higher terrace, which is an area of the Rader-Derly unit. Some of the lower portions of the Rader-Derly terrace that are nearest the river are correlative with the Bienville terrace *(21)*.

Terraces Along the Trinity River

The main soils on the stream terraces along the Trinity River are in the Bienville and Burleson-Ellis-Wilson general soil map units. The lowest soils on these terraces are in the Bienville unit. The terraces are well preserved and have relict point-bar ridges and swales that are readily apparent on the soil maps. The soils in the Bienville unit are on the terraces and flood plains. Bienville and minor soils, such as Derly, Eufaula, Portersprings, and Rader soils, are on the terraces. Gowker, Hatliff, and Navasan soils are on the flood plain. The swales in many of the lower terraces are interlaced with the more recent parent materials of the flood plain soils, indicating that in some areas of these terraces the soils are subject to flooding, if only rarely.

Most of the soils on the lower terraces, with the possible exception of the Derly soils, have a surface horizon and lower horizons that are sandy and loamy. These textures are consistent with fluvial channel and point-bar origin. The clayey lower horizons in the Derly soils may have formed in parent material deposited in oxbow lakes and thus have very localized overbank origin. The surface of most of these soils has probably been subject to wind action sometime in the past 50,000 years.

At least two terrace levels occur in areas of the Bienville unit. One level is less than 10 feet above the flood plain, and the other is 10 to 15 feet above. Soils in the Bienville unit seem to be restricted to these lower terrace levels. Also at these levels are some areas of the Burleson-Ellis-Wilson unit, particularly in the southeastern part of the county, east of Farm Road 247. The surface horizon and lower horizons of the soils of the Burleson-Ellis-Wilson unit are all clayey. The parent materials are probably of overbank flood basin origin *(6, 7)*.

The highest terraces along the Trinity River are 45 to 85 feet above the flood plain. The main soils on these terraces are in the Burleson-Ellis-Wilson unit in an area along State Highway 21, northeast of Midway. A few areas of the Rader-Derly and Rader-Gredge-Chazos units also are on the higher terraces east of Farm Road 247 and southeast of Midway. The parent materials of the soils on the high terraces are mostly clayey, which suggests an overbank origin instead of a channel or point-bar origin. The higher terraces do not have the fluvial depositional topography on their surfaces that occurs at the lower terrace levels.

The radii of curvature of the relict point-bar patterns on the surfaces of the lower terraces are considerably greater than those of the meanders of the present-day Trinity River. Meander radii are roughly proportional to stream discharge. This information suggests that the Paleo-Trinity River, which flowed at these lower terrace levels, had a much greater discharge of water than the present river. Stream terraces that are directly above the level of the flood plain along gulf coast streams and that have these large relict patterns have been referred to as Deweyville terraces. Wood from these terrace materials elsewhere in Texas and Louisiana have been radiocarbon dated at less than 10,000 years old to 30,000 years old *(1, 10)*.

Terraces along the Navasota River do not have Deweyville characteristics. However, a meander scar that is much larger than the meanders of the present-day river bounds part of the Holocene flood plain directly north of Texas Highway 21. Deweyville deposits may have been eroded away or buried by later Holocene flood plain deposits.

The higher terraces along the Trinity River and the terraces along the Navasota River may correlate with the coastwise upper Pleistocene Beaumont Formation, which has been estimated to be about 30,000 to 120,000 years old.

Terraces Along Bedias Creek and Other Tributaries

Most of the soils on terraces along Bedias Creek and other tributaries to the Trinity River are in the Rader-Derly general soil map unit. These soils may have formed in fine-grained parent materials of very local upland origin. These terraces are poorly preserved. The upper limits of many merge into the uplands and may be considered part of the FCE drape. These terraces are at an elevation of 50 to 75 feet above the flood plain along Bedias Creek.

Holocene Alluvium

The Holocene alluvium, which is material deposited on bottom land, is overlain by soils of the Gladewater, Kaufman-Gladewater, and Gowker-Nahatche general soil map units. The Gladewater unit occurs on the flood plain along the Navasota River. The Kaufman-Gladewater unit occurs on the flood plain along the Trinity River. The Gowker-Nahatche unit occurs on the flood plains along Bedias Creek and other tributaries to the Trinity and Navasota Rivers.

The clayey soils of the Gladewater and Kaufman-Gladewater units are developed on the flood basin or backswamp deposits of the rivers. Coarser materials, which can be found in the immediate vicinity of point bars and levees along other rivers, are largely absent along the Trinity and Navasota Rivers. They are probably at a depth of about 10 feet and are covered with thin drapes of clayey overbank sediments.

The somewhat coarser materials of the Gowker-Nahatche unit are derived from the silty and sandy parts of the Yegua Formation and from the reworking of materials of the FCE drape.

References

(1) Alford, J.J., and J.C. Holmes. 1985. Meander scars as evidence of major climatic change in southwest Louisiana. Ann. Assoc. Am. Geogr. 75: 395-403.

(2) American Association of State Highway and Transportation Officials. 1986. Standard specifications for highway materials and methods of sampling and testing. Ed. 14, 2 vol.

(3) American Society for Testing and Materials. 1993. Standard classification of soils for engineering purposes. ASTM Stand. D 2487.

(4) Aronow, Saul. Geology. *In* Soil survey of Grimes County, Texas. Forthcoming.

(5) Aronow, Saul. 1979. Geology. *In* Soil survey of Walker County, Texas. U.S. Dep. Agric., Soil Conserv. Serv. pp. 52-55.

(6) Aronow, Saul, and L.C. Nordt. 1988. Report on test drilling of low terraces of the Trinity River in the Madison County-Houston County area, Texas. Soil Conserv. Serv.

(7) Aronow, Saul, L.C. Nordt, and C.T. Hallmark. 1986. Geology and soils of eastern Madison County. Dep. Soil and Crop Sci., Tex. A&M Univ.

(8) Berg, R.R. 1979. Locality 7, Little Brazos River. *In* Claiborne sediments of the Brazos Valley, southeast Texas (guidebook). Houston Geol. Soc. pp. 96-97.

(9) Berg, R.R. 1979. Stratigraphy of the Claiborne Group. *In* Claiborne sediments of the Brazos Valley, southeast Texas (guidebook). Houston Geol. Soc. pp. 5-11.

(10) Bernard, H.A., and R.J. LeBlanc, Jr. 1965. Resume of the Quaternary geology of the northwestern Gulf of Mexico Province. *In* The Quaternary of the United States. Princeton Univ. Press. pp. 137-185.

(11) Broadfoot, Walter M. 1960. Field guide for evaluating cottonwood sites. U.S. Dep. Agric., Forest Serv., South. Forest Exp. Stn. Occas. Pap. 178.

(12) Broadfoot, Walter M. 1963. Guide for evaluating water oak sites. U.S. Dep. Agric., Forest Serv., South. Forest Exp. Stn. Res. Pap. SO-1.

(13) Broadfoot, Walter M., and R.M. Krinard. 1959. Guide for evaluating sweetgum sites. U.S. Dep. Agric., Forest Serv., South. Forest Exp. Stn. Occas. Pap. 176.

(14) Frantz, J.B., and M. Cox. 1988. Lure of the land, Texas county maps and the history of settlement.

(15) Hunt, C.B. 1974. Natural regions of the United States and Canada.

(16) Jackson, M.L.W., and L.E. Garner. 1982. Environmental geology of the Yegua-Jackson lignite belt, southeast Texas. Univ. Tex., Bur. of Econ. Geol. Rep. Invest. 129.

(17) LeBlanc, R.J., Jr. Environments of deposition of the Yegua Formation (Eocene), Brazos County, Texas. Unpublished master's thesis completed in 1970 at Texas A&M University.

(18) LeBlanc, R.J., Jr. 1979. Depositional systems in the Yegua Formation. *In* Claiborne sediments of the Brazos Valley, southeast Texas (guidebook). Houston Geol. Soc. pp. 18-25.

(19) McClintock, W.R., J.J. Castille, and Michael Stewart. 1979. Soil survey of Walker County, Texas. U.S. Dep. Agric., Soil Conserv. Serv.

(20) Neely, Cecil N. An early history of Madison County, Texas. Unpublished thesis completed in 1971 at Sam Houston State University.

(21) Nordt, L.C. 1986. Regional correlation of terraces and soils of the Brazos, Trinity, and Navasota Rivers of the Tertiary Coastal Plain of Texas. Soil Surv. Horizons, Vol. 27, No. 1, pp. 29-35.

(22) Nordt, L.C., and C.T. Hallmark. 1986. Pedogeomorphic evolution of the Boonville soils: Brazos County, Texas. *In* Agronomy abstracts. pp. 230-231.

(23) Olson, D.J. 1959. Site index curves for upland oak in the Southeast. U.S. Dep. Agric., Forest Serv., Southeast. Forest Exp. Stn. Res. Note 125.

(24) Stenzel, H.B. 1938. The geology of Leon County, Texas. Univ. Tex. Pub. 3818.

(25) Stenzel, H.B. 1940. The Yegua problem. Univ. Tex. Pub. 3945.

(26) United States Department of Agriculture. 1951 (being revised). Soil survey manual. U.S. Dep. Agric. Handb. 18.

(27) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210.

(28) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436.

(29) United States Department of Agriculture. 1976. Volume, yield, and stand tables for second growth southern pines. Forest Serv. Misc. Publ. 50.

(30) United States Department of Agriculture. 1984 (rev.). Procedures for collecting soil samples and methods of analysis for soil survey. Soil Surv. Invest. Rep. 1.

(31) University of Texas, Bureau of Economic Development. 1967. Geologic atlas of Texas, Palestine sheet.

(32) University of Texas, Bureau of Economic Development. 1968. Geologic atlas of Texas, Beaumont sheet.

(33) University of Texas, Bureau of Economic Development. 1970. Geologic atlas of Texas, Waco sheet.

(34) University of Texas, Bureau of Economic Development. 1974. Geologic atlas of Texas, Austin sheet.

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.

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.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as:

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

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.

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

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

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.

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

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. 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 fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, 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 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 are somewhat similar in all areas.

Compressible (in tables). The volume of soft soil decreases excessively under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

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. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are:

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

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.

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.

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 grazingland 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 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 periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

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.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by 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 fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

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 grains are grown. The soil is tilled for at least one growing season for weed control and decomposition of plant residue.

Fast intake (in tables). The movement of water into the soil is rapid.

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.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

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.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant that is not a grass or a sedge.

Fragile (in tables). The soil 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 and mottles.

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 up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 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 (geology). 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.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

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 at the surface of a mineral soil.

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 O, A, or E horizon. The B horizon is, in part, a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as accumulation of clay, sesquioxides, humus, or a combination of these; prismatic or blocky structure; redder or browner colors than those in the A horizon; or a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

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 A or B horizon. 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, the Arabic numeral 2 precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated rock (unweathered bedrock) beneath the soil. The bedrock commonly underlies a C horizon but 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-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

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 plants that are less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material. This contrasts 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

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

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 strength. The soil is not strong enough to support loads.

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.

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. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

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.

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 to move through the profile. Permeability is measured as the number of inches per hour that water moves through the saturated soil. Terms describing permeability are:

Very slow	less than 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. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Subsurface tunnels or pipelike cavities are formed 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.

Plinthite. The sesquioxide-rich, humus-poor, highly weathered mixture of clay with quartz and other diluents. It commonly appears as red mottles, usually in platy, polygonal, or reticulate patterns. Plinthite changes irreversibly to an ironstone hardpan or to irregular aggregates on repeated wetting and drying, especially if it is exposed also to heat from the sun. In a moist soil, plinthite can be cut with a spade. It is a form of laterite.

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 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.

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.

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 climax 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 the 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:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly 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

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Rippable bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

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 the 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-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

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 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 or of the underlying material. 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. 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.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

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 is generally silty or clayey, is slippery when wet, and is low in productivity.

Slippage (in tables). The soil mass is 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.

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.

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.

Sodicity. The degree to which a soil is affected by exchangeable sodium. Sodicity is expressed as a sodium absorption ratio (SAR) of a saturation extract, or the ratio of Na^{+} to Ca^{++} + Mg^{++}. The degrees of sodicity and their respective ratios are:

Slight	less than 13:1
Moderate	13-30:1
Strong	more than 30:1

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 underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, thickness of the line can be one fragment or more. It generally overlies material that weathered in place, and it is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

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.

Subsurface layer. Technically, the E horizon. Generally refers to a leached horizon lighter in color and lower in organic matter content than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed on the contour or at a slight angle to the contour across sloping soils. The terrace intercepts surface runoff, so that water soaks into the soil or flows slowly to a prepared outlet.

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). An otherwise suitable soil material that is too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, such as zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). There is a risk of caving or sloughing on banks of fill material.

Upland (geology). 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 in stream valleys by heavily loaded streams.

Weathering. All physical and chemical changes produced by atmospheric agents in rocks or other deposits at or near the earth's surface. 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

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1951-86 at Madisonville, Texas)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	60.6	38.4	49.5	80	14	140	2.78	1.06	4.13	5	0.4
February----	64.6	41.3	53.0	83	20	148	3.09	1.53	4.36	6	.1
March-------	72.2	48.4	60.3	88	26	338	2.89	1.16	4.13	5	.0
April-------	79.6	56.8	68.2	90	36	546	4.34	1.02	6.89	5	.0
May---------	85.8	63.5	74.7	95	44	766	4.70	2.17	6.82	6	.0
June--------	92.3	69.5	80.9	100	57	927	3.49	.91	5.42	5	.0
July--------	96.0	72.1	84.1	104	65	1,057	2.31	.84	3.49	4	.0
August------	96.5	71.5	84.0	105	61	1,054	2.73	.90	4.35	4	.0
September---	90.4	66.6	78.5	100	48	855	4.33	1.48	6.58	5	.0
October-----	82.0	56.5	69.3	95	36	598	4.36	1.04	7.18	5	.0
November----	70.9	47.1	59.0	87	25	291	3.77	1.55	5.66	5	.0
December----	63.8	40.9	52.4	82	19	156	3.04	1.75	4.27	5	.0
Yearly:											
Average----	79.6	56.1	67.8	---	---	---	---	---	---	---	---
Extreme----	---	---	---	106	14	---	---	---	---	---	---
Total------	---	---	---	---	---	6,876	41.83	34.45	49.49	60	.5

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily tempertures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1951-86 at Madisonville, Texas)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Mar. 6	Mar. 19	Mar. 28
2 years in 10 later than--	Feb. 23	Mar. 10	Mar. 22
5 years in 10 later than--	Feb. 3	Feb. 22	Mar. 9
First freezing temperature in fall:			
1 year in 10 earlier than--	Nov. 18	Nov. 13	Oct. 29
2 years in 10 earlier than--	Nov. 28	Nov. 20	Nov. 5
5 years in 10 earlier than--	Dec. 17	Dec. 4	Nov. 18

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-86 at Madisonville, Texas)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	274	252	227
8 years in 10	287	263	236
5 years in 10	313	285	253
2 years in 10	345	308	270
1 year in 10	>365	321	279

