SOIL SURVEY

Howard County Texas

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
TEXAS AGRICULTURAL EXPERIMENT STATION
Issued March 1969

Major fieldwork for this soil survey was done in the period 1959–63. Soil names and descriptions were approved in 1965. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1963. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station as part of the technical assistance furnished to the Martin-Howard Soil and Water Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY of Howard County, Tex., contains information that can be applied in managing farms and ranches; in selecting sites for roads, ponds, buildings, or other structures; and in judging tracts of land according to their suitability for agriculture, industry, or recreation.

Locating Soils

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

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information in the survey. This guide lists all of the soils of the county in alphabetic order by map symbol. It shows the page where each kind of soil is described, and also the page for the range site.

Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

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

Ranchers and others interested in range can find under "Range Management" groupings of the soils according to their suitability for range, and also the plants that grow on each range site.

Engineers and builders can find under "Engineering Applications of Soils" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

Scientists and others can read about how the soils were formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in Howard County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the section "General Nature of the County," which gives additional information about the county.

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SOIL SURVEY OF HOWARD COUNTY, TEXAS

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

HOWARD COUNTY, in the extreme southern part of the High Plains in Texas (fig. 1), has a total area of 583,680 acres, or 912 square miles. Elevation ranges from 2,100 to more than 2,800 feet. The nearly level and gently sloping plains extend from the northern and central parts of the county to steep, broken areas of the Edwards Plateau in the southern part. The most common soils in the county are loamy, but there are sandy and clayey soils in small areas. The climate is semiarid; average yearly rainfall is less than 19 inches.

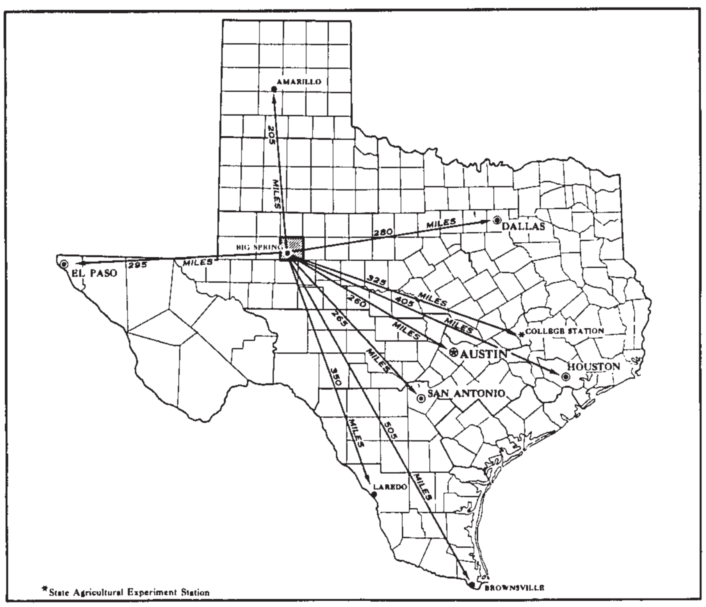

Figure 1.—**Location of Howard County in Texas.**

In 1964 about 60 percent of the acreage in the county was range and about 31 percent was cropland. The rest of the county was used for house lots, roads, and various other purposes. Cattle and sheep are the main livestock. Cotton and grain sorghum are the main crops, though some forage sorghum is also grown.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soils are in Howard County, where they are located, and how they can be used.

They went into the county knowing they likely would find many soils they had already seen, and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size and speed of streams; kinds of native plants or crops; kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into material that has not been changed much by leaching or by roots of plants.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. To use this survey efficiently, it is necessary to know the kinds of groupings most used in a local soil classification.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped.

Amarillo and Portales, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that go with their behavior in the natural, untouched landscape. Soils of one series can differ somewhat in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man.

Many soil series contain soils that differ in texture of their surface layer. According to such differences in texture, separations called soil types are made. Within a series, all the soils having a surface layer of the same texture belong to one soil type. Amarillo loamy fine sand and Amarillo fine sandy loam are two soil types in the Amarillo series. The difference in texture of their surface layers is apparent from their names.

Some types vary so much in slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the soil map as one unit. Such soil types are divided into phases. The name of a soil phase indicates a feature that affects management. For example, Amarillo fine sandy loam, 0 to

1 percent slopes, is one of several phases of Amarillo fine sandy loam, a soil type that ranges from nearly level to moderately sloping.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show woodlands, buildings, field borders, trees, and other details that greatly help in drawing boundaries accurately. The soil map in the back of this survey was prepared from the aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning management of farms and fields, a mapping unit is nearly equivalent to a soil type or a phase of a soil type. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil type or soil phase.

In preparing some detailed maps, the soil scientists have a problem of delineating areas where different kinds of soils are so intricately mixed, and so small in size that it is not practical to show them separately on the map. Therefore, they show this mixture of soils as one mapping unit and call it a soil complex. Ordinarily, a soil complex is named for the major kinds of soil in it, for example, Weymouth-Vernon clay loams, 1 to 3 percent slopes.

The soil scientist may also show as one mapping unit two or more soils that are mapped as one unit because their differences are not great enough to require that the soils be shown separately on the map. Such a mapping unit is called an undifferentiated soil group. An example is Amarillo and Cobb fine sandy loams, 1 to 3 percent slopes. Most surveys include areas where the soil material is so rocky, so shallow, or so frequently worked by wind and water that it cannot be classified by soil series. These areas are shown on the map like other mapping units, but are given descriptive names, such as Gypsum outcrop or Clayey alluvial land, and are called land types.

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

But only part of a soil survey is done when the soils have been named, described, and delineated on the map, and the laboratory data and yield data have been assembled. The mass of detailed information then needs to be organized in a way that it is readily useful to different groups of readers, among them farmers, ranchers, managers of woodland, engineers, and homeowners. Grouping soils that are similar in suitability for each specified use is the method of organization commonly used in the soil surveys. On basis of the yield and practice tables and other data, the soil scientists set up trial groups, and then test them by further study and by consultation with farmers, agronomists, engineers, and others. Then, the scientists adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Howard County, Tex. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of farming or other land use. Such a map is not suitable for planning the management of a farm or field, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect management.

The ten soil associations in the county are described in the following pages.

Soils of the High Plains

The soils of the High Plains occupy about 72 percent of Howard County and occur mostly in the western part. These soils are nearly level to gently sloping or undulating. They lie on an outwash plain dotted by many playa lakes, which provide most of the drainage for the High Plains. Six of the ten soil associations in the county are on the High Plains.

1. Tivoli-Brownfield association

Deep, nearly level to undulating, sandy soils

The soils of this association occur on broad uplands in the central and western parts of the county (fig. 2). They are nearly level to undulating, deep sands that have slopes of 0 to 5 percent. The association covers about 4 percent of the county.

Tivoli soils occupy about 45 percent of this association; Brownfield soils, about 40 percent; and Amarillo and Springer soils, most of the remaining 15 percent. The major soils, the Tivoli and Brownfield, are on about the same topography, but the Tivoli is more billowy. The minor soils, the Amarillo and Springer, are in more nearly level areas adjacent to the Brownfield soils.

Tivoli soils have a loose, pale-brown fine sand surface layer about 15 inches thick. It is underlain by many feet of loose, reddish-yellow fine sand that is neutral in reaction.

Brownfield soils have a brown fine sand surface layer about 30 inches thick. Their subsoil is yellowish-red to red sandy clay loam about 42 inches thick. The underlying material is crumbly, calcareous fine sandy loam.

This association is used mostly for range and is best suited to that use. The native vegetation in most places is a thick stand of shinnery oak and scattered clumps of sand bluestem, dropseed, and three-awn. About 10 percent of the association is planted to cotton and to grain sorghum, but the soils are droughty and highly susceptible to wind erosion when cultivated. Crop growth is limited by low rainfall. Dove and quail are the principal wildlife.