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
ArD	Arriola fine sandy loam, 5 to 8 percent slopes	722	0.3
BeB	Benchley clay loam, 1 to 5 percent slopes	702	0.2
BnB	Bienville loamy fine sand, 0 to 3 percent slopes	2,747	0.9
BoB	Boonville fine sandy loam, 1 to 3 percent slopes	21,397	7.1
BrA	Bremond-Wilson complex, 0 to 2 percent slopes	609	0.2
BuA	Burleson clay, 0 to 1 percent slopes	1,358	0.4
ChB	Chazos loamy fine sand, 1 to 5 percent slopes	12,068	4.1
CrB	Crockett loam, 1 to 3 percent slopes	2,825	0.9
DdA	Derly silt loam, 0 to 1 percent slopes	887	0.3
DeA	Derly-Rader complex, 0 to 1 percent slopes	7,833	2.6
DmA	Dimebox silty clay, 0 to 1 percent slopes	375	0.1
DuC	Dutek loamy fine sand, 1 to 5 pecent slopes	343	0.1
EeE	Ellis clay, 5 to 15 percent slopes	999	0.3
EmB	Elmina loamy fine sand, 1 to 3 percent slopes	2,336	0.8
EuB	Eufaula loamy fine sand, 1 to 5 percent slopes	780	0.3
EuE	Eufaula loamy fine sand, 5 to 15 percent slopes	769	0.3
FtB	Flatonia clay loam, 1 to 3 percent slopes	1,654	0.5
GaB	Gasil fine sandy loam, 1 to 5 percent slopes	4,307	1.4
Gg	Gladewater clay, occasionally flooded	1,685	0.6
Gh	Gladewater clay, frequently flooded	4,323	1.4
Gn	Gladewater and Nahatche soils, frequently flooded	1,935	0.6
Go	Gowker clay loam, frequently flooded	25,031	8.3
GpA	Gowker-Portersprings complex, 0 to 2 percent slopes	4,026	1.3
GrC	Gredge fine sandy loam, 1 to 5 percent slopes	15,826	5.2
GrD	Gredge fine sandy loam, 5 to 8 percent slopes	6,254	2.1
Ha	Hatliff fine sandy loam, frequently flooded	5,134	1.7
HuC	Huntsburg loamy fine sand, 1 to 5 percent slopes	1,053	0.4
JeD	Jedd fine sandy loam, 5 to 12 percent slopes	2,669	0.9
Ka	Kaufman clay, occasionally flooded	4,604	1.5
Kf	Kaufman clay, frequently flooded	2,247	0.7
KuC	Kurten fine sandy loam, 1 to 5 percent slopes	2,809	0.9
LfA	Lufkin fine sandy loam, 0 to 1 percent slopes	2,015	0.7
MaA	Mabank fine sandy loam, 0 to 1 percent slopes	2,450	0.8
Na	Nahatche loam, frequently flooded	10,846	3.6
NvB	Navasan loamy fine sand, 1 to 3 percent slopes	531	0.2
PaC	Padina loamy fine sand, 1 to 5 percent slopes	2,678	0.9
RaB	Rader fine sandy loam, 1 to 3 percent slopes	35,214	11.6
RbA	Rader-Derly complex, 0 to 2 percent slopes	12,016	4.0
RcB	Robco loamy fine sand, 1 to 3 percent slopes	9,128	3.0
RoC	Rosanky fine sandy loam, 1 to 5 percent slopes	2,231	0.7
RvC	Rosanky gravelly fine sandy loam, 1 to 5 percent slopes	250	0.1
SaB	Silawa fine sandy loam, 1 to 5 percent slopes	2,203	0.7
SdB	Silstid loamy fine sand, 1 to 5 percent slopes	2,029	0:7
SpB	Spiller fine sandy loam, 1 to 3 percent slopes	1,514	0.5
TaB	Tabor fine sandy loam, 1 to 3 percent slopes	9,345	3.1
ToD	Tonkavar loamy fine sand, 1 to 8 percent slopes	361	0.1
WcA	Wilson loam, 0 to 1 percent slopes	609	0.2
ZaB	Zack fine sandy loam, 1 to 5 percent slopes	27,300	9.0
ZaC2	Zack fine sandy loam, 3 to 8 percent slopes, eroded	2,700	0.9
ZaD	Zack fine sandy loam, 5 to 8 percent slopes	6,242	2.1
ZgC3	Zack-Gullied land complex, 3 to 8 percent slopes	905	0.3
ZuB	Zulch fine sandy loam, 1 to 3 percent slopes	30,500	10.1
	Water areas 2 to 39 acres in size	962	0.3
	Water areas more than 40 acres in size	115	*
	Total	302,451	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
BeB	Benchley clay loam, 1 to 5 percent slopes
BuA	Burleson clay, 0 to 1 percent slopes
ChB	Chazos loamy fine sand, 1 to 5 percent slopes
DmA	Dimebox silty clay, 0 to 1 percent slopes
GaB	Gasil fine sandy loam, 1 to 5 percent slopes
Go	Gowker clay loam, frequently flooded (where protected from flooding or not frequently flooded during the growing season)
GpA	Gowker-Portersprings complex, 0 to 2 percent slopes
Ha	Hatliff fine sandy loam, frequently flooded (where protected from flooding or not frequently flooded during the growing season)
HuC	Huntsburg loamy fine sand, 1 to 5 percent slopes
Na	Nahatche loam, frequently flooded (where protected from flooding or not frequently flooded during the growing season)
RaB	Rader fine sandy loam, 1 to 3 percent slopes
RbA	Rader-Derly complex, 0 to 2 percent slopes
SaB	Silawa fine sandy loam, 1 to 5 percent slopes
SpB	Spiller fine sandy loam, 1 to 3 percent slopes

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil).

Soil name and map symbol	Land capability	Improved bermudagrass	Common bermudagrass	Bahiagrass	Grain sorghum	Corn	Cotton lint
		AUM*	AUM*	AUM*	Bu	Bu	Lbs
ArD------------- Arriola	VIe	5.0	4.0	4.0	---	---	---
BeB------------- Benchley	IIIe	7.0	4.0	3.5	65	75	250
BnB------------- Bienville	IIs	9.0	3.5	3.5	---	80	---
BoB------------- Boonville	IIIe	7.0	4.0	4.0	---	25	---
BrA:							
Bremond--------	IIIe	6.5	3.5	3.5	70	70	400
Wilson---------	IIIe	6.0	---	---	45	35	300
BuA------------- Burleson	IIw	7.0	3.5	3.0	85	65	450
ChB------------- Chazos	IIIe	7.5	3.5	4.0	40	---	---
CrB------------- Crockett	IIIe	6.5	4.0	3.5	54	40	350
DdA------------- Derly	IIIw	5.5	---	3.5	50	---	---
DeA:							
Derly----------	IIIw	6.0	4.5	4.5	45	---	200
Rader----------	IIw	8.0	6.5	---	70	65	---
DmA------------- Dimebox	IIw	7.0	4.0	3.0	85	65	450
DuC------------- Dutek	IIIe	7.0	2.5	---	30	---	---
EeE------------- Ellis	VIe	4.0	3.0	---	---	---	---
EmB------------- Elmina	IIIe	7.5	4.0	4.0	---	30	---
EuB------------- Eufaula	IVe	5.0	---	---	20	---	---
EuE------------- Eufaula	VIe	5.0	---	---	---	---	---
FtB------------- Flatonia	IIe	6.0	3.5	3.5	60	60	350
GaB------------- Gasil	IIIe	8.0	4.0	4.0	50	---	300

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Improved bermudagrass	Common bermudagrass	Bahiagrass	Grain sorghum	Corn	Cotton lint
		AUM*	AUM*	AUM*	Bu	Bu	Lbs
Gg-------------- Gladewater	IVw	6.5	3.5	4.0	65	---	400
Gh-------------- Gladewater	Vw	6.0	3.5	3.5	---	---	---
Gn:							
Gladewater-----	Vw	7.0	3.5	3.5	---	---	---
Nahatche-------	Vw	9.0	5.0	8.0	---	---	---
Go-------------- Gowker	Vw	7.5	4.0	4.0	---	---	---
GpA:							
Gowker---------	IIw	8.0	4.0	4.0	105	75	525
Portersprings--	IIw	10.0	8.0	9.0	70	90	---
GrC------------- Gredge	IVe	6.5	3.0	3.0	---	25	---
GrD------------- Gredge	VIe	5.0	3.0	3.0	---	---	---
Ha-------------- Hatliff	Vw	9.0	4.0	4.0	---	---	---
HuC------------- Huntsburg	IVe	7.5	4.0	4.0	---	30	---
JeD------------- Jedd	VIe	---	---	---	---	---	---
Ka-------------- Kaufman	IIw	7.0	3.5	3.0	100	65	500
Kf-------------- Kaufman	Vw	7.0	3.5	3.0	---	---	---
KuC------------- Kurten	IVe	6.5	3.5	3.5	40	35	250
LfA------------- Lufkin	IIIw	5.5	3.0	3.0	45	35	200
MaA------------- Mabank	IIIw	6.0	3.5	3.5	55	40	330
Na-------------- Nahatche	Vw	9.0	4.0	4.0	---	---	---
NvB------------- Navasan	IIIe	7.0	2.5	---	---	---	---
PaC------------- Padina	IIIe	6.5	---	---	---	---	---
RaB------------- Rader	IIIe	8.0	4.0	4.0	70	60	200

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Improved bermudagrass	Common bermudagrass	Bahiagrass	Grain sorghum	Corn	Cotton lint
		AUM*	AUM*	AUM*	Bu	Bu	Lbs
RbA:							
Rader----------	IIIs	7.0	4.0	4.0	70	60	200
Derly----------	IIIw	5.0	4.0	4.0	45	---	200
RcB------------- Robco	IIe	7.5	4.0	4.0	---	---	---
RoC------------- Rosanky	IIIe	7.0	3.5	3.5	45	60	250
RvC------------- Rosanky	IIIe	6.5	3.0	3.0	---	55	---
SaB------------- Silawa	IIIe	8.0	4.0	4.0	45	40	300
SdB------------- Silstid	IIIe	7.0	2.5	2.5	30	---	---
SpB------------- Spiller	IIIe	7.5	3.5	3.5	---	---	---
TaB------------- Tabor	IIIe	7.0	3.0	3.0	55	40	---
ToD------------- Tonkavar	IVs	6.0	2.5	2.5	---	45	---
WcA------------- Wilson	IIIw	6.0	3.0	3.0	55	45	350
ZaB------------- Zack	IVe	6.0	3.0	3.0	---	25	---
ZaC2------------ Zack	VIe	4.5	2.5	2.5	---	---	---
ZaD------------- Zack	VIe	5.0	3.0	3.0	---	---	---
ZgC3:							
Zack-----------	VIe	4.5	3.5	---	---	---	---
Gullied land.							
ZuB------------- Zulch	IIIe	5.0	3.0	3.0	---	20	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

TABLE 7.--RANGELAND PRODUCTIVITY

(Only the soils that support rangeland vegetation suitable for grazing are listed)

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
BeB: Benchley	Clay Loam	6,000	5,000	3,200
BoB: Boonville	Claypan Prairie	6,000	5,000	4,000
BrA*:				
Bremond	Claypan Prairie	5,000	4,500	2,500
Wilson	Claypan Prairie	6,000	4,500	3,000
BuA: Burleson	Blackland	7,000	5,500	4,000
ChB: Chazos	Sandy Loam	5,500	4,500	3,000
CrB: Crockett	Claypan Prairie	6,000	5,000	3,000
DeA*:				
Derly	Claypan Savannah	5,000	4,000	2,500
Rader	Sandy Loam	6,000	4,500	3,500
DmA: Dimebox	Blackland	7,000	6,000	4,500
DuC: Dutek	Sandy	4,500	4,000	2,000
EeE: Ellis	Eroded Blackland	4,500	3,500	2,000
EuB, EuE: Eufaula	Deep Sand	4,000	2,800	2,000
FtB: Flatonia	Clay Loam	6,000	4,500	3,000
GaB: Gasil	Sandy Loam	6,000	4,500	3,500
Gg, Gh: Gladewater	Clayey Bottomland	6,000	4,500	3,000
Gn*:				
Gladewater	Clayey Bottomland	6,000	4,500	3,000
Nahatche	Loamy Bottomland	5,500	4,500	3,000
Go: Gowker	Loamy Bottomland	5,500	4,500	3,000
GrC, GrD: Gredge	Claypan Savannah	5,000	3,500	2,500

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
Ha----------------------- Hatliff	Loamy Bottomland-----------------------	5,500	4,500	3,000
JeD---------------------- Jedd	Sandy Loam-----------------------------	5,000	3,500	2,500
Ka, Kf------------------- Kaufman	Clayey Bottomland----------------------	7,500	6,000	4,000
KuC---------------------- Kurten	Claypan Savannah-----------------------	5,000	4,000	2,500
LfA---------------------- Lufkin	Claypan Savannah-----------------------	5,000	4,000	2,500
MaA---------------------- Mabank	Claypan Prairie------------------------	6,000	5,000	3,000
Na----------------------- Nahatche	Loamy Bottomland-----------------------	5,500	4,500	3,000
NvB---------------------- Navasan	Deep Sand------------------------------	5,000	4,000	3,000
PaC---------------------- Padina	Deep Sand------------------------------	4,500	3,500	2,250
RaB---------------------- Rader	Sandy Loam-----------------------------	6,000	4,500	3,500
RbA*:				
Rader-------------------	Sandy Loam-----------------------------	6,000	4,500	3,500
Derly-------------------	Claypan Savannah-----------------------	5,000	4,000	2,500
RcB---------------------- Robco	Sandy----------------------------------	4,500	4,000	2,600
RoC---------------------- Rosanky	Claypan Savannah-----------------------	6,000	4,500	3,000
RvC---------------------- Rosanky	Sandy Loam-----------------------------	6,000	4,500	3,000
SaB---------------------- Silawa	Sandy Loam-----------------------------	6,000	4,500	3,000
SdB---------------------- Silstid	Sandy----------------------------------	4,500	4,000	2,000
SpB---------------------- Spiller	Sandy Loam-----------------------------	6,000	4,500	3,000
TaB---------------------- Tabor	Sandy Loam-----------------------------	6,500	5,500	3,500
WcA---------------------- Wilson	Claypan Prairie------------------------	6,000	4,500	3,000
ZaB, ZaC2---------------- Zack	Claypan Prairie------------------------	4,500	3,500	2,500

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY--Continued

Soil name and map symbol	Range site	Potential annual production for kind of growing season		
		Favorable	Average	Unfavorable
		Lb/acre	Lb/acre	Lb/acre
ZaD----------------------- Zack	Claypan Prairie------------------------	4,500	3,500	2,500
ZgC3*:				
Zack--------------------	Claypan Prairie------------------------	4,500	3,500	2,500
Gullied land.				
ZuB----------------------- Zulch	Claypan Prairie------------------------	5,000	4,000	3,500

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
ArD------------- Arriola	6C	Slight	Moderate	Slight	Slight	Loblolly pine------- Shortleaf pine------	70 60	130 170	Loblolly pine, slash pine.
BnB------------- Bienville	10S	Slight	Severe	Moderate	Slight	Loblolly pine------- Shortleaf pine------	96 75	460 173	Loblolly pine, shortleaf pine.
DdA------------- Derly	4W	Slight	Severe	Moderate	Severe	Water oak----------- Willow oak----------	70 72	54 57	Water oak, sweetgum, willow oak.
EmB------------- Elmina	8S	Slight	Moderate	Moderate	Slight	Loblolly pine------- Shortleaf pine------	80 70	230 170	Loblolly pine, slash pine.
Gg, Gh---------- Gladewater	6W	Slight	Severe	Moderate	Severe	Water oak----------- Willow oak----------	85 85	112 117	Water oak, sweetgum.
Gn**:									
Gladewater-----	6W	Slight	Severe	Moderate	Severe	Water oak----------- Willow oak----------	85 85	112 117	Water oak, sweetgum.
Nahatche-------	6W	Slight	Severe	Moderate	Slight	Water oak----------- Willow oak---------- Eastern cottonwood--	92 91 ---	180 185 ---	Eastern cottonwood, water oak.
Go-------------- Gowker	6W	Slight	Moderate	Moderate	Moderate	Water oak----------- Southern red oak---- Green ash-----------	90 --- ---	175 --- ---	Water oak, sweetgum.
GpA**:									
Gowker---------	6W	Slight	Moderate	Moderate	Moderate	Water oak----------- Southern red oak---- Green ash-----------	90 --- ---	175 --- ---	Water oak, sweetgum.
Portersprings--	6A	Slight	Slight	Slight	Slight	Water oak----------- Pecan---------------	90 90	175 ---	Water oak.
Ha-------------- Hatliff	10W	Slight	Moderate	Moderate	Moderate	Loblolly pine------- Slash pine---------- Sweetgum------------ Water oak----------- Willow oak----------	95 --- --- --- ---	330 --- --- --- ---	Loblolly pine, slash pine, eastern cottonwood.
HuC------------- Huntsburg	10S	Moderate	Moderate	Moderate	Slight	Loblolly pine------- Shortleaf pine------	94 81	330 270	Loblolly pine.
Ka, Kf---------- Kaufman	4W	Slight	Moderate	Severe	Severe	Water oak-----------	70	58	Water oak, pecan.
Na-------------- Nahatche	6W	Slight	Severe	Moderate	Slight	Water oak----------- Willow oak---------- Eastern cottonwood--	92 91 ---	180 185 ---	Eastern cottonwood, water oak.
ToD------------- Tonkavar	8S	Slight	Moderate	Moderate	Moderate	Loblolly pine------- Shortleaf pine------	80 70	230 170	Loblolly pine, slash pine.

* Volume is the yield in board feet (Doyle rule) per acre per year over a 50-year period for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WOODLAND UNDERSTORY VEGETATION

(Only the soils suitable for production of commercial trees are listed)

Soil name and map symbol	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
		Lb/acre		Pct
ArD: Arriola	Favorable	2,500	Pinehill bluestem	25
	Normal	1,800	Longleaf uniola	15
	Unfavorable	1,000	Indiangrass	10
			Panicum	10
			Purpletop	5
BnB: Bienville	Favorable	---	Pinehill bluestem	20
	Normal	1,100	Little bluestem	20
	Unfavorable	---	Panicum	20
			Longleaf uniola	10
			Threeawn	10
DdA: Derly	Favorable	4,500	Florida paspalum	15
	Normal	3,500	Virginia wildrye	15
	Unfavorable	2,000	Little bluestem	10
			Beaked panicum	10
			Giant cane	10
			Panicum	10
			Redtop panicum	10
			Carolina jointtail	5
EmB: Elmina	Favorable	1,500	Pinehill bluestem	20
	Normal	1,250	Longleaf uniola	10
	Unfavorable	500	Purpletop	10
			Panicum	10
			American beautyberry	10
			Indiangrass	5
			Sedge	5
Gg, Gh: Gladewater	Favorable	3,500	Sedge	20
	Normal	2,000	Paspalum	15
	Unfavorable	1,500	Virginia wildrye	10
			Panicum	10
			Beaked panicum	5
			Purpletop	5
			Pinehill bluestem	5
Gn*:				
Gladewater	Favorable	3,500	Sedge	20
	Normal	2,000	Paspalum	15
	Unfavorable	1,500	Virginia wildrye	10
			Panicum	10
			Beaked panicum	5
			Purpletop	5
			Pinehill bluestem	5
Nahatche	Favorable	3,000	Hairy wildrye	20
	Normal	2,000	Spreading panicum	15
	Unfavorable	1,500	Rustyseed paspalum	15
			Panicum	10
			Bentawn plumegrass	5
			Switchcane	5
Go: Gowker	Favorable	3,500	Virginia wildrye	20
	Normal	2,500	Rustyseed paspalum	15
	Unfavorable	2,000	Beaked panicum	10
			Sedge	10
			Panicum	5
			Switchcane	5

See footnote at end of table.