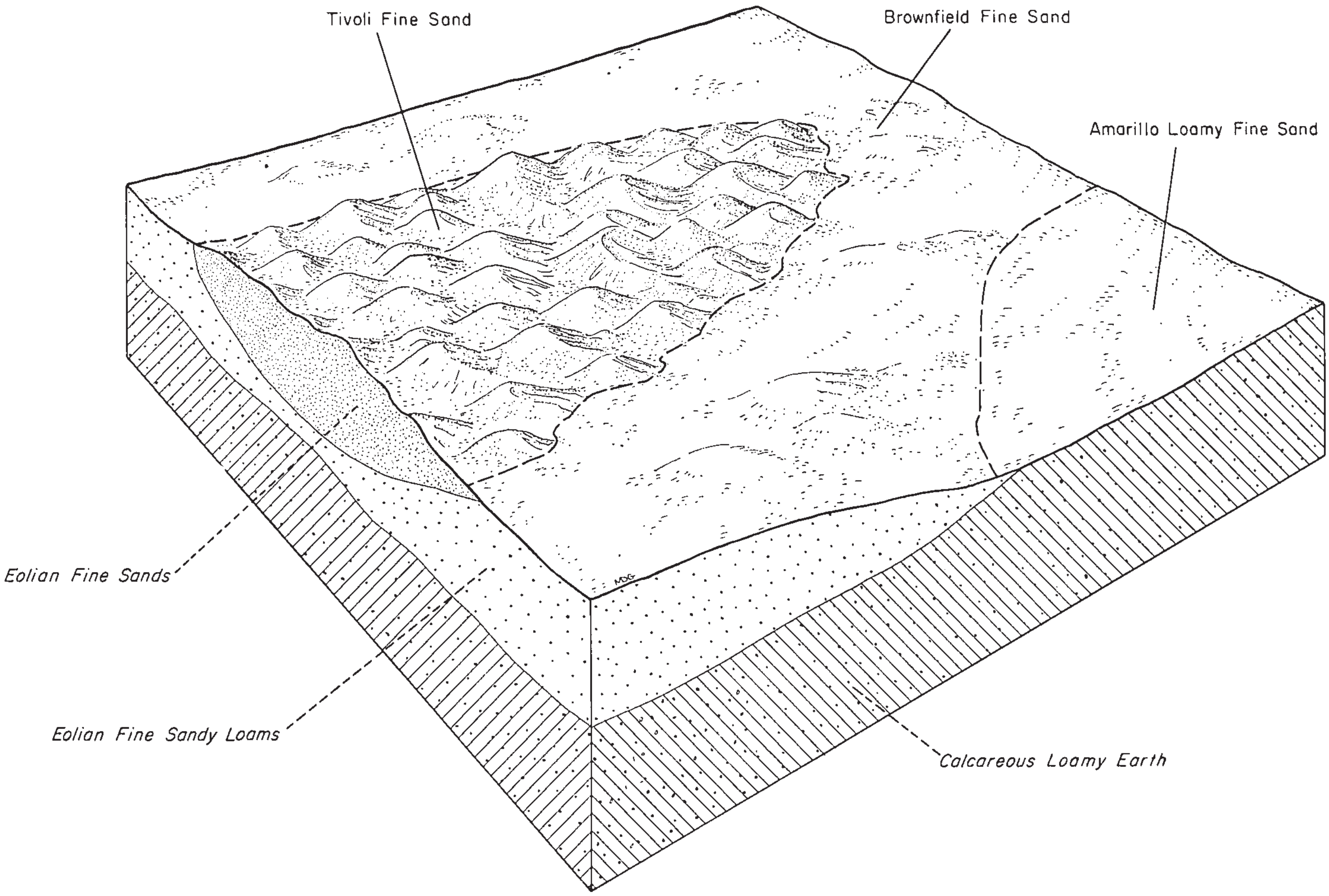

***Figure 2.*—An area typical of the Tivoli-Brownfield association.**

2. Amarillo-Springer association

Deep, nearly level to gently sloping, sandy soils

The nearly level to gently sloping, sandy soils of this association are on uplands in the central part of the county. The association covers about 7 percent of the county.

Amarillo soils occupy about 65 percent of this association; Springer soils, about 25 percent; and Brownfield soils, the remaining 10 percent. The Amarillo soils are at the lowest level on the uplands, the Springer soils are above them, and the Brownfield soils are at the highest point.

The Amarillo soils have a surface layer of loose, reddish-brown, neutral loamy fine sand about 8 to 15 inches thick. Their subsoil is a friable, neutral to mildly alkaline, reddish-brown sandy clay loam about 35 to 40 inches thick. The underlying material is crumbly, calcareous loam and sandy clay loam.

Springer soils have a loose, dark-brown, neutral loamy fine sand surface layer about 12 inches thick. Their subsoil is friable, neutral to mildly alkaline, reddish-brown and yellowish-red fine sandy loam about 36 inches thick. The underlying material is mildly alkaline loamy fine sand.

Most of this association is farmed to cotton and grain sorghum. The rest is used for small cattle ranches. The soils are suitable for cultivation but are highly susceptible to wind erosion. The low rainfall limits growth of crops. Dove and quail are the main kinds of wildlife.

3. Amarillo-Portales association

Deep, nearly level to gently sloping, loamy soils

The nearly level to gently sloping soils of this association occupy broad uplands in the central and southwestern parts of the county (fig. 3). Slopes range from 0 to 3 percent, and surfaces are plane to weakly convex. This association covers about 20 percent of the county.

The Amarillo soils make up about 60 percent of this association; the Portales soils, 25 percent; and the minor Arvana, Randall, and Veal soils, most of the remaining 15 percent. The Amarillo and Arvana soils have about the same topography and are at the highest points in the association. Below them are the Portales soils and, in some places, the minor Veal soils. The Portales soils are in plane to concave areas, and the Veal soils are on convex slopes. The minor Randall soils are in depressions, or playas, below the Portales soils.

The Amarillo soils have a friable, brown, neutral fine sandy loam surface layer about 5 to 15 inches thick. Their subsoil is friable, reddish-brown, neutral to mildly alkaline sandy clay loam about 20 to 38 inches thick. The underlying material is pink, very limy clay loam.

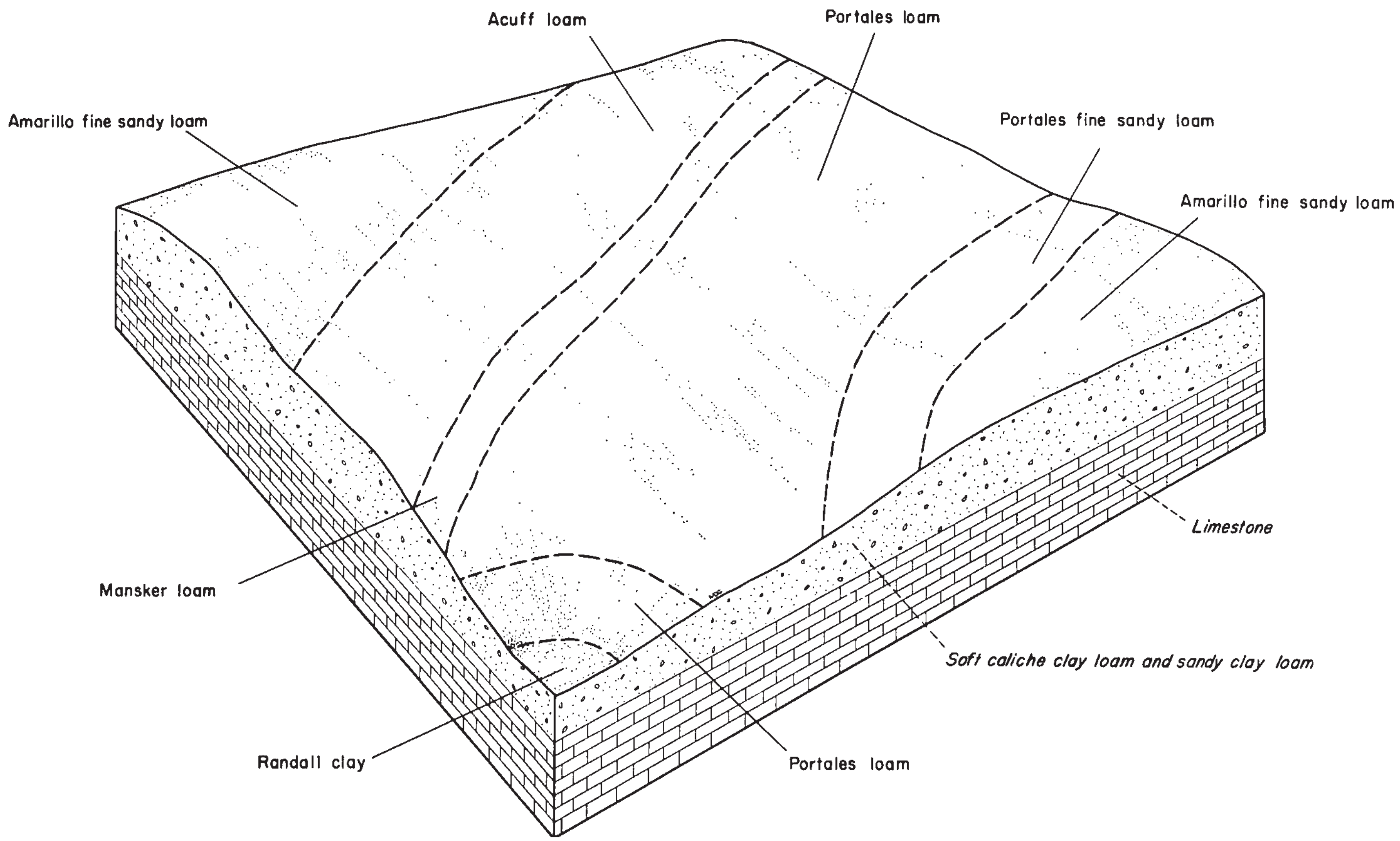

***Figure 3.*—Diagram showing areas typical of the Amarillo-Portales association.**

Portales soils have a friable, dark grayish-brown, calcareous fine sandy loam surface layer about 10 to 22 inches thick. Beneath this layer is 10 to 30 inches of friable, brown, calcareous sandy clay loam that is underlain by a strong accumulation of soft caliche.

About 90 percent of this association is planted to cotton and grain sorghum and the rest is range. The soils are suitable for cultivation, but wind erosion is a hazard. The low rainfall limits growth of crops.