TABLE 9.--WOODLAND UNDERSTORY VEGETATION--Continued

Soil name and map symbol	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
		Lb/acre		Pct
GpA*:				
Gowker	Favorable	3,500	Virginia wildrye	20
	Normal	2,500	Rustyseed paspalum	15
	Unfavorable	2,000	Beaked panicum	10
			Sedge	10
			Panicum	5
			Switchcane	5
Portersprings	Favorable	2,500	Longleaf uniola	20
	Normal	1,600	Switchgrass	15
	Unfavorable	1,000	Virginia wildrye	15
			Indiangrass	10
			Pinehill bluestem	10
			Purpletop	10
			Eastern gamagrass	10
			American beautyberry	5
			Greenbrier	5
Ha: Hatliff	Favorable	3,000	Spreading panicum	15
	Normal	2,000	Virginia wildrye	15
	Unfavorable	1,500	Rustyseed paspalum	15
			Longleaf uniola	10
			American beautyberry	5
			Peppervine	5
			Muscadine grape	5
HuC: Huntsburg	Favorable	3,500	Pinehill bluestem	30
	Normal	2,500	Indiangrass	10
	Unfavorable	1,500	Longleaf uniola	10
			Panicum	10
			Sedge	10
			Switchgrass	5
			Purpletop	5
			Purple lovegrass	5
Ka, Kf: Kaufman	Favorable	6,000	Virginia wildrye	20
	Normal	3,500	Sedge	20
	Unfavorable	1,500	Longleaf uniola	10
			Rustyseed paspalum	10
			Beaked panicum	5
			Switchgrass	5
			Eastern gamagrass	5
			Panicum	5
			Hawthorn	5
			Yaupon	5
Na: Nahatche	Favorable	3,000	Hairy wildrye	20
	Normal	2,000	Spreading panicum	15
	Unfavorable	1,500	Rustyseed paspalum	15
			Panicum	10
			Bentawn plumegrass	5
			Switchcane	5
ToD: Tonkavar	Favorable	1,400	Pinehill bluestem	15
	Normal	1,200	Longleaf uniola	15
	Unfavorable	800	Indiangrass	10
			Purpletop	10
			Brownseed paspalum	5
			Panicum	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
ArD------------------- Arriola	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Slight----------	Moderate: thin layer.
BeB------------------- Benchley	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
BnB------------------- Bienville	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: droughty.
BoB------------------- Boonville	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
BrA*:					
Bremond--------------	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight----------	Slight.
Wilson---------------	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
BuA------------------- Burleson	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey.	Severe: too clayey.
ChB------------------- Chazos	Slight----------	Slight----------	Moderate: slope, small stones.	Slight----------	Slight.
CrB------------------- Crockett	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----------	Slight.
DdA------------------- Derly	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
DeA*:					
Derly----------------	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Rader----------------	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight----------	Slight.
DmA------------------- Dimebox	Moderate: percs slowly, too clayey.	Moderate: too clayey, percs slowly.	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Severe: too clayey.
DuC------------------- Dutek	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy, slope.	Moderate: too sandy.	Moderate: droughty.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
EeE------------------- Ellis	Moderate: slope, percs slowly, too clayey.	Moderate: slope, too clayey, percs slowly.	Severe: slope.	Moderate: too clayey.	Severe: too clayey.
EmB------------------- Elmina	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
EuB------------------- Eufaula	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
EuE------------------- Eufaula	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: droughty, slope.
FtB------------------- Flatonia	Slight----------	Slight----------	Moderate: slope, small stones.	Slight----------	Slight.
GaB------------------- Gasil	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
Gg-------------------- Gladewater	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
Gh-------------------- Gladewater	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness, flooding.	Severe: wetness, too clayey.	Severe: wetness, flooding, too clayey.
Gn*:					
Gladewater-----------	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness, flooding.	Severe: wetness, too clayey.	Severe: wetness, flooding, too clayey.
Nahatche-------------	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
Go-------------------- Gowker	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
GpA*:					
Gowker---------------	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
Portersprings--------	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight----------	Slight.
GrC------------------- Gredge	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, slope.	Slight----------	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
GrD: Gredge	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
Ha: Hatliff	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
HuC: Huntsburg	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.
JeD: Jedd	Severe: small stones.	Severe: small stones.	Severe: slope, small stones.	Severe: large stones.	Severe: small stones, large stones.
Ka: Kaufman	Severe: flooding, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey.
Kf: Kaufman	Severe: flooding, percs slowly, too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey, flooding, percs slowly.	Severe: too clayey.	Severe: flooding, too clayey.
KuC: Kurten	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: small stones, percs slowly.	Slight	Slight.
LfA: Lufkin	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
MaA: Mabank	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
Na: Nahatche	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
NvB: Navasan	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
PaC: Padina	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
RaB: Rader	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight	Slight.
RbA*:					
Rader	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Slight	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
RbA*:					
Derly	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
RcB Robco	Moderate: wetness, too sandy.	Moderate: wetness, too sandy.	Moderate: slope, small stones, too sandy.	Moderate: wetness, too sandy.	Moderate: wetness, droughty.
RoC, RvC Rosanky	Slight	Slight	Moderate: slope.	Slight	Slight.
SaB Silawa	Slight	Slight	Moderate: slope.	Slight	Slight.
SdB Silstid	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
SpB Spiller	Slight	Slight	Moderate: slope.	Slight	Slight.
TaB Tabor	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, percs slowly.	Slight	Slight.
ToD Tonkavar	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: droughty.
WcA Wilson	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
ZaB, ZaC2 Zack	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, slope.	Slight	Slight.
ZaD Zack	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
ZgC3*:					
Zack	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly, slope.	Slight	Slight.
Gullied land.					
ZuB Zulch	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ard---------------- Arriola	Fair	Good	Good	Fair	Fair	---	Poor	Very poor.	Good	Fair	Poor	---
BeB---------------- Benchley	Good	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
BnB---------------- Bienville	Fair	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	---
Bob---------------- Boonville	Fair	Good	Good	---	---	Good	Fair	Fair	Good	---	Fair	Good.
BrA*:												
Bremond-----------	Fair	Good	Good	Good	---	Good	Poor	Poor	Good	---	Poor	Good.
Wilson------------	Fair	Fair	Good	---	---	Fair	Fair	Fair	Fair	---	Fair	Fair.
BuA---------------- Burleson	Good	Good	Poor	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Poor.
ChB---------------- Chazos	Fair	Good	Good	---	---	Good	Poor	Very poor.	Good	---	Very poor.	Good.
CrB---------------- Crockett	Fair	Good	Good	Good	---	Good	Poor	Poor	Good	---	Poor	Good.
DdA---------------- Derly	Fair	Fair	Good	Fair	Fair	---	Good	Good	Fair	Fair	Good	---
DeA*:												
Derly-------------	Fair	Fair	Good	Fair	Fair	---	Good	Good	Fair	---	Good	Fair.
Rader-------------	Fair	Good	Good	Good	---	Good	Poor	Poor	Good	---	Poor	Good.
DmA---------------- Dimebox	Good	Good	Poor	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Poor.
DuC---------------- Dutek	Poor	Fair	Good	Fair	---	Good	Very poor.	Very poor.	Fair	Fair	Very poor.	Good.
EeE---------------- Ellis	Poor	Fair	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
EmB---------------- Elmina	Poor	Fair	Good	Fair	Fair	---	Poor	Poor	Fair	Fair	Poor	---
EuB, EuE----------- Eufaula	Fair	Fair	Fair	---	---	Good	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
FtB---------------- Flatonia	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Fair.
GaB---------------- Gasil	Good	Good	Good	Good	---	Good	Very poor.	Very poor.	Good	---	Very poor.	Good.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Gg, Gh-------------- Gladewater	Poor	Fair	Fair	Fair	---	---	Poor	Good	Fair	Fair	Fair	---
Gn*:												
Gladewater---------	Poor	Fair	Fair	Fair	---	---	Poor	Good	Fair	Fair	Fair	---
Nahatche----------	Fair	Fair	Fair	Good	Fair	---	Poor	Fair	Fair	Good	Poor	---
Go----------------- Gowker	Poor	Fair	Fair	Good	---	Fair	Poor	Poor	Fair	Good	Poor	Fair.
GpA*:												
Gowker------------	Poor	Fair	Fair	Good	---	---	Poor	Poor	Fair	Good	Poor	---
Portersprings-----	Good	Good	Good	Good	---	---	Poor	Poor	Good	Good	Poor	---
GrC, GrD----------- Gredge	Fair	Good	Good	Good	---	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Ha----------------- Hatliff	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
HuC---------------- Huntsburg	Poor	Fair	Good	Good	Good	---	Poor	Very poor.	Fair	Good	Very poor.	---
JeD---------------- Jedd	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
Ka----------------- Kaufman	Fair	Fair	Poor	Good	---	Fair	Poor	Good	Fair	Good	Fair	Poor.
Kf----------------- Kaufman	Poor	Poor	Fair	Good	---	Fair	Poor	Good	Poor	Good	Fair	Fair.
KuC---------------- Kurten	Fair	Fair	Good	Good	---	Good	Poor	Very poor.	Fair	Good	Very poor.	Good.
LfA---------------- Lufkin	Fair	Good	Fair	Good	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
MaA---------------- Mabank	Fair	Good	Good	Good	---	Fair	Fair	Fair	Good	---	Fair	Fair.
Na----------------- Nahatche	Fair	Fair	Fair	Good	Fair	Fair	Poor	Fair	Fair	Good	Poor	Fair.
NvB---------------- Navasan	Poor	Fair	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
PaC---------------- Padina	Fair	Good	Fair	---	---	Fair	Poor	Very poor.	Fair	---	Very poor.	Fair.
RaB---------------- Rader	Fair	Good	Good	Good	---	Good	Poor	Poor	Good	---	Poor	Good.
RbA*:												
Rader-------------	Fair	Good	Good	Good	---	Good	Poor	Poor	Good	---	Poor	Good.
Derly-------------	Fair	Fair	Good	Fair	Fair	Fair	Good	Good	Fair	---	Good	Fair.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
RcB---------------- Robco	Fair	Fair	Good	---	---	Good	Poor	Very poor.	Fair	---	Very poor.	Good.
RoC, RvC----------- Rosanky	Fair	Good	Good	---	---	Fair	Poor	Very poor.	Good	---	Very poor.	Fair.
SaB---------------- Silawa	Fair	Good	Good	---	---	Good	Poor	Very poor.	Good	---	Very poor.	Good.
SdB---------------- Silstid	Poor	Poor	Fair	Poor	Poor	Good	Poor	Very poor.	Poor	Poor	Very poor.	Fair.
SpB---------------- Spiller	Good	Good	Good	Good	---	Good	Poor	Poor	Good	---	Poor	Good.
TaB---------------- Tabor	Fair	Good	Good	---	---	Good	Very poor.	Very poor.	Good	---	Very poor.	Good.
ToD---------------- Tonkavar	Poor	Fair	Good	Good	Good	---	Poor	Very poor.	Fair	Good	Very poor.	---
WcA---------------- Wilson	Fair	Fair	Good	---	---	Fair	Fair	Fair	Fair	---	Fair	Fair.
ZaB, ZaC2---------- Zack	Fair	Good	Good	Good	---	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
ZaD---------------- Zack	Fair	Good	Good	Good	---	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
ZgC3--------------- Zack	Fair	Good	Good	Good	---	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Gullied land.												
ZuB---------------- Zulch	Fair	Good	Good	Good	---	Fair	Fair	Fair	Good	---	Fair	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
ArD: Arriola	Moderate: depth to rock, too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Moderate: thin layer.
BeB: Benchley	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
BnB: Bienville	Severe: cutbanks cave.	Slight	Moderate: wetness.	Slight	Slight	Moderate: droughty.
BoB: Boonville	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, shrink-swell, wetness.	Severe: wetness.
BrA*:						
Bremond	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Slight.
Wilson	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
BuA: Burleson	Severe: cutbanks cave.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.
ChB: Chazos	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
CrB: Crockett	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
DdA: Derly	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
DeA*:						
Derly	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
Rader	Severe: wetness.	Moderate: wetness.	Severe: wetness, shrink-swell.	Moderate: wetness.	Moderate: wetness.	Slight.
DmA: Dimebox	Severe: cutbanks cave.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
DuC--------------- Dutek	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
EeE--------------- Ellis	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Severe: too clayey.
EmB--------------- Elmina	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
EuB--------------- Eufaula	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
EuE--------------- Eufaula	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
FtB--------------- Flatonia	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Slight.
GaB--------------- Gasil	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Slight.
Gg---------------- Gladewater	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, too clayey.
Gh---------------- Gladewater	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, flooding, too clayey.
Gn*:						
Gladewater-------	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, flooding, too clayey.
Nahatche---------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding.
Go---------------- Gowker	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
GpA*:						
Gowker-----------	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
Portersprings----	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
GrC, GrD----------Gredge	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
Ha----------------Hatliff	Severe: cutbanks cave, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: wetness, flooding.	Severe: wetness, flooding.
HuC---------------Huntsburg	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
JeD---------------Jedd	Severe: large stones.	Severe: large stones.	Severe: large stones.	Severe: slope, large stones.	Severe: large stones.	Severe: small stones, large stones.
Ka----------------Kaufman	Severe: cutbanks cave, wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Severe: too clayey.
Kf----------------Kaufman	Severe: cutbanks cave, wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, shrink-swell.	Severe: shrink-swell, low strength, flooding.	Severe: flooding, too clayey.
KuC---------------Kurten	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Slight.
LfA---------------Lufkin	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
MaA---------------Mabank	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
Na----------------Nahatche	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding.
NvB---------------Navasan	Severe: cutbanks cave.	Slight---------	Moderate: wetness.	Slight---------	Slight---------	Moderate: droughty.
PaC---------------Padina	Severe: cutbanks cave.	Slight---------	Slight---------	Slight---------	Slight---------	Moderate: droughty.
RaB---------------Rader	Severe: wetness.	Moderate: wetness.	Severe: wetness, shrink-swell.	Moderate: wetness.	Moderate: wetness.	Slight.
RbA*:						
Rader------------	Severe: wetness.	Moderate: wetness.	Severe: wetness, shrink-swell.	Moderate: wetness.	Moderate: wetness.	Slight.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
RbA*:						
Derly	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
RcB Robco	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness, shrink-swell.	Moderate: wetness.	Moderate: wetness.	Moderate: wetness, droughty.
RoC, RvC Rosanky	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Slight.
SaB Silawa	Slight	Slight	Slight	Slight	Slight	Slight.
SdB Silstid	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
SpB Spiller	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
TaB Tabor	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.	Slight.
ToD Tonkavar	Severe: cutbanks cave.	Slight	Moderate: wetness.	Moderate: slope.	Slight	Moderate: droughty.
WcA Wilson	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
ZaB Zack	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell.	Severe: low strength.	Slight.
ZaC2 Zack	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
ZaD Zack	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
ZgC3*:						
Zack	Moderate: too clayey.	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
Gullied land.						
ZuB Zulch	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
ArD Arriola	Severe: depth to rock, percs slowly.	Severe: depth to rock.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
BeB Benchley	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
BnB Bienville	Moderate: wetness.	Severe: seepage.	Severe: seepage, wetness.	Severe: seepage.	Fair: too sandy.
BoB Boonville	Severe: wetness, percs slowly.	Moderate	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
BrA*:					
Bremond	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Wilson	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
BuA Burleson	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
ChB Chazos	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
CrB Crockett	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
DdA Derly	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
DeA*:					
Derly	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Rader	Severe: wetness, percs slowly.	Slight	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
DmA: Dimebox	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
DuC: Dutek	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
EeE: Ellis	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
EmB: Elmina	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Severe: depth to rock, wetness.	Severe: seepage.	Fair: depth to rock, too sandy, wetness.
EuB: Eufaula	Severe: poor filter.	Severe: seepage.	Severe: seepage.	Severe: seepage.	Poor: seepage.
EuE: Eufaula	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Poor: seepage.
FtB: Flatonia	Severe: percs slowly.	Moderate: depth to rock, slope.	Severe: depth to rock, too clayey.	Moderate: depth to rock.	Poor: too clayey, hard to pack.
GaB: Gasil	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Gg, Gh: Gladewater	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Gn*:					
Gladewater	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Nahatche	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
Go: Gowker	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.
GpA*:					
Gowker	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, thin layer.
Portersprings	Severe: wetness, percs slowly.	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Fair: too clayey, wetness.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
GrC, GrD: Gredge	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Ha: Hatliff	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, seepage, wetness.	Poor: seepage, too sandy, wetness.
HuC: Huntsburg	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
JeD: Jedd	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: depth to rock, too clayey.
Ka, Kf: Kaufman	Severe: flooding, wetness, percs slowly.	Slight	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack.
KuC: Kurten	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
LfA: Lufkin	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
MaA: Mabank	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Na: Nahatche	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
NvB: Navasan	Severe: wetness, percs slowly, poor filter.	Severe: seepage, wetness.	Moderate: wetness, too sandy.	Severe: seepage.	Fair: too sandy, wetness.
PaC: Padina	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
RaB: Rader	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
RbA*:					
Rader	Severe: wetness, percs slowly.	Slight	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.

See footnote at end of table.