4. Reagan-Reeves association

Moderately deep and shallow, nearly level to sloping, calcareous, loamy soils

The nearly level to sloping, loamy soils of this association occupy broad uplands in the southwestern part of the county. Slopes are dominantly 0 to 1 percent, but knolls, and other high areas have slopes of 1 to 5 percent. Surfaces are plane to weakly convex. Several salt lakes are in this association. The association covers about 3 percent of the county.

Reagan soils make up about 50 percent of this association; Reeves soils, about 10 percent; and the minor Drake soils, Portales soils, and Gypsum outcrop, the remaining 40 percent. The Reeves soils are slightly higher in the landscape than the Reagan soils and have surfaces that are more convex. Ridges consisting of Gypsum outcrop rise about 2 to 4 feet above areas of Reagan and Reeves soils. The Drake soils are in ridgelike areas between Gypsum outcrop and the salt lakes. The position of the Portales soils is similar to that of the Reagan.

The Reagan soils have a friable, grayish-brown, calcareous loam surface layer about 4 to 14 inches thick. Beneath this layer is friable, pale-brown clay loam about 14 to 30 inches thick. The underlying layer is crumbly, very limy clay loam.

The Reeves soils have a pale-brown, calcareous loam surface layer about 6 inches thick. Beneath this layer is pale-brown, calcareous loam that is about 12 inches thick and that is underlain abruptly by a layer of gypsum several feet thick.

All of this association is range that is used mostly for large cattle ranches. On the Reagan soils the vegetation is mainly sideoats grama, black grama, sand dropseed, buffalograss, tobosa, and perennial three-awn. Annual grasses and broom snakeweed are the main plants on the Reeves soils. The more sloping areas of this association are susceptible to water erosion if the grass is overgrazed. All areas are susceptible to wind erosion. Some areas of Reagan soils are suitable as cropland, but other areas are so irregularly shaped that cultivation is impractical. Dove and quail are the main kinds of wildlife.

5. Acuff-Olton association

Deep, nearly level to gently sloping, dark-colored, loamy soils

The nearly level to gently sloping, loamy soils of this association occupy a broad plain in the northwestern and south-central parts of the county. Slopes range from 0 to 3 percent, and surfaces are plane to weakly convex (fig. 4).

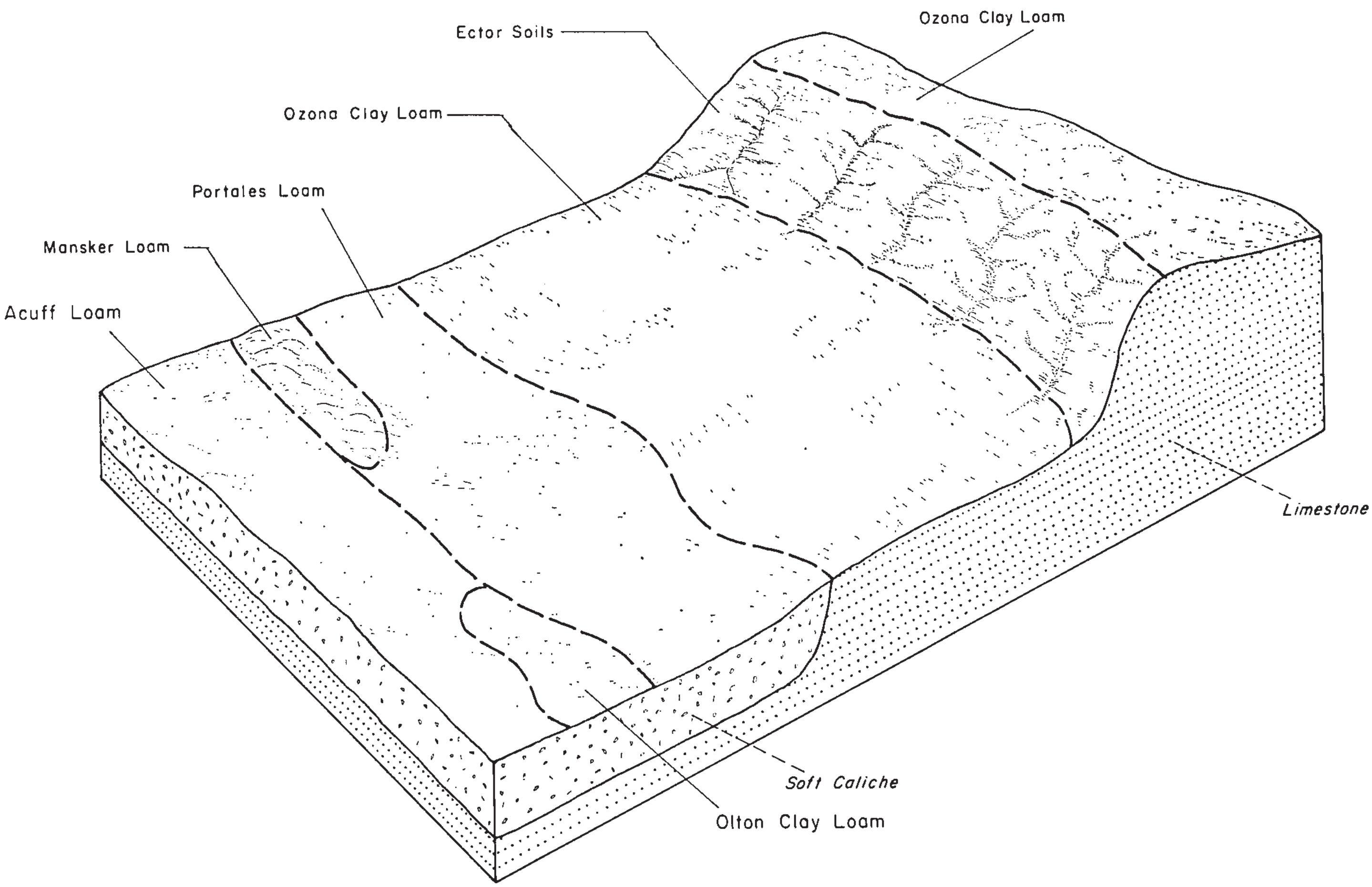

Figure 4.—Areas of the Acuff-Olton association.

This association, the largest in the county, covers about 24 percent of the land.

The Acuff soils and the Olton soils each make up about 25 percent of the association, and the minor Mansker, Portales, Amarillo, and Randall soils make up the remaining 50 percent. The Acuff, Olton, and Amarillo soils occur in similar positions. Mansker soils are gently sloping and lie below the Acuff soils but above the Portales soils. The Portales soils are slightly concave and are 8 to 10 feet lower than the Acuff soils. The Randall soils occupy depressions, or playas, in the lowest areas.

The Acuff soils have a friable, brown, neutral loam surface layer about 8 inches thick. Their subsoil is firm, reddish-brown, neutral to mildly alkaline sandy clay loam about 26 to 40 inches thick. This is underlain by crumbly clay loam that contains many soft masses of lime.

The Olton soils have a friable, dark-brown, neutral clay loam surface layer about 10 inches thick. Their subsoil is firm, reddish-brown, neutral to moderatly alkaline clay loam about 30 inches thick. Many soft and hard masses of lime are in the underlying material.

About 85 percent of this association is cultivated, and the rest is range on a few small cattle ranches. The soils are suitable for cultivation, but cultivated areas are susceptible to wind erosion. Water erosion is a hazard in the gently sloping and sloping areas. The low rainfall limits the growth of crops.

6. Potter-Mansker association

Gently sloping to steep soils that are very shallow and shallow over caliche

The gently sloping to steep, very shallow and shallow, loamy soils of this association occupy narrow areas of the uplands throughout most of the county. The largest areas are southeast of Big Spring. Slopes range from 0 to 30 percent. This association covers about 14 percent of the county.

The Potter soils make up about 50 percent of the association; the Mansker soils, about 20 percent; and the minor Berthoud and Mobeetie soils, most of the remaining 30 percent. The Mansker soils are in higher lying areas above the very shallow Potter soils, which occupy the breaks and steep areas. Below the Potter soils on foot slopes are the minor Berthoud and Mobeetie soils.

The Potter soils have a friable, brown, calcareous fine sandy loam to clay loam surface layer about 6 inches thick. Caliche fragments are common on the surface and in the profile. Caliche underlies the surface layer. This caliche is weakly cemented in the upper part, but it grades to calcareous loamy material as depth increases.

The Mansker soils have a friable, brown, calcareous surface layer about 8 inches thick. Beneath this layer is friable, light-brown calcareous loam about 8 inches thick. This loam, in turn, is underlain by pink, calcareous clay loam that has many concretions of caliche in the upper part.

All of this association is range on the large cattle ranches. The main grasses on the Potter soils are sideoats grama, slim tridens, hairy grama, fall witchgrass, and perennial three-awn. Javalinabrush and broom snakeweed are also common. Grasses common on the Mansker soils are sideoats grama, black grama, and buffalograss. Yucca and mesquite are also common. Runoff is rapid and water erosion is a hazard in the sloping areas. The Potter soils are too shallow and steep for cultivation. The Mansker soils can be cultivated, but they are droughty and produce poor crops. Wildlife is abundant in areas of this association in the southern part of the county. Deer, turkey, dove, and quail are the principal kinds of wildlife.