TABLE 13.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
RbA*:					
Derly	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
RcB Robco	Severe: wetness, percs slowly, poor filter.	Severe: seepage.	Severe: wetness.	Severe: seepage.	Poor: thin layer.
RoC, RvC Rosanky	Severe: percs slowly.	Moderate: slope.	Slight	Slight	Poor: thin layer.
SaB Silawa	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer.
SdB Silstid	Slight	Severe: seepage.	Moderate: too sandy.	Severe: seepage.	Poor: seepage.
SpB Spiller	Severe: percs slowly.	Severe: seepage.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
TaB Tabor	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
ToD Tonkavar	Severe: poor filter.	Severe: seepage.	Severe: too sandy.	Severe: seepage.	Poor: seepage, too sandy.
WcA Wilson	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
ZaB, ZaC2 Zack	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
ZaD Zack	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
ZgC3*:					
Zack	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Gullied land.					
ZuB Zulch	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
ArD------------------- Arriola	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
BeB------------------- Benchley	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
BnB------------------- Bienville	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
BoB------------------- Boonville	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
BrA*:				
Bremond--------------	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Wilson---------------	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
BuA------------------- Burleson	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
ChB------------------- Chazos	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
CrB------------------- Crockett	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
DdA------------------- Derly	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
DeA*:				
Derly----------------	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Rader----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
DmA------------------- Dimebox	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
DuC: Dutek	Good	Probable	Improbable: too sandy.	Fair: too sandy.
EeE: Ellis	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
EmB: Elmina	Fair: area reclaim, thin layer, wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
EuB: Eufaula	Good	Probable	Improbable: too sandy.	Fair: too sandy.
EuE: Eufaula	Good	Probable	Improbable: too sandy.	Fair: too sandy, slope.
FtB: Flatonia	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
GaB: Gasil	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Gg, Gh: Gladewater	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Gn*:				
Gladewater	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Nahatche	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Go: Gowker	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
GpA*:				
Gowker	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Portersprings	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
GrC, GrD: Gredge	Fair: shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ha: Hatliff	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness, too sandy.
HuC: Huntsburg	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
JeD: Jedd		Improbable: excess fines.	Improbable: excess fines.	Poor: large stones.
Ka: Kaufman	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Kf: Kaufman	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
KuC: Kurten	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
LfA: Lufkin	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
MaA: Mabank	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Na: Nahatche	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
NvB: Navasan	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy.
PaC: Padina	Good	Probable	Improbable: too sandy.	Poor: too sandy.
RaB: Rader	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
RbA*:				
Rader	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.
Derly	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
RcB: Robco	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too sandy, small stones.
RoC, RvC: Rosanky	Fair: thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
SaB: Silawa	Good	Probable	Probable	Fair: too clayey, small stones, area reclaim.
SdB: Silstid	Good	Probable	Improbable: too sandy.	Fair: too sandy.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
SpB------------------- Spiller	Good-----------------	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
TaB------------------- Tabor	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
ToD------------------- Tonkavar	Good-----------------	Probable-------------	Improbable: too sandy.	Poor: too sandy.
WcA------------------- Wilson	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
ZaB, ZaC2------------- Zack	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
ZaD------------------- Zack	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
ZgC3*:				
Zack-----------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Gullied land.				
ZuB------------------- Zulch	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
ArD-----------------Arriola	Moderate: depth to rock.	Severe: hard to pack.	Severe: no water.	Deep to water	Percs slowly, depth to rock, slope.	Erodes easily, depth to rock, percs slowly.
BeB-----------------Benchley	Slight---------	Severe: hard to pack.	Severe: no water.	Deep to water	Percs slowly, slope.	Percs slowly.
BnB-----------------Bienville	Severe: seepage.	Severe: piping, seepage.	Severe: cutbanks cave.	Deep to water	Droughty, fast intake.	Droughty.
BoB-----------------Boonville	Slight---------	Severe: wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly.	Wetness, erodes easily, percs slowly.
BrA*:						
Bremond-----------	Slight---------	Severe: hard to pack.	Severe: no water.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.
Wilson------------	Slight---------	Severe: hard to pack, wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly.	Wetness, erodes easily, percs slowly.
BuA-----------------Burleson	Slight---------	Severe: hard to pack.	Severe: no water.	Deep to water	Slow intake, percs slowly.	Percs slowly.
ChB-----------------Chazos	Slight---------	Moderate: hard to pack.	Severe: no water.	Deep to water	Fast intake, soil blowing, percs slowly.	Percs slowly.
CrB-----------------Crockett	Slight---------	Severe: hard to pack.	Severe: no water.	Deep to water	Percs slowly, erodes easily.	Erodes easily, percs slowly.
DdA-----------------Derly	Slight---------	Severe: hard to pack, wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly, erodes easily.	Wetness, erodes easily, percs slowly.
DeA*:						
Derly-------------	Slight---------	Severe: wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly, erodes easily.	Wetness, erodes easily, percs slowly.
Rader-------------	Slight---------	Moderate: hard to pack, wetness.	Severe: no water.	Percs slowly---	Wetness--------	Percs slowly.
DmA-----------------Dimebox	Slight---------	Severe: hard to pack.	Severe: no water.	Deep to water	Slow intake, percs slowly.	Percs slowly.
DuC-----------------Dutek	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake, slope.	Droughty.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
EeE: Ellis	Slight	Severe: hard to pack.	Severe: no water.	Deep to water	Slow intake, percs slowly, slope.	Slope, percs slowly.
EmB: Elmina	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Percs slowly, cutbanks cave.	Wetness, droughty.	Droughty, percs slowly.
EuB: Eufaula	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
EuE: Eufaula	Severe: seepage, slope.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Slope, droughty.
FtB: Flatonia	Slight	Severe: hard to pack.	Severe: no water.	Deep to water	Percs slowly	Percs slowly.
GaB: Gasil	Moderate: seepage.	Severe: piping.	Severe: no water.	Deep to water	Soil blowing, slope.	Favorable.
Gg, Gh: Gladewater	Slight	Severe: hard to pack, wetness.	Severe: slow refill.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.
Gn*:						
Gladewater	Slight	Severe: hard to pack, wetness.	Severe: slow refill.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Wetness, percs slowly.
Nahatche	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding	Wetness, flooding.	Wetness.
Go: Gowker	Moderate: seepage.	Severe: wetness.	Severe: no water.	Percs slowly, flooding.	Wetness, percs slowly, flooding.	Wetness, erodes easily, percs slowly.
GpA*:						
Gowker	Moderate: seepage.	Severe: wetness.	Severe: no water.	Percs slowly, flooding.	Wetness, percs slowly, flooding.	Wetness, erodes easily, percs slowly.
Portersprings	Slight	Moderate: wetness.	Severe: slow refill, cutbanks cave.	Favorable	Wetness	Favorable.
GrC, GrD: Gredge	Slight	Moderate: hard to pack.	Severe: no water.	Deep to water	Soil blowing, percs slowly, slope.	Erodes easily, percs slowly.
Ha: Hatliff	Severe: seepage.	Severe: seepage, piping, wetness.	Severe: cutbanks cave.	Flooding, cutbanks cave.	Wetness, droughty.	Wetness, droughty.
HuC: Huntsburg	Slight	Severe: wetness.	Severe: no water.	Percs slowly, slope.	Slope, wetness.	Wetness, percs slowly.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
JeD---------------- Jedd	Moderate: depth to rock.	Severe: piping.	Severe: no water.	Deep to water	Slope----------	Large stones, slope, droughty.
Ka, Kf------------ Kaufman	Slight---------	Severe: hard to pack, wetness.	Severe: slow refill.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Percs slowly.
KuC---------------- Kurten	Slight---------	Severe: hard to pack.	Severe: no water.	Deep to water	Soil blowing, percs slowly, erodes easily.	Erodes easily, percs slowly.
LfA---------------- Lufkin	Slight---------	Severe: hard to pack, wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly, erodes easily.	Wetness, erodes easily, percs slowly.
MaA---------------- Mabank	Slight---------	Severe: wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Na----------------- Nahatche	Moderate: seepage.	Severe: wetness.	Moderate: slow refill.	Flooding-------	Wetness, flooding.	Wetness.
NvB---------------- Navasan	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake.	Droughty.
PaC---------------- Padina	Severe: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Droughty, fast intake.	Droughty.
RaB---------------- Rader	Slight---------	Moderate: hard to pack, wetness.	Severe: no water.	Percs slowly---	Wetness--------	Percs slowly.
RbA*:						
Rader------------	Slight---------	Moderate: hard to pack, wetness.	Severe: no water.	Percs slowly---	Wetness--------	Percs slowly.
Derly------------	Slight---------	Severe: wetness.	Severe: no water.	Percs slowly---	Wetness, percs slowly, erodes easily.	Wetness, erodes easily, percs slowly.
RcB---------------- Robco	Severe: seepage.	Moderate: wetness.	Severe: no water.	Percs slowly---	Wetness--------	Erodes easily, droughty, percs slowly.
RoC---------------- Rosanky	Slight---------	Severe: piping.	Severe: no water.	Deep to water	Slope----------	Erodes easily.
RvC---------------- Rosanky	Slight---------	Severe: piping.	Severe: no water.	Deep to water	Slope----------	Erodes easily.
SaB---------------- Silawa	Severe: seepage.	Moderate: piping.	Severe: no water.	Deep to water	Slope, soil blowing.	Favorable.
SdB---------------- Silstid	Moderate: seepage.	Severe: seepage, piping.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Features affecting-- Drainage	Irrigation	Grassed waterways
SpB: Spiller	Slight	Moderate: hard to pack.	Severe: no water.	Deep to water	Fast intake, percs slowly, soil blowing.	Percs slowly.
TaB: Tabor	Slight	Moderate: hard to pack.	Severe: no water.	Deep to water	Soil blowing, percs slowly.	Erodes easily, percs slowly.
ToD: Tonkavar	Severe: seepage.	Severe: seepage.	Severe: no water.	Deep to water	Slope, droughty, fast intake.	Droughty.
WcA: Wilson	Slight	Severe: hard to pack, wetness.	Severe: no water.	Percs slowly	Wetness, percs slowly.	Wetness, erodes easily, percs slowly.
ZaB, ZaC2: Zack	Slight	Moderate: piping.	Severe: no water.	Deep to water	Slope, soil blowing, percs slowly.	Erodes easily, percs slowly.
ZaD: Zack	Slight	Moderate: piping.	Severe: no water.	Deep to water	Slope, soil blowing, percs slowly.	Erodes easily, percs slowly.
ZgC3*:						
Zack	Slight	Moderate: piping.	Severe: no water.	Deep to water	Slope, soil blowing, percs slowly.	Erodes easily, percs slowly.
Gullied land.						
ZuB: Zulch	Slight	Severe: wetness.	Severe: no water.	Percs slowly	Wetness, percs slowly, soil blowing.	Wetness, erodes easily, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
ArD-------------- Arriola	0-8	Fine sandy loam	SM, ML, CL-ML	A-4	0	95-100	95-100	75-95	45-70	<30	NP-7
	8-36	Clay-------------	CL, CH	A-7	0	95-100	95-100	90-100	75-95	43-60	18-30
	36-50	Weathered bedrock	---	---	---	---	---	---	---	---	---
BeB-------------- Benchley	0-12	Clay loam--------	CL	A-6, A-7	0	90-100	90-100	80-95	60-80	30-43	11-22
	12-19	Clay loam, clay	CL, CH	A-7	0	90-100	90-100	80-95	70-95	44-66	23-41
	19-72	Clay-------------	CH	A-7	0	95-100	90-100	90-100	75-95	56-75	33-46
	72-80	Stratified clay to shaly clay.	CL, CH	A-7	0	95-100	90-100	60-90	50-85	41-60	21-36
BnB-------------- Bienville	0-6	Loamy fine sand	SM	A-2-4, A-4	0	100	100	90-100	15-50	<25	NP-3
	6-80	Loamy fine sand, fine sandy loam, fine sand.	SM, ML	A-2-4, A-4	0	100	100	90-100	20-55	<25	NP-3
BoB-------------- Boonville	0-15	Fine sandy loam	ML, SM, CL-ML, SM-SC	A-4	0-1	95-100	85-98	70-95	40-65	<20	NP-7
	15-24	Clay-------------	CH, CL	A-7	0	95-100	90-100	85-100	70-90	45-65	25-40
	24-40	Clay loam, sandy clay loam, clay.	CH, CL	A-7, A-6	0	95-100	95-100	80-100	50-95	35-60	15-35
	40-80	Clay loam, sandy clay loam.	CL, SC	A-7, A-6	0-1	80-95	80-95	65-90	35-80	35-50	15-30
BrA*:											
Bremond---------	0-8	Loam-------------	CL, CL-ML, SC, SM	A-4, A-6	0-2	98-100	95-100	89-100	40-95	15-35	3-15
	8-18	Clay-------------	CH, CL	A-7, A-6	0-2	98-100	95-100	85-100	65-98	41-59	23-42
	18-68	Clay loam, clay	CH, CL	A-7, A-6	0-2	98-100	95-100	85-100	65-98	41-59	23-42
	68-80	Sandy clay loam, clay loam, clay.	CH, CL	A-7, A-6	0-2	90-100	85-100	75-100	53-98	35-59	20-42
Wilson----------	0-6	Loam-------------	CL	A-6	0	95-100	85-100	80-100	60-96	26-38	11-20
	6-42	Silty clay, clay, clay loam.	CL, CH	A-7-6	0	90-100	80-100	80-100	65-96	43-56	26-37
	42-80	Silty clay, clay, silty clay loam.	CL, CH	A-7-6, A-6	0	95-100	90-100	85-100	70-96	38-65	24-48
BuA-------------- Burleson	0-10	Clay-------------	CH, CL	A-7-6	0-2	90-100	90-100	90-99	67-97	45-57	28-39
	10-52	Clay, silty clay	CH	A-7-6	0-1	90-100	90-100	90-99	80-99	51-72	34-48
	52-80	Clay, silty clay	CH	A-7-6	0-2	90-100	80-100	75-99	67-98	60-84	40-60
ChB-------------- Chazos	0-14	Loamy fine sand	SM, SM-SC	A-2-4, A-4	0	80-100	80-100	60-98	20-50	<25	NP-4
	14-23	Clay, sandy clay	CL, CH	A-7-6	0	90-100	90-100	90-100	55-85	43-58	21-35
	23-63	Clay, sandy clay	CL, CH	A-7-6	0	90-100	90-100	90-100	55-85	43-58	21-35
	63-80	Clay, sandy clay, sandy clay loam.	CL, CH	A-7-6, A-6	0	90-100	90-100	80-100	50-80	35-55	15-35

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
CrB-------------- Crockett	0-6	Loam-------------	SM, ML, CL, SC	A-4, A-6	0-2	98-100	94-100	89-100	40-96	15-35	3-15
	6-17	Clay, clay loam, sandy clay.	CH, CL	A-7, A-6	0	89-100	85-100	85-100	63-98	40-59	23-42
	17-45	Clay, clay loam, sandy clay.	CH, CL	A-7, A-6	0	89-100	85-100	85-100	64-98	40-59	23-42
	45-60	Clay loam, sandy clay loam, clay.	CL, CH	A-6, A-7	0-5	90-100	85-100	75-100	53-90	30-60	15-40
	60-80	Stratified loam to very shaly clay.	CH, CL	A-7	0-5	90-100	90-100	90-100	72-99	45-71	27-52
DdA-------------- Derly	0-7	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	85-100	55-90	<30	NP-10
	7-23	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-95	35-60	20-36
	23-52	Clay, silty clay	CH, CL	A-7, A-6	0	100	100	90-100	75-95	39-60	26-36
	52-80	Clay, silty clay, clay loam.	CH, CL	A-7, A-6	0	100	100	90-100	56-95	34-60	20-36
DeA*:											
Derly-----------	0-6	Loam-------------	ML, CL, CL-ML	A-4	0	100	100	85-100	55-90	<30	NP-10
	6-23	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-95	35-60	20-36
	23-38	Clay, silty clay	CH, CL	A-7, A-6	0	100	100	90-100	75-95	38-60	26-36
	38-80	Clay, silty clay, clay loam.	CH, CL	A-7, A-6	0	100	100	90-100	56-95	34-60	20-36
Rader-----------	0-24	Fine sandy loam	ML, CL, SC, SM	A-2, A-4	0	95-100	95-100	90-100	34-72	18-28	3-10
	24-34	Sandy clay loam, loam, clay loam.	SC, CL	A-6, A-4	0	95-100	95-100	90-100	36-75	26-40	11-22
	34-50	Sandy clay, clay, clay loam.	CL, CH	A-6, A-7	0	95-100	95-100	90-100	51-90	36-60	18-38
	50-80	Sandy clay loam, sandy clay, clay.	SC, CL, CH	A-6, A-7	0	95-100	95-100	90-100	36-75	25-52	11-36
DmA-------------- Dimebox	0-6	Silty clay-------	CH	A-7-6, A-7-5	0	90-100	90-100	90-100	85-96	51-90	27-55
	6-52	Clay, silty clay	CH	A-7-6, A-7-5	0	90-100	90-100	90-100	85-96	51-90	27-55
	52-91	Clay-------------	CH	A-7-6, A-7-5	0	90-100	90-100	85-100	75-96	51-90	30-57
DuC-------------- Dutek	0-7	Loamy fine sand	SM, SP-SM	A-2, A-3	0	95-100	95-100	85-100	9-25	<22	NP-3
	7-26	Loamy fine sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	85-100	9-25	<22	NP-3
	26-45	Sandy clay loam, clay loam, sandy clay.	CL, SC, SM-SC, CL-ML	A-2, A-4, A-6	0	98-100	95-100	90-100	30-55	24-40	6-20
	45-80	Fine sandy loam, sandy clay loam, loam.	SC, SM-SC, CL-ML, CL	A-2, A-4, A-6	0	95-100	95-100	90-100	22-55	20-40	4-20

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
EeE-------------- Ellis	0-3	Clay-------------	CH	A-7-6	0-5	95-100	95-100	95-100	75-95	51-75	30-50
	3-25	Clay-------------	CH	A-7-6	0-5	95-100	95-100	95-100	75-95	51-75	30-50
	25-80	Shaly clay, very shaly clay, clay.	CH	A-7-6	0-5	95-100	95-100	90-100	75-95	51-75	30-50
EmB-------------- Elmina	0-5	Loamy fine sand	SM, SM-SC	A-2-4, A-4	0	95-100	95-100	60-95	15-40	<25	NP-4
	5-25	Loamy fine sand, fine sand.	SM, SM-SC	A-2-4, A-4	0	95-100	95-100	60-95	15-40	<25	NP-4
	25-47	Clay, sandy clay	CH	A-7-6	0	95-100	95-100	85-100	51-95	51-65	27-40
	47-58	Clay, sandy clay, sandy clay loam.	CH, CL, SC	A-7-6, A-6	0	95-100	95-100	85-100	40-95	35-65	20-40
	58-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
EuB-------------- Eufaula	0-60	Loamy fine sand	SM	A-2	0	100	98-100	90-100	15-35	<25	NP-4
	60-80	Loamy fine sand, fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100	5-35	<25	NP-4
EuE-------------- Eufaula	0-48	Loamy fine sand	SM	A-2	0	100	98-100	90-100	15-35	<25	NP-4
	48-80	Loamy fine sand, fine sand, fine sandy loam.	SM, SP-SM	A-2, A-3	0	100	98-100	82-100	5-35	<25	NP-4
FtB-------------- Flatonia	0-7	Clay loam--------	SC, CL, CH	A-6, A-7-6	0	80-100	80-100	75-100	40-70	39-56	21-34
	7-40	Clay, sandy clay, silty clay.	CH, CL	A-7-6	0	95-100	90-100	90-100	50-80	46-64	28-41
	40-48	Clay, clay loam, sandy clay.	CH, CL	A-7-6, A-6	0	95-100	90-100	80-100	60-90	35-56	15-34
	48-80	Silt loam, silty clay loam, silty clay.	CL, CH	A-6, A-7-6	0	95-100	85-100	80-100	55-98	35-70	15-45
GaB-------------- Gasil	0-8	Fine sandy loam	CL, ML, SC, SM	A-4	0	95-100	95-100	85-100	36-55	20-28	2-10
	8-80	Sandy clay loam, loam, fine sandy loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	95-100	95-100	85-100	36-71	22-40	7-20
Gg--------------- Gladewater	0-9	Clay-------------	CH, CL	A-7	0	100	100	90-100	80-95	48-75	25-50
	9-80	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	51-75	30-50
Gh--------------- Gladewater	0-7	Clay-------------	CH, CL	A-7	0	100	100	90-100	80-95	48-75	25-50
	7-80	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	51-75	30-50
Gn*:											
Gladewater------	0-9	Clay-------------	CH, CL	A-7	0	100	100	90-100	80-95	48-75	25-50
	9-80	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	51-75	30-50
Nahatche--------	0-13	Clay loam, loam	CL, SC	A-4, A-6	0	95-100	95-100	70-90	35-55	25-35	7-15
	13-80	Loam, clay loam, silty clay loam.	CL	A-6, A-4	0	100	100	85-100	60-90	25-40	8-20
Go--------------- Gowker	0-8	Clay loam--------	CL, SC	A-6	0	95-100	95-100	85-100	40-80	30-40	11-18
	8-45	Clay, clay loam, sandy clay.	CL	A-6, A-7	0	95-100	95-100	85-100	70-95	38-48	15-21
	45-80	Clay, sandy clay loam, clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	80-100	40-90	30-48	11-21

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments 3-10 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
GpA*:											
Gowker	0-25	Sandy clay loam	CL, SC	A-6	0	95-100	95-100	85-100	40-80	30-40	11-18
	25-51	Clay, clay loam, sandy clay.	CL	A-6, A-7	0	95-100	95-100	85-100	70-95	38-48	15-21
	51-80	Clay, sandy clay loam, clay loam.	CL, SC	A-6, A-7	0	95-100	95-100	80-100	40-90	30-48	11-21
Portersprings	0-15	Fine sandy loam	CL-ML, SC, SM, CL	A-4	0	100	95-100	85-100	36-75	21-30	3-10
	15-34	Sandy clay loam, clay loam.	CL	A-6, A-4	0	100	95-100	85-100	50-80	20-40	9-25
	34-58	Fine sandy loam, sandy clay loam.	CL, SC	A-4, A-6	0	100	95-100	85-100	40-60	20-35	9-20
	58-80	Fine sandy loam, loamy fine sand.	SM, SM-SC, SC	A-2-4, A-4	0	100	95-100	85-100	20-49	<25	NP-10
GrC	0-7	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4	0-1	90-100	90-100	75-85	35-55	<31	NP-7
Gredge											
	7-32	Sandy clay, clay	CH, CL	A-7-6	0-1	90-100	85-100	75-100	51-98	45-65	28-42
	32-45	Clay loam, sandy clay loam.	CL, CH	A-7-6	0-1	90-100	90-100	80-100	51-85	41-60	25-40
	45-63	Clay loam, sandy clay loam.	CL, SC	A-6, A-7-6	0-1	90-100	90-100	80-100	36-80	35-50	15-30
	63-80	Clay loam, sandy clay loam, fine sandy loam.	SC, CL	A-4, A-6	0-3	90-100	90-100	65-100	36-75	22-40	7-20
GrD	0-5	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-4	0-1	90-100	90-100	75-85	35-55	<31	NP-7
Gredge											
	5-24	Sandy clay, clay	CH, CL	A-7-6	0-1	90-100	85-100	75-100	51-98	45-65	28-42
	24-46	Clay loam, sandy clay loam.	CL, CH	A-7-6	0-1	90-100	90-100	80-100	51-85	41-60	25-40
	46-80	Clay loam, sandy clay loam, fine sandy loam.	SC, CL	A-4, A-6	0-3	90-100	90-100	65-100	36-75	22-40	7-20
Ha	0-9	Fine sandy loam	SM, CL, ML, SC	A-4	0	100	95-100	65-95	36-55	<30	NP-10
Hatliff											
	9-80	Stratified loam to sand.	SP-SM, SM, SC, SM-SC	A-2-4, A-4, A-3	0	100	95-100	50-90	5-45	<30	NP-9
HuC	0-18	Loamy fine sand	SM, SM-SC	A-2-4, A-4	0	90-100	85-100	50-95	15-45	<25	NP-4
Huntsburg											
	18-58	Sandy clay, clay	CL, CH, SC	A-7	0	90-100	90-100	70-100	36-90	44-55	22-30
	58-74	Clay loam, sandy clay, clay.	CL, CH, SC	A-7	0	90-100	90-100	70-100	36-90	48-62	25-36
JeD	0-5	Fine sandy loam	SM, ML	A-4	0-2	85-100	80-100	70-100	36-70	<30	NP-7
Jedd	5-25	Clay, sandy clay, sandy clay loam.	CL, SC, CH	A-7-6, A-6, A-7-5	0-4	90-100	90-100	70-100	34-87	35-61	15-29
	25-60	Cemented, unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments 3-10 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ka--------------- Kaufman	0-6	Clay-------------	CH	A-7-6, A-7-5	0	100	100	90-100	80-100	56-96	33-62
	6-58	Clay-------------	CH	A-7-6, A-7-5	0	100	100	95-100	90-100	65-102	45-71
	58-80	Clay-------------	CH	A-7-6, A-7-5	0	100	100	95-100	85-100	64-102	45-71
Kf--------------- Kaufman	0-10	Clay-------------	CH	A-7-6, A-7-5	0	100	100	90-100	80-100	56-96	33-62
	10-54	Clay-------------	CH	A-7-6, A-7-5	0	100	100	95-100	90-100	65-102	45-71
	54-80	Clay-------------	CH	A-7-6, A-7-5	0	100	100	95-100	85-100	64-102	45-71
KuC-------------- Kurten	0-8	Fine sandy loam	SM, ML, SM-SC	A-2-4, A-4	0-2	95-100	95-100	85-100	34-80	15-30	NP-7
	8-51	Clay, silty clay	CH, CL	A-7-6	0-2	95-100	95-100	89-100	65-95	41-59	25-42
	51-58	Clay, silty clay	CH, CL	A-7-6	0-1	95-100	95-100	89-100	65-95	41-59	25-42
	58-80	Clay, clay loam, loam.	CH, CL	A-6, A-7-6	0-1	95-100	95-100	89-100	60-90	35-59	20-40
LfA-------------- Lufkin	0-9	Fine sandy loam	SM, CL, ML, SC	A-4	0-5	90-100	80-100	80-100	40-85	<30	NP-10
	9-44	Clay, clay loam, silty clay loam.	CH, CL	A-7-6	0	90-100	90-100	90-100	65-95	45-67	30-45
	44-80	Clay, clay loam, sandy clay loam.	CH, CL, SC	A-7	0	70-100	70-100	55-100	44-90	40-86	25-55
MaA-------------- Mabank	0-10	Fine sandy loam	CL, CL-ML, SM-SC, SC	A-4, A-6	0	95-100	95-100	80-98	40-70	19-32	4-15
	10-45	Clay, clay loam	CH, CL	A-7, A-6	0	95-100	95-100	95-100	60-85	38-55	22-37
	45-65	Clay, clay loam	CH, CL	A-7, A-6	0	95-100	95-100	95-100	60-85	38-55	22-37
Na--------------- Nahatche	0-8	Loam-------------	CL	A-6, A-7, A-4	0	100	100	90-100	54-92	25-47	8-25
	8-39	Loam, clay loam, silty clay loam.	CL	A-6, A-4	0	100	100	85-100	60-90	25-40	8-20
	39-60	Stratified loam to silty clay loam.	CL	A-6, A-7	0	100	100	90-100	60-90	30-45	11-25
NvB-------------- Navasan	0-8	Loamy fine sand	SM, SM-SC	A-2-4	0	95-100	95-100	50-75	15-35	<25	NP-5
	8-45	Loamy fine sand, loamy sand.	SM, SM-SC	A-2-4	0	95-100	95-100	50-75	15-35	<25	NP-5
	45-55	Sandy loam, fine sandy loam.	SM, SC, ML, CL	A-4	0-1	90-100	90-100	60-85	35-60	20-30	3-10
	55-75	Sandy clay loam, clay loam.	SC, CL	A-4, A-6	0-1	90-100	90-100	65-95	35-75	22-36	8-20
PaC-------------- Padina	0-5	Loamy fine sand	SM, SM-SC	A-2-4	0	100	95-100	85-100	15-35	<25	NP-5
	5-52	Fine sand, loamy fine sand.	SM, SP-SM, SM-SC	A-2-4, A-3	0	100	95-100	85-100	8-28	<25	NP-5
	52-80	Sandy clay loam, fine sandy loam.	SC, CL	A-2, A-4, A-6, A-7	0	90-100	90-100	90-100	25-65	22-42	8-22

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments 3-10 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
RaB-------------- Rader	0-25	Fine sandy loam	ML, CL, SC, SM	A-2, A-4	0	95-100	95-100	90-100	34-72	18-28	3-10
	25-34	Sandy clay loam, loam, clay loam.	SC, CL	A-6	0	95-100	95-100	90-100	36-75	26-40	11-22
	34-50	Sandy clay, clay, clay loam.	CL, CH	A-6, A-7	0	95-100	95-100	90-100	51-90	36-60	18-38
	50-96	Sandy clay loam, sandy clay, clay.	SC, CL, CH	A-6, A-7	0	95-100	95-100	90-100	36-75	25-52	11-36
RbA*:											
Rader-----------	0-24	Very fine sandy loam.	ML, CL, SC, SM	A-2, A-4	0	95-100	95-100	90-100	34-72	18-28	3-10
	24-29	Sandy clay loam, loam, clay loam.	SC, CL	A-6	0	95-100	95-100	90-100	36-75	26-40	11-22
	29-33	Sandy clay, clay, clay loam.	CL, CH	A-6, A-7	0	95-100	95-100	90-100	51-90	36-60	18-38
	33-80	Sandy clay loam, sandy clay, clay.	SC, CL, CH	A-6, A-7	0	95-100	95-100	90-100	36-75	25-52	11-36
Derly-----------	0-8	Loam-------------	ML, CL, CL-ML	A-4	0	100	100	85-100	55-90	<30	NP-10
	8-22	Clay loam, silty clay loam, silty clay.	CL, CH	A-7, A-6	0	100	100	90-100	70-95	35-60	20-36
	22-46	Clay, silty clay	CH, CL	A-7, A-6	0	100	100	90-100	75-95	38-60	26-36
	46-80	Clay, silty clay, clay loam.	CH, CL	A-7, A-6	0	100	100	90-100	56-95	34-60	20-36
RcB-------------- Robco	0-8	Loamy fine sand	SM, SP-SM	A-2-4, A-3	0	80-100	80-100	65-95	8-35	<25	NP-3
	8-24	Loamy fine sand, fine sand.	SM, SP-SM	A-2-4, A-3	0	80-100	80-100	65-95	8-35	<25	NP-3
	24-28	Sandy clay loam, loam, clay loam.	SC, CL	A-6, A-4	0	98-100	98-100	80-100	36-75	26-40	8-22
	28-80	Clay loam, sandy clay loam.	CL	A-6, A-7	0	98-100	98-100	80-100	50-80	36-50	16-28
RoC-------------- Rosanky	0-5	Fine sandy loam	SM	A-2-4, A-4	0-2	80-100	75-100	75-100	30-50	<30	NP-7
	5-39	Sandy clay, clay	CL, SC, CH	A-6, A-7-6	0-2	85-100	75-100	75-100	49-90	37-56	19-34
	39-64	Sandy clay loam, fine sandy loam.	SC, CL, CL-ML, SM-SC	A-4, A-6	0	80-100	75-100	75-100	36-60	23-40	5-19
	64-80	Weathered bedrock	---	---	---	---	---	---	---	---	---
RvC-------------- Rosanky	0-10	Gravelly fine sandy loam.	SM	A-2-4, A-4	0-5	65-85	35-78	35-75	25-45	<30	NP-7
	10-28	Sandy clay, clay	CL, SC, CH	A-6, A-7-6	0-2	85-100	75-100	75-100	49-90	37-56	19-34
	28-60	Sandy clay loam, fine sandy loam.	SC, CL, CL-ML, SM-SC	A-4, A-6	0	80-100	75-100	75-100	36-60	23-40	5-19
	60-80	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
SaB-------------- Silawa	0-10	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4	0	95-100	95-100	70-100	40-60	<26	NP-7
	10-57	Sandy clay loam, fine sandy loam.	CL, SC	A-4, A-6	0	85-100	85-100	80-100	35-65	25-40	8-18
	57-80	Fine sandy loam, gravelly fine sandy loam, sandy clay loam.	CL, CL-ML, SC, SM-SC	A-4, A-6, A-2-4, A-2-6	0-2	70-100	70-100	38-100	18-60	21-34	4-14
SdB-------------- Silstid	0-8	Loamy fine sand	SM, SP-SM	A-2-4, A-3	0-1	90-100	85-100	80-100	9-25	<25	NP-3
	8-32	Fine sand, loamy fine sand.	SM, SP-SM	A-2, A-4, A-3	0-1	90-100	85-100	80-100	9-25	<25	NP-3
	32-60	Sandy clay loam, loam, fine sandy loam.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2-4, A-2-6	0-1	90-100	85-200	75-100	30-55	20-43	4-26
	60-80	Sandy clay loam, loam, fine sandy loam.	SC, CL, SM-SC, CL-ML	A-4, A-6, A-2-4, A-2-6	0-1	90-100	80-100	70-100	22-55	20-43	4-25
SpB-------------- Spiller	0-14	Fine sandy loam	SM	A-4, A-2-4	0	100	95-100	80-100	20-50	<30	NP-5
	14-39	Sandy clay, clay loam, clay.	CL, CH, SC	A-7-6	0	100	95-100	90-100	40-70	41-55	18-28
	39-56	Sandy clay, clay loam, sandy clay loam.	CL, SC	A-2-7, A-6, A-7-6, A-2-6	0	100	95-100	85-100	30-70	30-49	11-25
	56-80	Fine sandy loam, sandy clay loam, sandy clay.	CL, CL-ML, SC, CH	A-4, A-6, A-7-6, A-2	0	100	95-100	80-100	20-60	26-55	5-28
TaB-------------- Tabor	0-14	Fine sandy loam	ML, SM, CL-ML, SM-SC	A-4, A-2-4	0	85-100	75-100	70-100	30-55	<25	NP-7
	14-58	Clay-------------	CH, CL	A-7	0	95-100	90-100	85-100	55-90	45-65	25-40
	58-70	Clay, clay loam, sandy clay loam.	CH, CL, SC	A-7, A-6	0	95-100	90-100	75-100	40-90	35-60	15-35
ToD-------------- Tonkavar	0-6	Loamy fine sand	SM, SM-SC	A-2-4	0	95-100	95-100	50-80	15-30	<25	NP-5
	6-48	Sand, loamy fine sand, loamy sand.	SM, SM-SC, SP-SM	A-2-4, A-3	0	95-100	95-100	50-75	5-30	<25	NP-5
	48-72	Sandy clay loam, clay loam, fine sandy loam.	SC, CL	A-4, A-6, A-2-4, A-2-6	0	95-100	95-100	50-90	15-55	20-39	8-20
	72-80	Weathered bedrock	---	---	---	---	---	---	---	---	---
WcA-------------- Wilson	0-6	Loam-------------	CL	A-6	0	95-100	85-100	80-100	60-96	26-38	11-20
	6-43	Silty clay, clay, clay loam.	CL, CH	A-7-6	0	90-100	80-100	80-100	65-96	43-56	26-37
	43-80	Silty clay, clay, silty clay loam.	CL, CH	A-7-6, A-6	0	95-100	90-100	85-100	70-96	38-65	24-48