Soils of the Rolling Plains

The soils of the Rolling Plains occupy about 23 percent of the county and are mainly in the eastern part. The soils on this plain formed mainly in outwash and material derived from the Triassic red beds. In an area near Vealmoor they are underlain by Triassic sandstone. The soils are crossed by a well-developed system of drains and small streams. Three of the ten soil associations in the county are on the Rolling Plains.

7. *Amarillo-Cobb association*

Nearly level to moderately sloping, loamy soils that are deep and moderately deep over caliche and sandstone

The nearly level to moderately sloping, loamy soils of this association occupy a broad upland plain near Vealmoor in the northwestern part of the county. Slopes are dominantly 0 to 5 percent, and surfaces are plane to undulating (fig. 5). This association covers about 4 percent of the county.

The Amarillo soils make up about 75 percent of this association; the Cobb soils, 15 percent; and the minor Mobeetie, Spade, and Latom soils, the remaining 10 percent. The Amarillo and Cobb soils are in about the same topography, below the Mobeetie, Spade, and Latom soils, which are on the slopes and ridges.

The Amarillo soils have a friable, brown, neutral fine sandy loam surface layer about 5 to 15 inches thick. Their subsoil is friable, reddish-brown, neutral to mildly alkaline sandy clay loam about 20 to 38 inches thick. The underlying material is soft caliche.

The Cobb soils have a friable, dark-brown, neutral fine sandy loam surface layer about 8 to 15 inches thick. Their subsoil is friable, yellowish-red, mildly alkaline sandy clay loam about 28 inches thick. The underlying material is a weakly cemented sandstone.

About 50 percent of this association is cultivated, and the rest is range on large cattle ranches. The major soils are suitable for cultivation but are susceptible to wind erosion where cultivated. Water erosion is a hazard in the gently sloping and moderately sloping areas. The low rainfall limits growth of crops. Wildlife is abundant in the association, and turkey, dove, and quail are the most plentiful kinds.

8. *Olton-Weymouth association*

Nearly level to gently sloping, loamy soils that are deep and shallow over caliche and red-bed clay

The nearly level to gently sloping, loamy soils of this association occupy broad uplands in the northeastern part of the county. Slopes range from 0 to 3 percent, and sur-

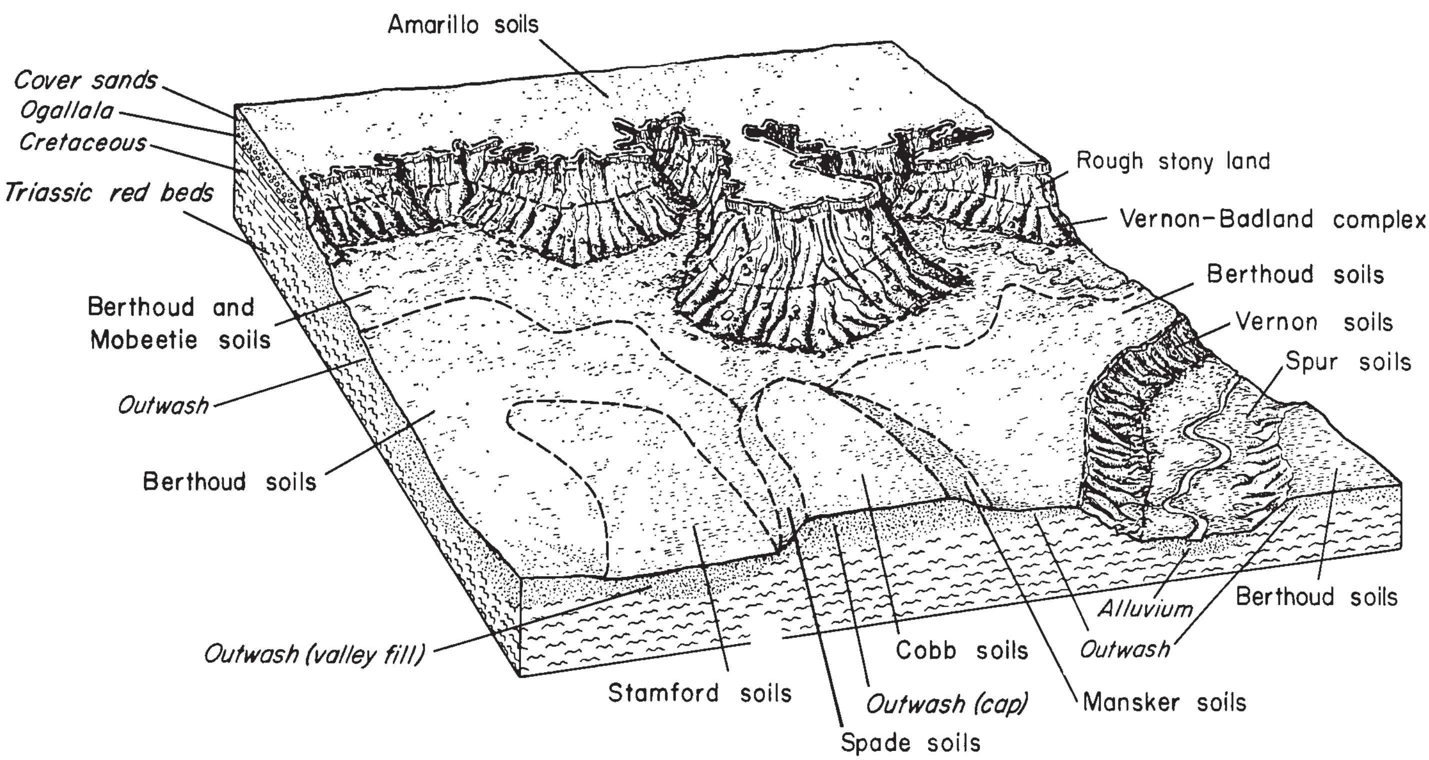

Figure 5.—Areas of Cobb and other soils in the Amarillo-Cobb association.

faces are plane to weakly convex. The association covers about 9 percent of the county.

The Olton soils make up about 55 percent of the association; the Weymouth soils, 11 percent; and the minor Stamford, Vernon, and Spade soils most of the remaining 34 percent. The Weymouth and Vernon soils are gently sloping and occur in convex areas above the Olton soils. The Stamford soils occupy the concave areas in the lowest part of the topography. The Spade soils occupy ridges on higher lying knolls within areas of Weymouth soils.

The Olton soils have a friable, dark-brown, neutral clay loam surface layer about 8 to 12 inches thick. Their subsoil is a firm, reddish-brown, neutral to moderately alkaline clay loam about 17 to 45 inches thick. The underlying material is a pink crumbly loam that contains many hard and soft masses of lime.

The Weymouth soils consist of friable, reddish-brown, calcareous clay loam that extends to a depth of 12 to 20 inches and is underlain by a mixture of soft caliche and red-bed clay.

About 50 percent of this association is cultivated, and the rest is range used for large cattle ranches. Cotton and grain sorghum are the main crops. The soils are suitable for cultivation, but cultivated areas are susceptible to wind erosion. The gently sloping areas are susceptible to water erosion. Because the Weymouth soils are droughty, they are better suited to grass than to cultivated crops. Turkey, dove, and quail are abundant.

9. *Stamford-Dalby-Vernon association*

Nearly level to gently sloping, calcareous soils that are deep and shallow over red beds

The nearly level to gently sloping soils of this association occupy a broad, broken red-bed plain in the eastern part of the county. Dominant slopes range from 0 to 3 percent. This association covers about 10 percent of the county.

The Stamford and Dalby soils make up about 45 percent of the association; Vernon soils, about 30 percent; and Clayey alluvial land, areas of badland, and the Weymouth soils, the remaining 25 percent. Vernon soils are in sloping areas above the Stamford and Dalby soils. The minor Weymouth soils occupy the highest points of knolls or ridges. Clayey alluvial land is in low concave areas, and badland is on breaks adjacent to the Vernon soils.

The Stamford soils have a firm, reddish-brown, calcareous clay surface layer about 8 to 20 inches thick. Beneath this layer is firm, reddish-brown, calcareous clay about 14 to 32 inches thick. The underlying material consists of massive red-bed clay.

The Dalby soils have a firm, reddish-brown, calcareous clay surface layer about 4 to 10 inches thick. Beneath this layer is firm, reddish-brown, calcareous clay about 36 inches thick. The underlying material is massive, calcareous clay.

The Vernon soils are firm, reddish-brown, calcareous, and clayey. They are about 15 inches thick over massive red-bed clay.

Most of this association is range on large cattle ranches. Some of the common grasses are sideoats grama, vine-mesquite, tobosa, and buffalograss. Mesquite and pricklypear are troublesome woody plants. The soils in this association are highly susceptible to water erosion if a plant cover is not maintained. Although the Stamford and Dalby soils can be cultivated, they are too droughty for good growth of crops and are better suited to range. Deer, turkey, quail, and dove are the main kinds of wildlife.

Soils of the Edwards Plateau

The soils of the Edwards Plateau occupy about 5 percent of the county. They extend from the city of Big Spring southeastward to the county line. This plateau is a Cretaceous limestone upland plain that has gentle to steep slopes. It is a drainage divide from which most of the water flows into Beals Creek. The soils of the Edwards Plateau are in one soil association.

10. *Ector-Uvalde association*

Gently sloping to steep, calcareous, loamy soils that are very shallow and moderately deep over limestone and marl

The gently sloping to steep, loamy soils of this association are on a broad limestone plain in the southern part of the county. Slopes range from 1 to 12 percent and surfaces are generally undulating (fig. 6). This association covers about 5 percent of the county.

The Ector soils make up about 50 percent of the association, and the Uvalde soils, about 10 percent. The minor Ozona and Tobosa soils and rock outcrops make up most of the remaining 40 percent. The Ector soils and the rock outcrops are at the highest points in the landscape. The Uvalde and Tobosa soils lie in the valleys below the Ector and Ozona soils.

The Ector soils have a friable, brown, calcareous, loamy surface layer about 7 inches thick. Limestone fragments make up about 55 percent of this layer, by volume. The underlying material is hard limestone that is several feet thick.

The Uvalde soils have a friable, dark-brown, calcareous silty clay loam surface layer 10 to 22 inches thick. Beneath this layer is a crumbly, brown, calcareous silty clay loam 10 to 30 inches thick. The underlying material is crumbly, very limy clay loam.

All of this association is in large cattle ranches and is used for native range. Some of the common grasses are little bluestem, sideoats grama, blue grama, slim tridens, black grama, and buffalograss. The Ector soils are too shallow and too stony for cultivation, but some of the larger areas of the Uvalde and Ozona soils can be farmed. Sloping areas are susceptible to water erosion. Deer, turkey, dove, and quail are the main kinds of wildlife.

Descriptions of the Soils

This section describes the soil series and mapping units in Howard County. The acreage and proportionate extent of each mapping unit are shown in table 1.

The procedure is first to describe the soil series, and then the mapping units in the series. Thus, to get full information on any one mapping unit, it is necessary to read the description of that unit and also the description of the series to which it belongs. An essential part of each soil series is the description of the soil profile. A soil profile is the sequence of layers beginning at the surface and continuing downward to depths beyond which roots of most plants do not penetrate. Each soil series contains

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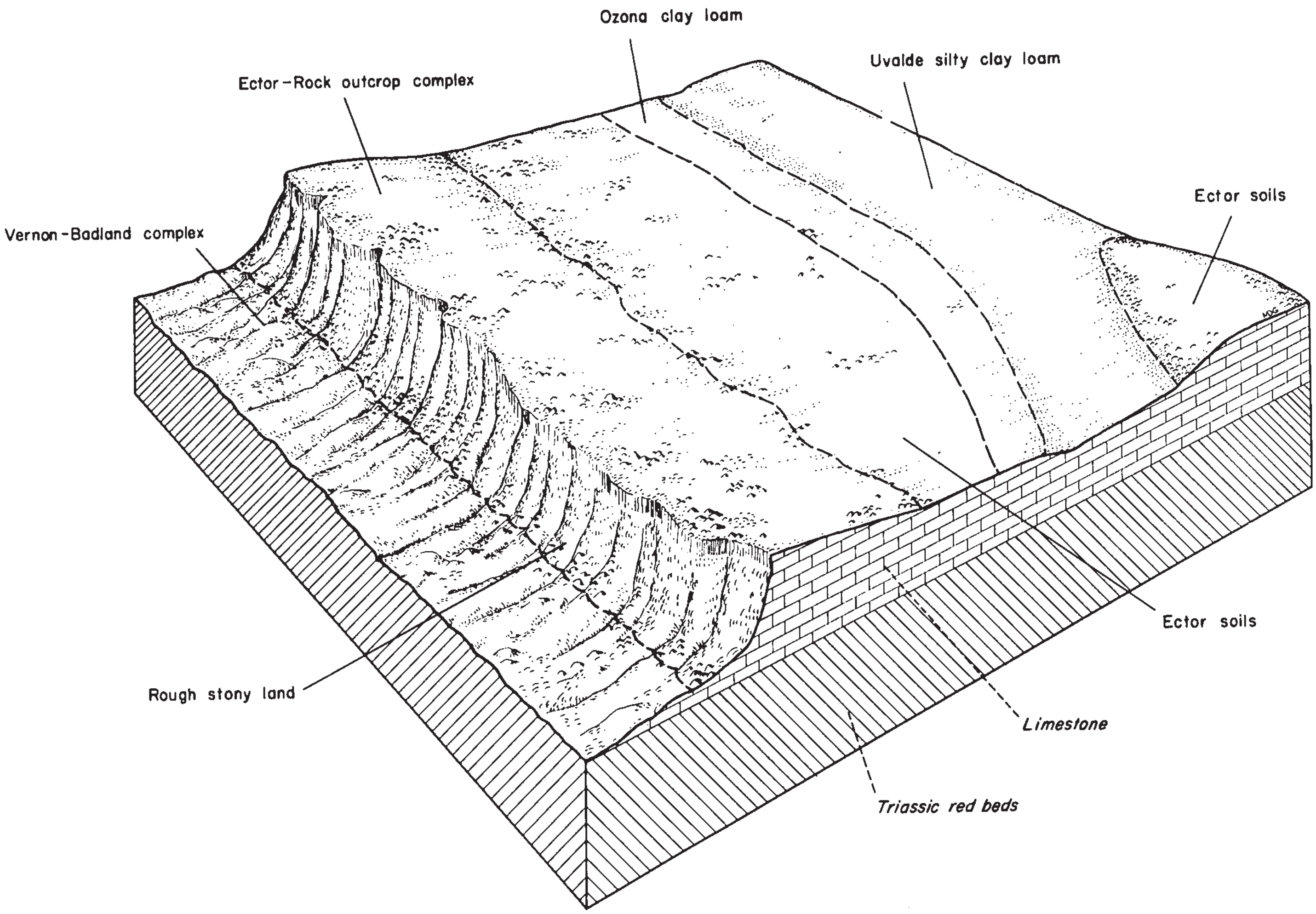

***Figure 6.*—Soils in an area typical of the Ector-Uvalde association.**

both a brief nontechnical and a detailed technical description of the soil profile. The nontechnical description will be useful to most readers. The detailed technical description is included for soil scientists, engineers, and others who need to make thorough and precise studies of the soils.

Each mapping unit contains suggestions on how it can be managed under dryfarming. Management of soils under native grass, however, is discussed in the section "Range Management." The discussion is by range sites, or groups of soils that produce about the same kind of range vegetation and that require about the same management when used for grazing. Behavior of the soils when used as sites for structures or as material for construction is discussed in the section "Engineering Applications of Soils."

Acuff Series

The Acuff series consists of deep, well-drained, loamy soils that are nearly level to gently sloping. These soils are on broad uplands, where they developed from unconsolidated alluvial and eolian deposits. They occur in the western part of the county. The largest areas are near Knott in the northwestern part.

In a typical profile, the surface layer of these soils is brown, crumbly loam about 8 inches thick. The subsoil is reddish-brown, neutral to mildly alkaline sandy clay loam about 32 inches thick. The underlying layer is a prominent accumulation of pink caliche of sandy clay loam texture.

Most of the acreage of these soils is cultivated to cotton and sorghums. Crops grow well on these soils. A few areas are used for range. Sideoats grama, silver bluestem, tobosa, dropseed, and buffalograss are common native grasses.

Profile of Acuff loam, 0 to 1 percent slopes, 0.3 mile west and 100 feet north of the southeast corner of section 29, block 33, T-3-N, Texas and Pacific Railroad Survey; or 100 feet north of FM Road 1785, from a point 4.3 miles west and 1 mile south of Vealmoor School; in a pasture:

A1—0 to 8 inches, brown (7.5YR 4/3) loam, dark brown (7.5YR 3/3) when moist; weak, subangular blocky, and granular structure; slightly hard when dry, friable when moist; many fine roots; neutral; clear boundary.

B21t—8 to 20 inches, reddish-brown (5YR 5/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, prismatic and fine subangular blocky structure; hard when dry, firm when moist; many fine roots, few clay films; neutral; gradual boundary.

B22t—20 to 31 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, prismatic and fine subangular blocky