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
ZaB-------------- Zack	0-7	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4	0-1	90-100	90-100	70-95	40-65	<30	NP-7
	7-24	Clay-------------	CH	A-7-6	0-1	90-100	90-100	90-100	75-95	50-70	30-45
	24-30	Clay, clay loam	CH, CL	A-7-6	0-1	90-100	90-100	90-100	70-95	42-60	25-38
	30-36	Clay loam, silty clay loam, sandy clay loam.	CL	A-6, A-7-6	0-1	90-100	90-100	80-95	51-90	30-42	11-20
	36-80	Loam, clay loam, silty clay loam.	CL	A-4, A-6	0-1	90-100	90-100	80-100	51-90	26-40	8-20
ZaC2------------- Zack	0-7	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4	0-1	90-100	90-100	70-95	40-65	<30	NP-7
	7-14	Clay-------------	CH	A-7-6	0-1	90-100	90-100	90-100	75-95	50-70	30-45
	14-26	Clay, clay loam	CH, CL	A-7-6	0-1	90-100	90-100	90-100	70-95	42-60	25-38
	26-36	Clay loam, silty clay loam, sandy clay loam.	CL	A-6, A-7-6	0-1	90-100	90-100	80-95	51-90	30-42	11-20
	36-80	Loam, clay loam, silty clay loam.	CL	A-4, A-6	0-1	90-100	90-100	80-100	51-90	26-40	8-20
ZaD-------------- Zack	0-5	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4	0-1	90-100	90-100	70-95	40-65	<30	NP-7
	5-17	Clay-------------	CH	A-7-6	0-1	90-100	90-100	90-100	75-95	50-70	30-45
	17-33	Clay, clay loam	CH, CL	A-7-6	0-1	90-100	90-100	90-100	70-95	42-60	25-38
	33-60	Loam, clay loam, silty clay loam.	CL	A-4, A-6	0-1	90-100	90-100	80-100	51-90	26-40	8-20
ZgC3*:											
Zack------------	0-4	Fine sandy loam	SM, SM-SC, ML, CL-ML	A-4	0-1	90-100	90-100	70-95	40-65	<30	NP-7
	4-11	Clay-------------	CH	A-7-6	0-1	90-100	90-100	90-100	75-95	50-70	30-45
	11-38	Clay, clay loam	CH, CL	A-7-6	0-1	90-100	90-100	90-100	70-95	42-60	25-38
	38-60	Loam, clay loam, silty clay loam.	CL	A-4, A-6	0-1	90-100	90-100	80-100	51-90	26-40	8-20
Gullied land.											
ZuB-------------- Zulch	0-9	Fine sandy loam	SM, ML	A-4	0	95-100	95-100	70-100	40-60	<30	NP-7
	9-18	Clay, silty clay	CH, CL	A-7-6	0	95-100	95-100	90-100	75-95	41-60	20-35
	18-41	Clay, silty clay	CH, CL	A-7-6	0	95-100	95-100	90-100	75-95	41-60	20-38
	41-60	Shaly clay, clay, clay loam.	CH, CL	A-6, A-7-6	0	95-100	95-100	90-100	65-90	35-76	18-57

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
ArD--------------	0-8	8-20	1.40-1.60	2.0-6.0	0.11-0.15	4.5-6.5	Low----------	0.43	2	3	<2
Arriola	8-36	40-60	1.35-1.60	<0.06	0.12-0.18	4.5-5.5	High---------	0.32			
	36-50	---	---	---	---	---	-------------	----			
BeB--------------	0-12	20-35	1.35-1.55	0.6-2.0	0.15-0.20	5.6-7.3	Moderate-----	0.32	5	6	1-3
Benchley	12-19	30-50	1.45-1.60	0.06-0.2	0.12-0.18	5.6-7.3	High---------	0.32			
	19-72	40-55	1.55-1.65	0.06-0.2	0.12-0.18	5.1-7.3	High---------	0.32			
	72-80	40-55	1.60-1.70	0.06-0.2	0.12-0.18	5.1-8.4	Moderate-----	0.32			
BnB--------------	0-6	5-15	1.35-1.60	2.0-6.0	0.08-0.11	5.1-6.5	Very low-----	0.20	5	2	<2
Bienville	6-80	5-20	1.35-1.70	2.0-6.0	0.08-0.13	5.1-6.0	Very low-----	0.20			
BoB--------------	0-15	8-20	1.30-1.50	0.6-2.0	0.11-0.15	5.1-6.5	Low----------	0.43	5	3	<1
Boonville	15-24	40-55	1.20-1.45	<0.06	0.12-0.18	5.6-7.3	High---------	0.32			
	24-40	25-45	1.40-1.70	0.06-0.2	0.15-0.18	5.6-7.8	Moderate-----	0.37			
	40-80	25-40	1.35-1.60	0.06-0.2	0.10-0.15	7.4-8.4	Moderate-----	0.37			
BrA*:											
Bremond---------	0-8	10-18	1.45-1.60	0.6-2.0	0.11-0.20	5.1-7.3	Low----------	0.43	5	5	<2
	8-18	40-50	1.35-1.50	<0.06	0.14-0.18	5.6-7.3	High---------	0.32			
	18-68	30-50	1.40-1.65	<0.06	0.15-0.18	6.1-8.4	High---------	0.32			
	68-80	27-50	1.40-1.65	<0.06	0.15-0.18	6.6-8.4	High---------	0.32			
Wilson----------	0-6	18-27	1.40-1.65	0.2-0.6	0.15-0.20	5.6-7.3	Low----------	0.43	5	5	<2
	6-42	35-50	1.50-1.70	<0.06	0.12-0.15	5.6-8.4	High---------	0.37			
	42-80	35-60	1.50-1.70	<0.06	0.12-0.15	6.6-8.4	High---------	0.37			
BuA--------------	0-10	40-60	1.35-1.50	<0.06	0.12-0.18	5.6-7.3	Very high----	0.32	5	4	1-3
Burleson	10-52	40-60	1.40-1.55	<0.06	0.12-0.18	6.1-7.3	Very high----	0.32			
	52-80	40-60	1.40-1.55	<0.06	0.12-0.18	7.4-8.4	Very high----	0.32			
ChB--------------	0-14	5-12	1.40-1.65	2.0-6.0	0.06-0.10	5.6-7.3	Very low-----	0.20	5	2	<1
Chazos	14-23	35-50	1.30-1.60	0.06-0.2	0.15-0.18	5.6-6.5	Moderate-----	0.32			
	23-63	35-50	1.30-1.60	0.06-0.2	0.15-0.18	5.6-7.3	Moderate-----	0.32			
	63-80	25-45	1.40-1.60	0.06-0.2	0.15-0.18	6.1-8.4	Moderate-----	0.28			
CrB--------------	0-6	5-20	1.50-1.60	0.6-2.0	0.11-0.20	5.6-7.3	Low----------	0.43	5	5	<2
Crockett	6-17	40-55	1.35-1.60	<0.06	0.14-0.18	5.6-7.3	High---------	0.32			
	17-45	35-55	1.40-1.65	<0.06	0.15-0.18	6.1-8.4	High---------	0.32			
	45-60	20-50	1.50-1.70	<0.06	0.12-0.20	6.1-8.4	Moderate-----	0.32			
	60-80	30-60	1.50-1.70	<0.06	0.11-0.15	6.6-8.4	High---------	0.32			
DdA--------------	0-7	8-20	1.40-1.60	0.6-2.0	0.13-0.24	5.1-6.5	Low----------	0.37	5	5	<2
Derly	7-23	30-45	1.40-1.55	0.06-0.2	0.15-0.22	4.5-6.0	Moderate-----	0.37			
	23-52	40-60	1.45-1.60	<0.06	0.12-0.18	4.5-6.0	High---------	0.32			
	52-80	30-60	1.44-1.65	<0.06	0.12-0.18	5.6-7.3	High---------	0.32			
DeA*:											
Derly-----------	0-6	8-20	1.40-1.60	0.6-2.0	0.13-0.24	5.1-6.5	Low----------	0.37	5	5	.5-2
	6-23	30-45	1.40-1.55	0.06-0.2	0.15-0.22	4.5-6.0	Moderate-----	0.37			
	23-38	40-60	1.45-1.60	<0.06	0.12-0.18	4.5-6.0	High---------	0.32			
	38-80	30-60	1.44-1.65	<0.06	0.12-0.18	5.6-7.3	High---------	0.32			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
DeA*:											
Rader-----------	0-24	5-20	1.40-1.60	2.0-6.0	0.10-0.15	4.5-6.5	Low----------	0.32	5	3	<2
	24-34	18-30	1.40-1.60	0.2-0.6	0.12-0.18	5.1-6.5	Moderate-----	0.32			
	34-50	35-50	1.45-1.70	<0.06	0.12-0.18	4.5-5.5	High---------	0.32			
	50-80	24-45	1.45-1.70	0.06-0.2	0.12-0.18	5.1-8.4	Moderate-----	0.32			
DmA-------------- Dimebox	0-6	40-60	1.40-1.50	<0.06	0.12-0.18	5.1-7.3	Very high----	0.32	5	4	1-5
	6-52	40-60	1.40-1.50	<0.06	0.12-0.18	5.1-7.3	Very high----	0.32			
	52-91	40-60	1.40-1.50	<0.06	0.12-0.18	5.1-8.4	Very high----	0.32			
DuC-------------- Dutek	0-7	3-12	1.30-1.60	6.0-20	0.05-0.10	5.6-6.5	Very low-----	0.20	5	2	<1
	7-26	3-12	1.30-1.60	6.0-20	0.05-0.10	5.6-6.5	Very low-----	0.20			
	26-45	18-35	1.30-1.65	0.6-2.0	0.12-0.17	5.1-6.5	Low----------	0.24			
	45-80	10-30	1.30-1.65	0.6-6.0	0.10-0.16	4.5-6.5	Low----------	0.24			
EeE-------------- Ellis	0-3	40-50	1.35-1.55	<0.06	0.12-0.18	6.6-8.4	High---------	0.32	3	4	1-3
	3-25	40-60	1.35-1.55	<0.06	0.12-0.18	7.4-8.4	High---------	0.32			
	25-80	40-60	1.40-1.65	<0.06	0.10-0.15	7.4-8.4	High---------	0.32			
EmB-------------- Elmina	0-5	4-14	1.40-1.60	6.0-20.0	0.06-0.10	4.5-6.5	Very low-----	0.20	3	2	<1
	5-25	3-12	1.40-1.60	6.0-20.0	0.05-0.10	4.5-6.5	Very low-----	0.20			
	25-47	35-55	1.35-1.60	<0.06	0.10-0.15	3.6-6.0	High---------	0.32			
	47-58	30-55	1.35-1.60	<0.06	0.10-0.15	3.6-6.0	High---------	0.37			
	58-60	---	---	---	---	---	-------------	----			
EuB-------------- Eufaula	0-60	2-10	1.35-1.50	6.0-20	0.07-0.11	5.6-6.5	Very low-----	0.17	5	2	<1
	60-80	2-12	1.50-1.70	6.0-20	0.07-0.13	5.1-7.3	Low----------	0.17			
EuE-------------- Eufaula	0-48	2-10	1.35-1.50	6.0-20	0.07-0.11	5.6-6.5	Very low-----	0.17	5	2	<1
	48-80	2-12	1.50-1.70	6.0-20	0.07-0.13	5.1-7.3	Low----------	0.17			
FtB-------------- Flatonia	0-7	14-35	1.40-1.65	0.2-0.6	0.12-0.19	6.1-7.3	Moderate-----	0.32	4	6	1-4
	7-40	35-50	1.50-1.70	0.06-0.2	0.12-0.20	6.1-8.4	High---------	0.32			
	40-48	25-40	1.40-1.70	0.06-0.2	0.12-0.19	7.4-8.4	Moderate-----	0.37			
	48-80	15-50	1.60-1.80	<0.06	0.11-0.19	7.4-8.4	Moderate-----	0.43			
GaB-------------- Gasil	0-8	8-20	1.50-1.60	2.0-6.0	0.11-0.15	5.6-6.5	Low----------	0.24	5	3	<1
	8-80	15-35	1.50-1.60	0.6-2.0	0.12-0.19	5.1-6.5	Moderate-----	0.32			
Gg--------------- Gladewater	0-9	30-60	1.35-1.55	0.06-0.2	0.15-0.20	5.6-6.5	Very high----	0.32	5	4	1-3
	9-80	40-60	1.40-1.60	<0.06	0.15-0.18	4.5-8.4	Very high----	0.32			
Gh--------------- Gladewater	0-7	30-60	1.35-1.55	0.06-0.2	0.15-0.20	5.6-6.5	Very high----	0.32	5	4	1-3
	7-80	40-60	1.40-1.60	<0.06	0.15-0.18	4.5-8.4	Very high----	0.32			
Gn*:											
Gladewater------	0-9	30-60	1.35-1.55	0.06-0.2	0.15-0.20	5.6-7.3	Very high----	0.32	5	4	1-3
	9-80	40-60	1.40-1.60	<0.06	0.15-0.18	4.5-8.4	Very high----	0.32			
Nahatche--------	0-13	15-25	1.10-1.30	0.6-2.0	0.10-0.15	5.1-7.8	Moderate-----	0.28	5	3	1-3
	13-80	18-35	1.20-1.50	0.6-2.0	0.10-0.15	5.1-7.8	Moderate-----	0.28			
Go--------------- Gowker	0-8	28-35	1.20-1.50	0.6-2.0	0.12-0.20	5.6-6.5	Moderate-----	0.32	5	5	1-3
	8-45	28-45	1.30-1.60	0.06-0.2	0.12-0.20	5.6-7.3	Moderate-----	0.37			
	45-80	28-45	1.30-1.60	0.2-0.6	0.12-0.20	5.6-8.4	Moderate-----	0.37			
GpA*:											
Gowker----------	0-25	28-35	1.20-1.50	0.6-2.0	0.12-0.20	5.6-6.5	Moderate-----	0.32	5	5	1-3
	25-51	28-45	1.30-1.60	0.06-0.2	0.12-0.20	5.6-7.3	Moderate-----	0.37			
	51-80	28-45	1.30-1.60	0.2-0.6	0.12-0.20	5.6-8.4	Moderate-----	0.37			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
GpA*:											
Porterspings	0-15	10-26	1.25-1.35	0.6-2.0	0.12-0.17	6.1-7.3	Low	0.32	5	5	1-3
	15-34	20-35	1.30-1.45	0.2-0.6	0.13-0.18	5.6-7.8	Moderate	0.28			
	34-58	10-25	1.35-1.55	0.6-2.0	0.12-0.17	5.6-7.8	Low	0.28			
	58-80	5-15	1.40-1.65	2.0-6.0	0.08-0.12	5.6-7.8	Low	0.28			
GrC Gredge	0-7	7-15	1.30-1.55	0.6-2.0	0.11-0.15	4.5-6.5	Low	0.43	5	3	<1
	7-32	40-55	1.40-1.60	<0.06	0.13-0.18	4.5-6.0	High	0.37			
	32-45	25-40	1.40-1.60	0.06-0.2	0.13-0.18	4.5-7.8	Moderate	0.37			
	45-63	20-35	1.40-1.60	0.2-0.6	0.13-0.18	5.6-8.4	Moderate	0.37			
	63-80	15-35	1.30-1.60	0.2-0.6	0.07-0.18	5.6-8.4	Moderate	0.37			
GrD Gredge	0-5	7-15	1.30-1.55	0.6-2.0	0.11-0.15	4.5-6.5	Low	0.43	5	3	<1
	5-24	40-55	1.40-1.60	<0.06	0.13-0.18	4.5-6.0	High	0.37			
	24-46	25-40	1.40-1.60	0.06-0.2	0.13-0.18	4.5-7.8	Moderate	0.37			
	46-80	15-35	1.30-1.60	0.2-0.6	0.07-0.18	5.6-8.4	Moderate	0.37			
Ha Hatliff	0-9	8-20	1.20-1.50	2.0-6.0	0.11-0.15	5.1-7.3	Low	0.28	5	3	<1
	9-80	8-18	1.20-1.50	2.0-6.0	0.05-0.11	5.1-7.3	Low	0.24			
HuC Huntsburg	0-18	5-12	1.30-1.50	6.0-20	0.06-0.11	5.6-6.5	Very low	0.28	5	2	<2
	18-58	35-55	1.40-1.60	0.06-0.2	0.10-0.15	4.5-5.5	Moderate	0.32			
	58-74	35-55	1.40-1.60	<0.06	0.10-0.18	4.5-5.5	High	0.32			
JeD Jedd	0-5	10-18	1.20-1.40	0.6-2.0	0.10-0.15	5.6-6.5	Low	0.28	2	3	<1
	5-25	35-60	1.35-1.55	0.2-0.6	0.13-0.17	4.5-6.0	Moderate	0.32			
	25-60	---	---	---	---	---	-------------	----			
Ka Kaufman	0-6	50-86	1.20-1.45	<0.06	0.12-0.18	5.6-8.4	Very high	0.32	5	4	1-4
	6-58	60-86	1.25-1.45	<0.06	0.10-0.16	5.6-8.4	Very high	0.32			
	58-80	60-86	1.35-1.55	<0.06	0.10-0.16	5.6-8.4	Very high	0.32			
Kf Kaufman	0-10	50-86	1.20-1.45	<0.06	0.12-0.18	5.6-8.4	Very high	0.32	5	4	1-4
	10-54	60-86	1.25-1.45	<0.06	0.10-0.16	5.6-8.4	Very high	0.32			
	54-80	60-86	1.35-1.55	<0.06	0.10-0.16	5.6-8.4	Very high	0.32			
KuC Kurten	0-8	7-18	1.45-1.60	0.6-2.0	0.11-0.15	5.6-7.3	Low	0.43	5	3	<1
	8-51	40-60	1.35-1.50	<0.06	0.14-0.18	4.5-7.3	High	0.37			
	51-58	40-55	1.35-1.50	<0.06	0.14-0.18	4.5-7.8	High	0.37			
	58-80	30-50	1.35-1.50	<0.06	0.13-0.18	4.5-7.8	Moderate	0.37			
LfA Lufkin	0-9	15-25	1.35-1.55	0.6-2.0	0.11-0.18	5.1-6.5	Low	0.43	5	3	<2
	9-44	35-50	1.40-1.60	<0.06	0.12-0.18	4.5-7.8	Very high	0.32			
	44-80	35-50	1.30-1.50	<0.06	0.10-0.14	6.1-8.4	High	0.37			
MaA Mabank	0-10	10-25	1.50-1.65	0.6-2.0	0.11-0.15	5.6-6.5	Low	0.43	5	3	1-2
	10-45	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-7.3	High	0.32			
	45-65	35-50	1.45-1.65	<0.6	0.12-0.18	5.6-8.4	High	0.32			
Na Nahatche	0-8	18-35	1.10-1.30	0.6-2.0	0.15-0.20	5.1-7.8	Moderate	0.28	5	6	1-3
	8-39	18-35	1.20-1.50	0.6-2.0	0.10-0.15	5.1-7.8	Moderate	0.28			
	39-60	18-35	1.30-1.60	0.6-2.0	0.10-0.15	5.1-7.8	Moderate	0.28			
NvB Navasan	0-8	2-10	1.40-1.60	6.0-20	0.07-0.11	5.1-7.3	Very low	0.17	5	2	<1
	8-45	2-10	1.40-1.60	6.0-20	0.07-0.11	5.1-7.3	Very low	0.17			
	45-55	5-15	1.40-1.60	0.2-0.6	0.10-0.15	4.5-7.3	Very low	0.24			
	55-75	20-35	1.40-1.65	0.2-0.6	0.13-0.18	5.1-6.0	Moderate	0.24			
PaC Padina	0-5	2-10	1.20-1.50	6.0-20	0.07-0.11	5.6-7.3	Very low	0.17	5	2	<1
	5-52	2-10	1.20-1.50	6.0-20	0.05-0.08	5.6-7.3	Very low	0.17			
	52-80	18-35	1.40-1.60	0.6-2.0	0.14-0.18	5.1-6.5	Low	0.24			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
RaB--------------- Rader	0-25	5-20	1.40-1.60	2.0-6.0	0.10-0.15	4.5-6.5	Low----------	0.32	5	3	<2
	25-34	18-30	1.40-1.60	0.2-0.6	0.12-0.18	5.1-6.5	Moderate-----	0.32			
	34-50	35-50	1.45-1.70	<0.06	0.12-0.18	4.5-5.5	High---------	0.32			
	50-96	24-45	1.45-1.70	0.06-0.2	0.12-0.18	5.1-8.4	Moderate-----	0.32			
RbA*:											
Rader-----------	0-24	5-20	1.40-1.60	2.0-6.0	0.10-0.15	4.5-6.5	Low----------	0.32	5	3	<2
	24-29	18-30	1.40-1.60	0.2-0.6	0.12-0.18	5.1-6.5	Moderate-----	0.32			
	29-33	35-50	1.45-1.70	<0.06	0.12-0.18	4.5-5.5	High---------	0.32			
	33-80	24-45	1.45-1.70	0.06-0.2	0.12-0.18	5.1-8.4	Moderate-----	0.32			
Derly-----------	0-8	8-20	1.40-1.60	0.6-2.0	0.13-0.24	4.5-6.5	Low----------	0.37	5	5	<2
	8-22	30-45	1.40-1.55	0.06-0.2	0.15-0.22	4.5-6.0	Moderate-----	0.37			
	22-46	40-60	1.45-1.60	<0.06	0.12-0.18	4.5-6.0	High---------	0.32			
	46-80	30-60	1.44-1.65	<0.06	0.12-0.18	5.6-7.3	High---------	0.32			
RcB--------------- Robco	0-8	2-10	1.40-1.60	6.0-20	0.04-0.10	5.1-6.5	Very low-----	0.24	5	2	<1
	8-24	2-10	1.40-1.60	6.0-20	0.04-0.10	5.1-6.5	Very low-----	0.24			
	24-28	27-35	1.50-1.65	0.2-0.6	0.12-0.18	4.5-6.0	Moderate-----	0.32			
	28-80	20-30	1.55-1.70	0.06-0.2	0.12-0.18	4.5-7.3	High---------	0.37			
RoC--------------- Rosanky	0-5	5-18	1.20-1.40	0.6-2.0	0.10-0.14	5.1-6.5	Low----------	0.28	5	3	<2
	5-39	35-50	1.40-1.60	0.2-0.6	0.11-0.17	5.1-6.0	Moderate-----	0.32			
	39-64	15-35	1.40-1.65	0.2-0.6	0.10-0.16	5.1-6.0	Low----------	0.37			
	64-80	---	---	---	---	---	-------------	----			
RvC--------------- Rosanky	0-10	5-18	1.20-1.40	0.6-2.0	0.08-0.14	5.1-6.5	Low----------	0.20	5	8	<2
	10-28	35-50	1.40-1.60	0.2-0.6	0.11-0.17	5.1-6.0	Moderate-----	0.32			
	28-60	15-35	1.40-1.65	0.2-0.6	0.10-0.16	5.1-6.0	Low----------	0.37			
	60-80	---	---	---	---	---	-------------	----			
SaB--------------- Silawa	0-10	10-20	1.35-1.55	2.0-6.0	0.10-0.15	5.1-6.5	Low----------	0.24	5	3	.5-2
	10-57	18-35	1.35-1.60	0.6-2.0	0.12-0.17	4.5-6.0	Low----------	0.32			
	57-80	12-30	1.40-1.65	2.0-6.0	0.08-0.15	4.5-6.0	Low----------	0.32			
SdB--------------- Silstid	0-8	3-12	1.40-1.60	6.0-20	0.05-0.10	5.6-7.3	Low----------	0.17	5	2	<1
	8-32	3-12	1.40-1.60	6.0-20	0.05-0.10	5.6-7.3	Low----------	0.17			
	32-60	18-32	1.50-1.70	0.6-2.0	0.10-0.16	5.1-6.5	Low----------	0.24			
	60-80	---	---	---	---	---	-------------	----			
SpB--------------- Spiller	0-14	10-20	1.40-1.60	2.0-6.0	0.11-0.15	5.6-7.3	Low----------	0.28	5	3	<1
	14-39	35-45	1.40-1.65	0.06-0.2	0.12-0.18	5.1-6.5	Moderate-----	0.32			
	39-56	20-40	1.40-1.65	0.2-0.6	0.12-0.18	5.1-7.3	Moderate-----	0.32			
	56-80	10-40	1.35-1.65	0.06-0.2	0.10-0.18	5.1-8.4	Low----------	0.32			
TaB--------------- Tabor	0-14	8-20	1.50-1.60	0.6-2.0	0.11-0.15	5.1-6.5	Low----------	0.43	5	3	<1
	14-58	40-55	1.45-1.65	<0.06	0.14-0.18	4.5-5.5	High---------	0.32			
	58-70	25-45	1.45-1.65	<0.06	0.14-0.18	5.6-8.4	High---------	0.32			
ToD--------------- Tonkavar	0-6	3-12	1.45-1.65	6.0-20	0.06-0.10	5.6-7.3	Very low-----	0.17	5	1	<1
	6-48	3-12	1.45-1.65	6.0-20	0.05-0.10	5.1-6.5	Very low-----	0.17			
	48-72	18-35	1.55-1.70	0.6-2.0	0.10-0.17	4.5-6.0	Moderate-----	0.24			
	72-80	---	---	---	---	---	-------------	----			
WcA--------------- Wilson	0-6	18-27	1.40-1.65	0.2-0.6	0.15-0.20	5.6-7.3	Low----------	0.43	5	5	<2
	6-43	35-50	1.50-1.70	<0.06	0.12-0.15	5.6-8.4	High---------	0.37			
	43-80	35-60	1.50-1.70	<0.06	0.12-0.15	6.6-8.4	High---------	0.37			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
ZaB------------- Zack	0-7	7-15	1.15-1.30	0.6-2.0	0.11-0.15	5.1-6.5	Low----------	0.43	3	3	<1
	7-24	40-60	1.30-1.45	<0.06	0.12-0.18	5.6-7.3	High---------	0.37			
	24-30	35-55	1.30-1.50	<0.06	0.12-0.20	5.6-8.4	High---------	0.37			
	30-36	20-35	1.35-1.60	0.06-0.2	0.12-0.18	6.6-8.4	Moderate-----	0.37			
	36-80	15-35	1.35-1.60	0.06-0.2	0.07-0.18	7.4-8.4	Low----------	0.37			
ZaC2------------- Zack	0-7	7-15	1.15-1.30	0.6-2.0	0.11-0.15	5.1-6.5	Low----------	0.43	3	3	<1
	7-14	40-60	1.30-1.45	<0.06	0.12-0.18	5.6-7.3	High---------	0.37			
	14-26	35-55	1.30-1.50	<0.06	0.12-0.20	5.6-8.4	High---------	0.37			
	26-36	20-35	1.35-1.60	0.06-0.2	0.12-0.18	6.6-8.4	Moderate-----	0.37			
	36-80	15-35	1.35-1.60	0.06-0.2	0.07-0.18	7.4-8.4	Low----------	0.37			
ZaD------------- Zack	0-5	7-15	1.15-1.30	0.6-2.0	0.11-0.15	5.1-6.5	Low----------	0.43	3	3	<1
	5-17	40-60	1.30-1.45	<0.06	0.12-0.18	5.6-7.3	High---------	0.37			
	17-33	35-55	1.30-1.50	<0.06	0.12-0.20	5.6-8.4	High---------	0.37			
	33-60	15-35	1.35-1.60	0.06-0.2	0.07-0.18	7.4-8.4	Low----------	0.37			
ZgC3*:											
Zack------------	0-4	7-15	1.15-1.30	0.6-2.0	0.11-0.15	5.1-6.5	Low----------	0.43	3	3	<1
	4-11	40-60	1.30-1.45	<0.06	0.12-0.18	5.6-7.3	High---------	0.37			
	11-38	35-55	1.30-1.50	<0.06	0.12-0.20	5.6-8.4	High---------	0.37			
	38-60	15-35	1.35-1.60	0.06-0.2	0.07-0.18	7.4-8.4	Low----------	0.37			
Gullied land.											
ZuB------------- Zulch	0-9	4-12	1.50-1.70	0.6-2.0	0.11-0.15	5.6-7.3	Low----------	0.43	4	3	<2
	9-18	35-50	1.40-1.60	<0.06	0.13-0.18	5.6-7.8	High---------	0.32			
	18-41	35-55	1.40-1.60	<0.06	0.13-0.18	6.1-8.4	High---------	0.32			
	41-60	35-50	1.40-1.70	<0.06	0.10-0.18	6.6-8.4	Moderate-----	0.37			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
ArD--------------- Arriola	D	None---------	---	---	>6.0	---	---	20-40	Soft	High-----	High.
BeB--------------- Benchley	C	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
BnB--------------- Bienville	A	None---------	---	---	4.0-6.0	Apparent	Dec-Apr	>60	---	Low------	High.
BoB--------------- Boonville	D	None---------	---	---	0.5-1.0	Perched	Nov-Feb	>60	---	High-----	Low.
BrA*:											
Bremond----------	D	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
Wilson-----------	D	None---------	---	---	0.5-1.5	Perched	Nov-Mar	>60	---	High-----	High.
BuA--------------- Burleson	D	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
ChB--------------- Chazos	C	None---------	---	---	>6.0	---	---	>60	---	High-----	High.
CrB--------------- Crockett	D	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
DdA--------------- Derly	D	None---------	---	---	0-1.5	Perched	Oct-May	>60	---	High-----	High.
DeA*:											
Derly------------	D	None---------	---	---	0-1.5	Perched	Dec-Apr	>60	---	High-----	High.
Rader------------	D	None---------	---	---	2.0-5.0	Perched	Dec-Mar	>60	---	High-----	Moderate.
DmA--------------- Dimebox	D	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
DuC--------------- Dutek	A	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
EeE--------------- Ellis	D	None---------	---	---	>6.0	---	---	>60	---	High-----	Low.
EmB--------------- Elmina	C	None---------	---	---	1.5-3.5	Perched	Oct-Jun	40-60	Soft	High-----	High.
EuB, EuE---------- Eufaula	A	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate.
FtB--------------- Flatonia	D	None---------	---	---	>6.0	---	---	40-60	Soft	High-----	Low.
GaB--------------- Gasil	B	None---------	---	---	>6.0	---	---	>60	---	Low------	Moderate.

See footnote at end of table.

TABLE 18.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hard-ness	Uncoated steel	Concrete
					Ft			In			
Gg----------------- Gladewater	D	Occasional	Brief or long.	Nov-May	0-3.5	Apparent	Nov-May	>60	---	High-----	Moderate.
Gh----------------- Gladewater	D	Frequent----	Brief or long.	Nov-May	0-3.5	Apparent	Nov-May	>60	---	High-----	Moderate.
Gn*:											
Gladewater-------	D	Frequent----	Brief or long.	Nov-May	0-3.5	Apparent	Nov-May	>60	---	High-----	Moderate.
Nahatche---------	C	Frequent----	Long------	Nov-May	0.5-1.5	Apparent	Nov-May	>60	---	High-----	Moderate.
Go----------------- Gowker	C	Frequent----	Brief-----	Oct-May	0.5-2.5	Perched	Oct-May	>60	---	High-----	Moderate.
GpA*:											
Gowker-----------	C	Occasional	Brief-----	Oct-May	0.5-2.5	Perched	Oct-May	>60	---	High-----	Moderate.
Portersprings----	C	Rare--------	---	---	2.0-3.0	Apparent	Sep-Jun	>60	---	Moderate	Low.
GrC, GrD---------- Gredge	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Low.
Ha----------------- Hatliff	C	Frequent----	Brief-----	Nov-May	0-2.0	Apparent	Nov-Mar	>60	---	Low------	Moderate.
HuC---------------- Huntsburg	D	None--------	---	---	0.5-2.0	Perched	Oct-May	>60	---	High-----	High.
JeD---------------- Jedd	C	None--------	---	---	>6.0	---	---	20-40	Soft	High-----	Moderate.
Ka----------------- Kaufman	D	Occasional	Brief-----	Feb-May	1.5-4.0	Apparent	Nov-Apr	>60	---	High-----	Low.
Kf----------------- Kaufman	D	Frequent----	Long------	Feb-May	1.5-4.0	Apparent	Nov-Apr	>60	---	High-----	Low.
KuC---------------- Kurten	D	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
LfA---------------- Lufkin	D	None--------	---	---	0.5-1.0	Perched	Oct-Mar	>60	---	High-----	Moderate.
MaA---------------- Mabank	D	None--------	---	---	0.5-1.0	Perched	Dec-Mar	>60	---	High-----	Moderate.
Na----------------- Nahatche	C	Frequent----	Long------	Nov-May	0.5-1.5	Apparent	Nov-May	>60	---	High-----	Moderate.
NvB---------------- Navasan	A	None or rare	---	---	3.0-5.0	Perched	Jan-Dec	>60	---	High-----	High.
PaC---------------- Padina	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate.
RaB---------------- Rader	D	None--------	---	---	2.0-5.0	Perched	Dec-Mar	>60	---	High-----	Moderate.

See footnote at end of table.