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

Soils	Area	Extent
	Acres	*Percent*
Acuff loam, 0 to 1 percent slopes	27, 914	4. 8
Acuff loam, 1 to 3 percent slopes	8, 078	1. 4
Amarillo fine sandy loam, 0 to 1 percent slopes	28, 005	4. 8
Amarillo fine sandy loam, 1 to 3 percent slopes	31, 944	5. 5
Amarillo fine sandy loam, 3 to 5 percent slopes	548	([1])
Amarillo loamy fine sand, 0 to 3 percent slopes	24, 017	4. 1
Amarillo and Cobb fine sandy loams, 1 to 3 percent slopes	7, 729	1. 3
Amarillo and Cobb fine sandy loams, 3 to 5 percent slopes	1, 155	. 2
Arvana fine sandy loam, 1 to 3 percent slopes	633	. 1
Arvana fine sandy loam, shallow, 1 to 3 percent slopes	1, 868	. 3
Berthoud loam, 1 to 3 percent slopes	8, 796	1. 5
Berthoud loam, 3 to 5 percent slopes	1, 499	. 3
Brownfield fine sand, 0 to 3 percent slopes	10, 182	1. 7
Brownfield fine sand, thin surface variant, 0 to 3 percent slopes	4, 154	. 7
Clayey alluvial land	16, 547	2. 8
Drake soils, 3 to 5 percent slopes	2, 250	. 4
Drake soils, 5 to 20 percent slopes	206	([1])
Ector soils	15, 528	2. 7
Ector-Rock outcrop complex	15, 523	2. 7
Gomez loamy fine sand	1, 101	. 2
Gypsum outcrop	2, 608	. 4
Latom fine sandy loam, 1 to 8 percent slopes	3, 629	. 6
Mansker loam, 0 to 1 percent slopes	642	. 1
Mansker loam, 1 to 3 percent slopes	14, 916	2. 6
Mansker loam, 3 to 5 percent slopes	1, 770	. 3
Mobeetie fine sandy loam, 1 to 3 percent slopes	4, 886	. 8
Mobeetie fine sandy loam, 3 to 5 percent slopes	3, 900	. 7
Olton clay loam, 0 to 1 percent slopes	36, 620	6. 3
Olton clay loam, 1 to 3 percent slopes	6, 017	1. 0
Ozona clay loam, 1 to 3 percent slopes	6, 657	1. 1
Portales fine sandy loam, 0 to 1 percent slopes	15, 797	2. 7
Portales fine sandy loam, 1 to 3 percent slopes	8, 513	1. 5
Portales loam, 0 to 1 percent slopes	31, 673	5. 4
Portales loam, 1 to 3 percent slopes	28, 570	4. 9
Potter soils	40, 155	6. 9
Randall clay	3, 755	. 6
Reagan loam, 0 to 1 percent slopes	8, 972	1. 5
Reagan-Gypsum outcrop complex	5, 249	. 9
Reeves loam, 1 to 3 percent slopes	1, 856	. 3
Roscoe clay	3, 291	. 6
Rough stony land	8, 759	1. 5
Rowena clay loam, 0 to 1 percent slopes	11, 705	2. 0
Rowena clay loam, 1 to 3 percent slopes	1, 177	. 2
Saline alluvial land	985	. 2
Sandy alluvial land	1, 682	. 3
Simona fine sandy loam, 1 to 3 percent slopes	711	. 1
Spade-Latom sandy loams, 1 to 3 percent slopes	1, 542	. 3
Spade-Latom sandy loams, 3 to 5 percent slopes	1, 196	. 2
Springer fine sandy loam, 0 to 1 percent slopes	1, 429	. 2
Springer fine sandy loam, 1 to 3 percent slopes	1, 623	. 3
Springer loamy fine sand, undulating	10, 167	1. 7
Springer soils, severely eroded	165	([1])
Spur clay loam	4, 577	. 8
Stamford and Dalby clays, 0 to 1 percent slopes	13, 718	2. 4
Stamford and Dalby clays, 1 to 3 percent slopes	11, 264	1. 9
Tivoli fine sand	12, 322	2. 1
Tobosa clay, 0 to 2 percent slopes	1, 972	. 3
Uvalde silty clay loam, 0 to 1 percent slopes	1, 348	. 2
Uvalde silty clay loam, 1 to 3 percent slopes	1, 464	. 3
Veal fine sandy loam, 1 to 3 percent slopes	13, 429	2. 3
Veal fine sandy loam, 3 to 5 percent slopes	1, 642	. 3
Vernon soils, 1 to 3 percent slopes	10, 083	1. 7
Vernon-Badland complex	17, 421	3. 0
Weymouth-Vernon clay loams, 1 to 3 percent slopes	8, 154	1. 4
Zavala fine sandy loam	1, 480	. 3
Zita fine sandy loam, 0 to 1 percent slopes	2, 071	. 4
Gravel and caliche pits	1, 143	. 2
Lakes	3, 304	. 6
Total	583, 680	100. 0

[1] Less than 0.1 percent.

structure; very hard when dry, firm when moist; few fine roots, thin clay skins; noncalcareous; mildly alkaline; gradual boundary.

B3—31 to 40 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) when moist; weak prismatic and weak subangular blocky structure; hard when dry, friable when moist; calcareous; moderately alkaline; abrupt boundary.

C1ca—40 to 60 inches, pink (5YR 8/4) sandy clay loam, pink (5YR 7/4) when moist; about 30 percent, by volume, is soft calcium carbonate; calcareous; diffuse boundary.

C2—60 to 70 inches, pink (5YR 7/4) sandy clay loam, light reddish brown (5YR 6/4) when moist; about 10 percent, by volume, is soft calcium carbonate; calcareous.

The A horizon ranges from 6 to 10 inches in thickness and from loam to sandy clay loam in texture. When this horizon is dry, its color value ranges from 3 to 5, chroma is 3 or 4, and hue is 5YR and 7.5YR.

The B horizon ranges from 26 to 40 inches in thickness. When dry, it has value of 4 or 5, chroma of 4 to 6, and hue of 2.5YR and 7.5YR. The lower part of the B horizon is calcareous.

Calcium carbonate in soft lumps and strongly cemented concretions make up 20 to 50 percent of the Cca horizon, by volume. Depth to the Cca horizon ranges from 30 to 50 inches.

Acuff soils have a less clayey subsoil than the closely associated Olton soils. The surface layer of the Acuff soils contains more clay and organic matter than that of the Amarillo and Arvana soils. Acuff soils are deep to soft caliche, whereas Arvana soils are moderately deep to hard caliche. Acuff soils are less alkaline than the Portales and Rowena soils.

Acuff loam, 0 to 1 percent slopes (AcA).—This nearly level soil occupies broad upland areas that range from 20 to several hundred acres in size. Its profile is the one described as typical for the series.

Included with this soil in the mapping were areas of Mansker soils less than 5 acres in size. These included areas are in the slightly more sloping places.

This moderately permeable soil has slow surface runoff. Available water capacity and natural fertility are high.

This soil is suitable for large-scale farming. Most of it is cultivated to cotton and grain sorghum. Forage sorghum and small grains are sometimes grown for grazing. A few areas are used for native range.

Cropping systems that produce large amounts of residue are beneficial. Residues left on the surface help to control erosion and, if they are plowed under, to improve tilth. Contour farming helps to conserve moisture. (Capability unit IIIce-1; Deep Hardland range site)

Acuff loam, 1 to 3 percent slopes (AcB).—This gently sloping soil occurs in upland areas that are much longer than they are wide. Generally, these areas are less than 200 acres in size. This soil has a slightly thinner subsoil than that in the profile described as typical for the series. Also, accumulated lime is a little nearer the surface.

Included in the mapping were areas of a Mansker loam less than 5 acres in size. These included areas are in slightly more sloping places.

This soil is moderately permeable and is naturally fertile. Available water capacity is high. Crops grow well on this soil, but it is more susceptible to water erosion than the nearly level Acuff loam because more water runs off.

This soil is well suited to large-scale farming. About 95 percent of it is cultivated, mainly to cotton and grain sorghum. Forage sorghum and small grains are also grown, mostly for soil cover and grazing.

Contour farming and terraces are used to control erosion and conserve moisture. Cropping systems that include grain sorghum or other crops that produce large amounts of residue are beneficial. The residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IIIe-1; Deep Hardland range site)

Amarillo Series

In the Amarillo series are deep, neutral, well-drained, sandy and loamy soils that are nearly level to moderately sloping. These soils occur mainly in the western part of the county, where they developed in loamy alluvial and eolian materials. Amarillo soils are more extensive in this county than the soils of any other series.

In a typical profile, the surface layer is brown, crumbly, neutral fine sandy loam about 13 inches thick. The subsoil is reddish-brown, mildly alkaline sandy clay loam about 33 inches thick. The underlying layer is pink, soft caliche of clay loam texture.

Most of the acreage of Amarillo soils is farmed to cotton and sorghums, but some areas are used for range. Blue grama, sideoats grama, and buffalograss are common. Cropland is susceptible to wind and water erosion.

Profile of an Amarillo fine sandy loam, 100 feet south from a point on a county road, the point 1 mile north and 0.5 mile east of Knott school; in a field:

Ap—0 to 6 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; structureless; slightly hard when dry, very friable when moist; noncalcareous; neutral; clear boundary.

A1—6 to 13 inches, brown (7.5YR 4/4) heavy fine sandy loam, dark brown (7.5YR 3/4) when moist; weak prismatic to weak, medium, subangular blocky structure; slightly hard when dry, friable when moist; few fine tubes and pores; noncalcareous; neutral; clear boundary.

B21t—13 to 32 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, very coarse, prismatic and medium subangular blocky structure; very hard when dry, friable when moist; few insect burrows, worm casts, tubes, and pores; noncalcareous; mildly alkaline; clear boundary.

B22t—32 to 46 inches, reddish-brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) when moist; moderate, coarse, prismatic and moderate, medium, subangular blocky structure; few patchy clay films on faces of the prisms; very hard when dry, friable when moist; few fine tubes and pores; few films and threads of calcium carbonate in the lower part; soil mass is noncalcareous and mildly alkaline; clear boundary.

C1ca—46 to 64 inches, pink (7.5YR 8/4) clay loam, pink (7.5YR 7/4) when moist; calcareous; up to 40 percent, by volume, is soft lumps and strongly cemented concretions of calcium carbonate; gradual boundary.

C2—64 to 72 inches +, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) when moist; calcareous; up to 20 percent, by volume, is calcium carbonate.

The A horizon ranges from 6 to 15 inches in thickness and, when dry, from reddish brown to light brown in hue of 5YR to 7.5YR, value of 4 to 6, and chroma of 3 to 4. Texture ranges from loamy fine sand to fine sandy loam.