TABLE 18.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness	Uncoated steel	Concrete
					Ft			In			
RbA*:											
Rader	D	None	---	---	2.0-5.0	Perched	Dec-Mar	>60	---	High	Moderate.
Derly	D	None	---	---	0-1.5	Perched	Dec-Apr	>60	---	High	High.
RcB Robco	C	None	---	---	1.5-3.5	Perched	Jan-Apr	>60	---	High	High.
RoC, RvC Rosanky	C	None	---	---	>6.0	---	---	>60	---	High	Low.
SaB Silawa	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
SdB Silstid	A	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate.
SpB Spiller	C	None	---	---	>6.0	---	---	>60	---	High	Moderate.
TaB Tabor	D	None	---	---	>6.0	---	---	>60	---	High	High.
ToD Tonkavar	A	None	---	---	4.0-6.0	Perched	Nov-May	>60	---	Moderate	High.
WcA Wilson	D	None	---	---	0.5-1.5	Perched	Nov-Mar	>60	---	High	High.
ZaB, ZaC2 Zack	D	None	---	---	>6.0	---	---	>60	---	High	Low.
ZaD Zack	D	None	---	---	>6.0	---	---	>60	---	High	Low.
ZgC3*:											
Zack	D	None	---	---	>6.0	---	---	>60	---	High	Low.
Gullied land.											
ZuB Zulch	D	None	---	---	0.5-1.0	Perched	Dec-Feb	>60	---	High	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--PHYSICAL ANALYSES OF SELECTED SOILS

(Data determined by the Soil Characterization Laboratory, Texas A&M University, College Station, Texas. Dashes indicate data were not determined)

Soil name and sample number	Depth	Horizon	Particle-size distribution: Sand: Very coarse (2-1 mm)	Coarse (1-0.5 mm)	Medium (0.5-0.25 mm)	Fine (0.25-0.1 mm)	Very fine (0.1-0.05 mm)	Total (2-0.05 mm)	Silt (0.05-0.002 mm)	Clay (<0.002 mm)	COLE	Bulk density 1/3-bar	Water content 1/3-bar
	In		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Cm/cm	g/cc	Pct (wt)
Bienville: [1]	0-7	Ap	0.0	0.0	0.4	57.8	30.0	88.2	9.4	2.4	0.009	1.46	25.4
(S85TX-313-003)	7-14	E	0.0	0.0	0.5	57.5	30.0	88.0	9.0	3.0	0.009	1.42	22.0
	14-24	E/Bt	0.0	0.0	0.4	59.0	28.3	87.0	8.1	4.2	0.005	1.34	17.2
	24-33	B/E	0.0	0.0	0.4	66.0	20.5	87.1	9.1	3.8	0.007	1.36	23.2
	33-48	E/B1	0.0	0.0	0.5	52.7	33.8	87.0	9.8	3.2	0.010	1.38	23.8
	48-68	E/B2	0.0	0.0	0.4	53.5	33.8	87.7	9.0	3.3	0.002	1.38	26.3
	68-80	E/B3	0.0	0.0	0.5	58.9	30.5	89.9	7.9	2.2	0.000	1.40	15.0
Derly: [2]	0-8	A	0.2	0.3	1.0	13.6	19.0	34.1	41.4	24.5	0.047	1.54	25.8
(S85TX-313-001)	8-22	Btg1	0.1	0.1	0.6	10.3	16.8	27.9	31.6	40.5	0.086	1.53	25.6
	22-46	Btg2	0.1	0.1	0.7	11.7	19.1	31.7	34.0	34.4	0.069	1.62	22.9
	46-66	Btg3	0.1	0.1	0.5	10.5	19.9	31.1	34.9	34.0	0.062	1.63	22.4
	66-80	BC	0.0	0.1	1.7	16.1	16.8	34.7	27.4	37.9	0.072	1.59	24.6
Kaufman: [3]	0-6	Ap	0.0	0.2	1.1	12.0	5.5	18.8	25.5	55.7	0.141	1.22	36.0
(S85TX-313-004)	6-24	A	0.1	0.2	1.2	13.2	5.9	20.6	20.7	58.7	0.150	1.21	37.2
	24-41	Bss1	0.0	0.1	1.0	12.0	5.7	18.8	19.6	61.6	0.150	1.25	37.6
	41-58	Bss2	0.1	0.1	1.2	15.2	6.1	22.7	19.0	58.3	0.164	1.21	40.6
	58-80	BC	0.1	0.1	1.3	19.9	8.8	30.2	19.0	50.8	0.124	1.36	33.6
Rader: [3]	0-6	A	0.5	0.5	1.3	21.4	34.6	58.3	38.0	3.7	0.011	1.54	23.1
(S85TX-313-002)	6-24	E	0.3	0.4	1.2	21.0	34.2	57.1	37.8	5.1	0.004	1.53	22.2
	24-29	Bt/E1	0.4	0.4	1.0	20.2	31.1	53.1	35.9	11.0	0.015	1.55	17.7
	29-33	Bt/E2	0.3	0.3	0.9	19.3	25.6	46.4	31.2	22.4	0.034	1.52	22.3
	33-45	Btg	0.2	0.1	0.5	12.8	16.9	30.5	27.7	41.8	0.093	1.41	30.1
	45-61	Btss	0.1	0.1	0.6	15.6	18.8	35.2	29.6	35.2	0.081	1.59	25.1
	61-80	BCg	0.1	0.1	0.4	19.3	24.0	43.9	28.7	27.4	0.048	1.60	21.9

See footnotes at end of table.

TABLE 19.--PHYSICAL ANALYSES OF SELECTED SOILS--Continued

Soil name and sample number	Depth	Horizon	Particle-size distribution: Sand: Very coarse (2-1 mm)	Sand: Coarse (1-0.5 mm)	Sand: Medium (0.5-0.25 mm)	Sand: Fine (0.25-0.1 mm)	Sand: Very fine (0.1-0.05 mm)	Sand: Total (2-0.05 mm)	Silt (0.05-0.002 mm)	Clay (<0.002 mm)	COLE	Bulk density 1/3-bar	Water content 1/3-bar
	In		Pct	Pct	Pct	Pct	Pct	Pct	Pct	Pct	Cm/cm	g/cc	Pct (wt)
Zulch:[3]	0-9	Ap	0.0	0.1	1.2	31.2	26.6	59.1	36.6	4.3	0.010	1.33	24.4
(S85TX-313-005)	9-18	Btg1	0.0	0.1	0.7	15.2	18.1	34.1	31.6	34.3	0.101	1.41	29.2
	18-35	Btg2	0.2	0.1	0.7	13.6	15.4	30.0	34.5	35.5	0.105	1.41	29.7
	35-41	B/C	0.1	0.2	0.3	5.8	12.7	19.1	33.9	47.0	---	---	---
	41-47	C/B	0.0	0.2	0.1	1.8	7.2	9.3	35.3	55.4	---	---	---
	47-60	C	0.0	0.1	0.2	2.0	15.5	17.8	31.9	50.3	---	---	---

[1] Location of the pedon sample: from intersection of Farm Road 2548 and Texas Highway 21 in Midway, northeast 4.4 miles on Texas Highway 21, southeast 1.0 mile on Farm Road 2548, south 0.4 mile on ranch road, and southeast 150 feet in a pastured area. This soil is a taxadjunct because the Bt horizon does not increase in content of clay sufficiently to qualify as an argillic horizon.

[2] Location of the pedon sample: from intersection of Farm Road 2548 and Texas Highway 21 in Midway, northeast 2.3 miles on Texas Highway 21, north 0.3 mile on oil well road, and east 250 feet in a pastured area. This pedon was sampled as a Lufkin taxadjunct.

[3] Location of the pedon sample is the same as that of the typical pedon described in the section "Soil Series and Their Morphology."

TABLE 20.--CHEMICAL ANALYSES OF SELECTED SOILS

(Data determined by the Soil Characterization Laboratory, Texas A&M University, College Station, Texas. Dashes indicate data were not available. CEC means cation-exchange capacity)

Soil name and sample number	Depth	Horizon	Extractable bases: Ca	Extractable bases: Mg	Extractable bases: K	Extractable bases: Na	CEC (Sum of cat-ions)	Base saturation (sum)	pH 1:1 soil: water	Organic carbon	Electrical conductivity	Exchangeable sodium
			Meq/100g					Pct		Pct	mmhos/cm	Pct
Bienville: [1]	0-7	Ap	0.8	0.1	0.2	0.0	2.5	44	5.9	0.34	---	---
(S85TX-313-003)	7-14	E	1.0	0.1	0.1	0.0	2.0	60	6.1	0.19	---	---
	14-24	E/Bt	0.9	0.1	0.1	0.0	2.2	50	6.2	0.19	---	---
	24-33	B/E	0.5	0.2	0.1	0.0	1.9	42	6.0	0.10	---	---
	33-48	E/B1	0.5	0.1	0.1	0.0	1.5	47	6.2	0.07	---	---
	48-68	E/B2	0.4	0.1	0.1	0.0	1.3	46	6.1	0.06	---	---
	68-80	E/B3	0.4	0.1	0.1	0.0	0.9	67	6.0	0.08	---	---
Derly: [2]	0-8	A	9.5	2.3	0.3	0.2	13.8	90	5.6	1.24	---	1
(S85TX-313-001)	8-22	Btg1	16.8	3.4	0.2	0.9	24.1	89	5.8	0.40	---	4
	22-46	Btg2	16.0	3.2	0.2	2.1	20.3	100	7.0	0.39	2.5	6
	46-66	Btg3	15.8	3.0	0.2	2.4	19.5	100	7.3	0.16	3.6	7
	66-80	BC	17.3	2.5	0.2	2.8	24.0	95	7.0	0.09	3.0	7
Kaufman: [3]	0-6	Ap	29.6	3.6	0.7	0.1	38.6	88	5.3	1.74	---	---
(S85TX-313-004)	6-24	A	31.9	1.4	0.5	0.4	37.0	93	5.4	0.81	---	1
	24-41	Bss1	32.5	1.0	0.6	1.1	38.3	92	5.7	1.04	---	3
	41-58	Bss2	35.9	0.7	0.7	1.7	45.5	86	6.2	0.72	---	4
	48-80	BC	45.2	0.7	0.4	1.8	40.9	100	6.7	0.42	---	4
Rader: [3]	0-6	A	1.8	0.4	0.3	---	3.4	74	6.3	0.74	---	---
(S85TX-313-002)	6-24	E	1.0	0.0	0.1	---	2.7	41	5.5	0.22	---	---
	24-29	Bt/E1	1.6	0.0	0.1	---	4.2	40	5.0	0.22	---	---
	29-33	Bt/E2	3.6	0.7	0.1	0.2	8.7	52	4.9	0.26	---	2
	33-45	Btg	10.9	2.7	0.3	1.4	20.8	74	4.9	0.34	---	7
	45-61	Btss	10.2	2.3	0.2	2.2	18.7	79	5.4	0.13	0.7	10
	61-80	BCg	10.6	2.1	0.2	2.8	14.4	100	6.1	0.26	2.4	13
Zulch: [3]	0-9	Ap	1.3	0.2	0.2	0.1	4.6	39	4.4	0.77	---	2
(S85TX-313-005)	9-18	Btg1	24.2	7.1	0.2	1.0	32.9	99	5.7	0.61	0.3	3
	18-35	Btg2	26.5	7.5	0.2	2.3	34.5	100	6.7	0.43	1.4	5
	35-41	B/C	47.0	9.9	0.4	3.4	43.3	100	7.7	0.29	1.2	6
	41-47	C/B	37.1	11.4	0.5	3.8	46.0	100	7.6	0.18	1.1	7
	47-60	C	32.4	10.8	0.5	3.5	43.1	100	7.6	0.02	0.7	7

[1] Location of the pedon sample: from intersection of Farm Road 2548 and Texas Highway 21 in Midway, northeast 4.4 miles on Texas Highway 21, southeast 1.0 mile on Farm Road 2548, south 0.4 mile on ranch road, and southeast 150 feet in a pastured area. This soil is a taxadjunct because the Bt horizon does not increase in content of clay sufficiently to qualify as an argillic horizon.

[2] Location of the pedon sample: from intersection of Farm Road 2548 and Texas Highway 21 in Midway, northeast 2.3 miles on Texas Highway 21, north 0.3 mile on oil well road, and east 250 feet in a pastured area. This pedon was sampled as a Lufkin taxadjunct.

[3] Location of the pedon sample is the same as that of the typical pedon described in the section "Soil Series and Their Morphology."

TABLE 21.--ENGINEERING INDEX TEST DATA

Soil name, report number, horizon, and depth in inches	Classification		Percentage passing sieve--						Liquid limit	Plasticity index	Specific gravity (particle density)	Shrinkage		
	AASHTO	Unified	5/8 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200				Limit	Linear	Ratio
									Pct		g/cc	Pct	Pct	
Bienville: [1] (S85TX-313-003)														
E--------7 to 14	A-2-4(0)	SM	100	100	100	100	100	22	23	3	2.64	20.0	0	1.63
B/E-----24 to 33	A-2-4(0)	SM	100	100	100	100	99	22	22	2	2.65	23.0	0	1.62
Derly: [2] (S85TX-313-001)														
Btg1-----8 to 22	A-7-6(22)	CL	100	100	100	100	99	78	47	29	2.60	13.0	15.6	1.99
Btg2----22 to 46	A-7-6(22)	CL	100	100	100	100	99	76	46	30	2.63	11.0	16.8	2.08
Kaufman: [3] (S85TX-313-004)														
A--------6 to 24	A-7-6(43)	CH	100	100	100	100	99	84	72	47	2.60	55.0	23.0	1.98
Bss1----24 to 41	A-7-6(40)	CH	100	100	100	100	100	77	70	51	2.63	54.0	22.9	1.97
Rader: [3] (S85TX-313-002)														
E--------6 to 24	A-4(0)	CL-ML	100	100	100	99	98	58	20	4	2.63	17.0	5.3	1.79
B/E1----24 to 29	A-4(0)	CL-ML	100	100	100	99	98	52	21	4	2.60	20.0	1.0	1.72
B/E2----29 to 33	A-4(0)	CL-ML	100	100	100	99	98	52	21	4	2.60	20.0	1.0	1.72
Btss----45 to 61	A-7-6(23)	CL	100	100	100	100	100	77	47	31	2.64	16.0	14.0	1.88
Zulch: [3] (S85TX-313-005)														
Ap------0 to 9	A-4(0)	ML	98	97	97	96	94	57	23	3	2.62	24.0	0	1.57
Btg2---18 to 35	A-7-6(29)	CH	100	100	99	99	98	76	53	40	2.68	11.0	18.3	1.97
C------47 to 60	A-7-6(55)	CH	100	100	100	100	100	89	76	57	2.65	11.0	23.5	1.84

[1] Location of the pedon sample: from intersection of Farm Road 2548 and Texas Highway 21 in Midway, northeast 4.4 miles on Texas Highway 21, southeast 1.0 mile on Farm Road 2548, south 0.4 mile on ranch road, and southeast 150 feet in a pastured area. This is a taxadjunct because the Bt horizon does not increase in content of clay sufficiently to qualify as an argillic horizon.

[2] Location of the pedon sample: from intersection of Farm Road 2548 and Texas Highway 21 in Midway, northeast 2.3 miles on Texas Highway 21, north 0.3 mile on oil well road, and east 250 feet in a pastured area. This pedon was sampled as a Lufkin taxadjunct.

[3] Location of the pedon sample is the same as that of the typical pedon described in the section "Soil Series and Their Morphology."

TABLE 22.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Arriola	Fine, mixed, thermic Albaquultic Hapludalfs
Benchley	Fine, montmorillonitic, thermic Udertic Argiustolls
*Bienville	Sandy, siliceous, thermic Psammentic Paleudalfs
Boonville	Fine, montmorillonitic, thermic Mollic Albaqualfs
Bremond	Fine, montmorillonitic, thermic Udertic Paleustalfs
Burleson	Fine, montmorillonitic, thermic Udic Pellusterts
Chazos	Fine, mixed, thermic Aquic Paleustalfs
Crockett	Fine, montmorillonitic, thermic Udertic Paleustalfs
Derly	Fine, montmorillonitic, thermic Typic Glossaqualfs
Dimebox	Fine, montmorillonitic, thermic Udic Pellusterts
Dutek	Loamy, siliceous, thermic Arenic Haplustalfs
Ellis	Fine, montmorillonitic, thermic Udertic Ustochrepts
Elmina	Clayey, montmorillonitic, thermic Aquic Arenic Hapludalfs
Eufaula	Sandy, siliceous, thermic Psammentic Paleustalfs
*Flatonia	Fine, montmorillonitic, thermic Udertic Argiustolls
*Gasil	Fine-loamy, siliceous, thermic Ultic Paleustalfs
Gladewater	Fine, montmorillonitic, nonacid, thermic Vertic Haplaquepts
Gowker	Fine-loamy, siliceous, thermic Cumulic Hapludolls
Gredge	Fine, montmorillonitic, thermic Aquic Paleustalfs
Hatliff	Coarse-loamy, siliceous, nonacid, thermic Aquic Udifluvents
Huntsburg	Fine, mixed, thermic Plinthaquic Paleudalfs
Jedd	Fine, mixed, thermic Ultic Paleustalfs
Kaufman	Very-fine, montmorillonitic, thermic Typic Pelluderts
Kurten	Fine, montmorillonitic, thermic Udertic Paleustalfs
Lufkin	Fine, montmorillonitic, thermic Vertic Albaqualfs
Mabank	Fine, montmorillonitic, thermic Vertic Albaqualfs
Nahatche	Fine-loamy, siliceous, nonacid, thermic Aeric Fluvaquents
Navasan	Loamy, siliceous, thermic Grossarenic Paleustalfs
Padina	Loamy, siliceous, thermic Grossarenic Paleustalfs
Portersprings	Fine-loamy, siliceous, thermic Aquic Argiudolls
Rader	Fine-loamy, mixed, thermic Aquic Paleustalfs
Robco	Loamy, mixed, thermic Aquic Arenic Paleustalfs
Rosanky	Fine, mixed, thermic Ultic Paleustalfs
Silawa	Fine-loamy, siliceous, thermic Ultic Haplustalfs
Silstid	Loamy, siliceous, thermic Arenic Paleustalfs
Spiller	Fine, mixed, thermic Ultic Paleustalfs
Tabor	Fine, montmorillonitic, thermic Udertic Paleustalfs
Tonkavar	Loamy, siliceous, thermic Grossarenic Paleudalfs
Wilson	Fine, montmorillonitic, thermic Vertic Ochraqualfs
Zack	Fine, montmorillonitic, thermic Aquic Paleustalfs
Zulch	Fine, montmorillonitic, thermic Vertic Albaqualfs

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