The B2t horizon ranges from 20 to 38 inches in thickness. It ranges from loam to sandy clay loam in texture and from reddish brown to yellowish red or red in hue of 5YR to 2.5YR.

In depth from the surface, the Cca horizon ranges from 25 to 50 inches. Soft lumps and strongly and weakly cemented concentrations of calcium carbonate make up 20 to 60 percent of this horizon, by volume.

Depth to the C2 horizon ranges from 40 to 70 inches. This horizon contains 10 to 20 percent less calcium carbonate than the horizon above it. Figure 7 shows a profile typical for the Amarillo series.

Amarillo soils have a more clayey subsoil than the Springer soils and a thinner, less sandy surface layer than Brownfield soils. Amarillo soils are deep over soft caliche, whereas Arvana soils are moderately deep over indurated caliche and Cobb soils are moderately deep over sandstone. Amarillo soils have less organic matter in the surface layer and a sandier subsoil than the Olton soils. The surface layer is sandier and contains less organic matter than that of the Acuff soils.

Amarillo fine sandy loam, 0 to 1 percent slopes (AfA).—This soil occupies broad, irregularly shaped, slightly convex to plane upland areas that range from 50 to 400 acres in size. The profile of this soil is similar to the one described as typical for the series.

Included with this soil in mapping were areas of Veal and Portales soils less than 5 acres in size. The Veal soils are in the shallow, more sloping parts; and the Portales, in the lower, weakly concave places.

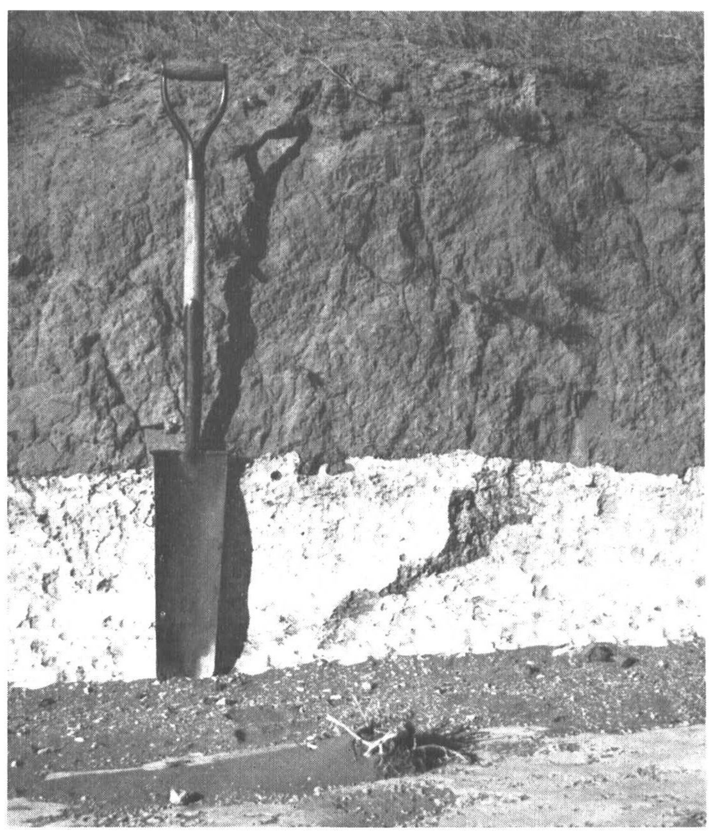

Figure 7.—**Typical profile of an Amarillo fine sandy loam.**

This moderately permeable soil takes in water well, and surface runoff is slow. Available water capacity is moderate. Cultivated areas are susceptible to soil blowing.

This soil is suitable for large-scale farming and is well suited to the locally grown crops. Most of it is cultivated to cotton and grain sorghum. Forage sorghum and small grains are sometimes grown for soil cover and grazing. A few areas are in native range.

Cropping systems that produce large amounts of residues are desirable. Residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. Terraces control water erosion and help to conserve moisture. (Capability unit IIIe–2; Sandy Loam range site)

Amarillo fine sandy loam, 1 to 3 percent slopes (AfB).—This soil occupies long narrow, irregularly shaped, convex to plane upland areas that range from 10 to 150 acres in size. The brown surface layer is about 6 to 10 inches thick, but otherwise the profile of this soil is similar to the one described as typical for the series.

Included with this soil in mapping were areas of Veal and Portales soils less than 5 acres in size. The Veal soils are in the shallow, more sloping parts; and the Portales, in lower, weakly concave spots. Narrow, shallow gullies cut a few areas of this soil.

This moderately permeable soil takes in water well, and surface runoff is moderate. Its available water capacity is moderate, and it is easily worked and naturally fertile. Cultivated areas are susceptible to moderate soil blowing and water erosion.

This soil is suitable for large-scale farming and is well suited to locally grown crops. Most of it is cultivated to cotton and grain sorghum. Forage sorghum and small grains are sometimes grown for soil cover and grazing. Some areas are in native range.

Terraces are needed to control water erosion, and they help to conserve moisture. Cropping systems that produce large amounts of residue are beneficial. Residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IIIe–2; Sandy Loam range site)

Amarillo fine sandy loam, 3 to 5 percent slopes (AfC).—This moderately sloping soil occupies irregularly shaped, convex uplands. It has a reddish-brown fine sandy loam surface layer about 6 to 8 inches thick. The subsoil is about 20 to 28 inches thick over a layer of lime accumulation.

Included with this soil in the mapping were spots of moderately deep Arvana soils less than 2 acres in size. Also included were small eroded spots where erosion is moderately severe.

This moderately permeable soil takes in water well and has moderate available water capacity. Because runoff is rapid, cultivated areas are highly susceptible to water erosion. Soil blowing is also a hazard.

This soil is suitable for large-scale farming of locally grown crops. Cotton and grain sorghum are the main crops. Forage sorghum and small grains are also grown, chiefly for soil cover and grazing.

Management is needed mainly for controlling water erosion. An effective practice is growing crops that produce large amounts of residue and keeping all of the residue on the surface. Terraces and contour farming also help to reduce water erosion. (Capability unit IVe–1; Sandy Loam range site)

Amarillo loamy fine sand, 0 to 3 percent slopes (AmB).—This soil occupies broad, concave and convex upland areas that range from 1,500 to 2,000 acres in size. These areas are mostly in the central part of the county.

This soil has a reddish-brown loamy fine sand surface layer about 8 to 15 inches thick. The subsoil is also reddish brown, but it is a sandy clay loam about 32 to 40 inches thick. A layer of lime accumulation begins at a depth of 40 to 50 inches.

Included in the mapping were areas of Brownfield soils that have a loose fine sand surface layer about 30 inches thick. These areas are less than 10 acres in size. Also included were small depressional areas of Zita soils.

Most of the rain that falls is absorbed by this soil, and the water from light showers is used efficiently by crops and grass. Available water capacity is moderate. Use of this soil for tilled crops is limited by wind erosion, which is a greater hazard on this soil than on Amarillo fine sandy loam, 1 to 3 percent slopes.

Amarillo loamy fine sand, 0 to 3 percent slopes, is suitable for large-scale farming of locally grown crops. Most of it is planted to cotton and grain sorghum. Forage sorghum is sometimes grown for grazing. A few areas are used for native range.

Management is needed mainly for controlling soil blowing. Crops that produce large amounts of residues are essential, for residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IVe–2; Sandyland range site)

Amarillo and Cobb fine sandy loams, 1 to 3 percent slopes (AsB).—These soils occupy upland areas in the northern part of the county. Their total acreage is about 75 percent Amarillo fine sandy loam, 20 percent Cobb fine sandy loam, and 5 percent other soils. Amarillo and Cobb soils occur together in about 60 percent of the acreage, but only one of these soils is in most of the other areas. Where both soils occur, the Cobb soil occupies low ridgetops and the Amarillo soil is in lower lying areas that slope toward drains. Each soil has a profile similar to the one described as typical for its respective series. Cobb soils are similar to Amarillo soils but are underlain by weakly cemented sandstone at a depth of about 38 inches.

Included in the mapping, in areas of Cobb soils, were small areas of Spade fine sandy loam on ridgetops and small, rounded knolls.

These Amarillo and Cobb soils are moderately permeable and have moderate available water capacity. They are easily worked and are naturally fertile. Most cultivated fields, however, have been slightly damaged by wind and water erosion.

These soils are suitable for large-scale farming of crops grown locally. The main crops are cotton, grain sorghum, forage sorghum, and small grain. A few areas are in native range.

Terraces are needed to control water erosion and to help conserve moisture. Crops that produce large amounts of residues are beneficial, for residues left on the surface help to control erosion and, if they are plowed under, to maintain organic matter. (Capability unit IIIe–2; Sandy Loam range site)

Amarillo and Cobb fine sandy loams, 3 to 5 percent slopes (AsC).—These soils occupy long, narrow, undulating ridges in the northern part of the county, above areas of Amarillo and Cobb fine sandy loams, 1 to 3 percent slopes. Of the total acreage, about 40 percent is Amarillo fine sandy loam; 54 percent, Cobb fine sandy loam; and 6 percent, Spade fine sandy loam. The Amarillo and Cobb soils occur together in about 90 percent of the acreage. In other areas only one of these soils occurs. Areas of Amarillo fine sandy loam have plane to convex surfaces, but areas of Cobb fine sandy loam are mostly convex.

The Amarillo fine sandy loam has a reddish-brown, noncalcareous surface layer about 8 inches thick. Its subsoil is reddish sandy clay loam, which is about 38 inches deep over accumulated calcium carbonate.

The Cobb fine sandy loam has a brown, noncalcareous surface layer about 6 inches thick. The subsoil is reddish sandy clay loam, 18 inches deep over weakly cemented sandstone.

The soils in this unit have moderate to high available water capacity and are naturally fertile. Water erosion is a hazard.

Because of their slopes, these soils are not suitable for continuous cropping of cotton or other clean-tilled crops. Most areas are native range.

Management is needed for controlling water erosion. Crops that produce large amounts of residue are needed, for residues left on the surface are effective protection. Terraces and contour farming also help in controlling water erosion. (Capability unit IVe–1; Sandy Loam range site)

Arvana Series [1]

The Arvana series consists of gently sloping, well-drained, loamy soils. These soils formed in a thin mantle of sandy eolian material that was deposited over caliche.

In a typical profile, the plow layer is brown, moderately alkaline, crumbly fine sandy loam about 8 inches thick. The subsoil is reddish-brown to red sandy clay loam that is moderately alkaline and about 24 inches thick. The underlying layer consists of fragments of hard platy caliche that are smooth and rounded on top, but are knobby on the bottom.

The moderately deep Arvana soils are used as cropland, but the shallow soils are used mostly as range. Cultivated areas are susceptible to both wind and water erosion.

Profile of Arvana fine sandy loam, 1 to 3 percent slopes, 0.15 mile west from a point on a county road, 4 miles north of post office in Knott; or 0.25 mile south and 0.15 mile west of the northeast corner of section 42, block 33, T–3–N.; in a field:

Ap—0 to 8 inches, brown (7.5YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) when moist; structureless; slightly hard when dry, very friable when moist; many fine roots and few worm casts; noncalcareous; moderately alkaline; abrupt boundary.

B21t—8 to 20 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, coarse, prismatic and weak subangular blocky structure; few patchy clay films on peds; hard when dry, friable when moist; few fine roots, pores, and worm casts; noncalcareous; moderately alkaline; gradual boundary.

B22t—20 to 32 inches, red (2.5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) when moist; coarse prismatic and weak subangular blocky structure; few patchy clay films on peds; very hard when dry, friable when moist; few fine roots, pores, and worm casts; noncalcareous; moderately alkaline; abrupt, wavy boundary.

Ccam—32 to 36 inches, indurated platy caliche; the upper 1 inch is laminar; plates are smooth on top and are rough and have small pendants on bottom; strongly cemented calcium carbonate.

The A horizon ranges from 4 to 12 inches in thickness. When this horizon is dry, it has value of 4 to 5, chroma of 2 to 4, and hue of 7.5YR and 5YR.

The B2t horizon ranges from 18 to 28 inches in thickness and from heavy loam to sandy clay loam in texture. When this horizon is dry, its color ranges from red to reddish brown in hue of 5YR to 2.5YR, value of 3 to 5, and chroma of 4 to 6. Reaction ranges from neutral to moderately alkaline, but the soil matrix of the B2t horizon is noncalcareous. In some places, a few films and threads of calcium carbonate occur in the lower few inches of the B2t horizon. Depth to the Ccam horizon ranges from 16 to 40 inches.

The Arvana soils have a layer of indurated caliche at a depth 40 inches or less, whereas the Amarillo soils have soft caliche at a depth of more than 40 inches. Arvana soils are shallow to moderately deep over caliche, but Cobb soils are moderately deep over bedrock. Arvana soils are not so limy as the Mansker and Portales soils.

Arvana fine sandy loam, 1 to 3 percent slopes (AvB).—This gently sloping soil occurs in upland areas that have a slightly convex surface and that range from 10 to 50 acres in size. The profile of this soil is the one described as typical for the series.

Included with this soil in mapping in about the same topography were small spots of Veal fine sandy loam and of Arvana fine sandy loam, shallow.

Permeability of this soil is moderate to rapid. Available water capacity is limited in areas where the indurated caliche is near the surface.

This soil is suitable for large-scale farming of locally grown crops. Grain sorghum and cotton are the main crops. Forage sorghum and small grains are grown on some farms for soil cover and grazing. A few areas are used for native range.

Cropping systems that produce large amounts of residue are desirable, for residues left on the surface help to control water and wind erosion and to maintain fertility. Contour farming helps to control water erosion and to conserve moisture. In some places terraces are necessary for controlling water erosion. (Capability unit IIIe–2; Sandy Loam range site)

Arvana fine sandy loam, shallow, 1 to 3 percent slopes (AwB).—This soil occupies slightly convex, oval upland areas that generally range from 10 to 80 acres in size. The profile of this soil has a thinner surface layer and subsoil than those in the profile described as typical for the series. Also, depth to indurated caliche is much less; it ranges from 16 to 20 inches.

This soil is moderately to moderately rapidly permeable. It takes in water well. Available water capacity is low, however, and wind and water erosion are likely.

Included with this soil in mapping were small areas of Potter soils less than 1 acre in size. These included areas occur in slightly higher places.

Most of the acreage is range, for which this soil is well suited. Use for cultivated crops is limited because caliche is near the surface, but some cotton and grain sorghum are

[1] In this survey the soils having a Ccam horizon at a depth of 16 to 20 inches were mapped as part of the Arvana series. In future surveys the soils that have a Ccam horizon at this depth will be included as part of another series.

grown in a few areas. A small acreage in forage sorghum and small grains is used for grazing.

Management is needed mainly for controlling erosion, conserving moisture, and maintaining tilth. Contour farming and terraces help to conserve moisture and to control water erosion. Cropping systems that produce large amounts of residue are beneficial. Residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IVe-3; Sandy Loam range site)

Berthoud Series [2]

The Berthoud series consists of calcareous loamy soils that are gently sloping to moderately sloping. These soils are moderately deep over a layer of accumulated lime. They developed on foot slopes and alluvial fans below escarpments.

The surface layer is grayish-brown, granular, calcareous loam about 8 inches thick. The subsoil is brown, calcareous loam about 16 inches thick. It has weak subangular blocky to granular structure. The underlying layer is pale-brown loam that contains white powdery lime.

Most of the acreage of Berthoud soils is range. A few of the common grasses are little bluestem, Arizona cottontop, sideoats grama, black grama, dropseed, and buffalograss. Yucca and mesquite are also common. Runoff water from steeper areas above would be a hazard if these soils were cultivated.

Profile of a Berthoud loam, 0.3 mile south and 0.3 mile west of the northeast corner of section 2, block 32, T-1-S, Texas and Pacific Railroad Survey; or about 50 feet east of the east entrance to Webb Air Force Base; in the southwestern part of Big Spring:

A1—0 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak subangular blocky and granular structure; slightly hard when dry, very friable when moist; common worm casts; calcareous; moderately alkaline; diffuse boundary.

B2—8 to 24 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak subangular blocky and granular structure; hard when dry, friable when moist; granules mainly are of worm casts; few films and threads of calcium carbonate; gradual boundary.

Cca—24 to 64 inches, pale-brown (10YR 6/3) heavy loam, brown (10YR 5/3) when moist; fine and medium subangular blocky structure; hard when dry, friable when moist; few white, powdery masses of calcium carbonate; moderately alkaline; calcareous.

All horizons of these soils range from loam to clay loam in texture. The A horizon ranges from 6 to 10 inches in thickness. It is 7 inches thick in places where color value is 3.5 for moist soil. When this horizon is dry, its color value ranges from 4 to 6, chroma ranges from 2 to 4, and hue is 7.5YR or 10YR.

Structure of the A and B horizons ranges from weak to moderate and from subangular blocky to granular. Segregated calcium carbonate in films, threads, or fine soft masses occurs below a depth of 15 inches. A few small fragments of limestone are in the B and C horizons in some places. In most places a few waterworn siliceous pebbles are throughout the profile.

Depth to the Cca horizon ranges from 20 to 36 inches. The calcium carbonate in the Cca horizon is slightly less visible in the lower part than in the upper part.

Berthoud soils are lighter colored than the Mansker and Portales soils, and they are more loamy than Mobeetie soils. Berthoud soils are deeper over accumulated lime than the Mansker, Potter, and Veal soils and contain less organic matter than the Portales soils.

Berthoud loam, 1 to 3 percent slopes (BeB).—This soil occurs on foot slopes below escarpments and alluvial fans in long, narrow areas that range from about 40 to 100 acres in size. Most areas adjoin and are below the more sloping Berthoud soils. The surface layer of this soil is grayish-brown loam that ranges from 8 to 10 inches in thickness. The subsoil is brown, calcareous loam that is about 16 inches thick in most places but ranges from 12 to 24 inches in thickness.

Included in mapping, in about the same topography as this soil, were areas of Mansker loam and Veal fine sandy loam. The included areas were less than 5 acres in size. Also included, as knolls less than 1 acre in size, were areas of the Potter soils.

This Berthoud soil has a moderately permeable subsoil, but it is likely to be eroded by runoff from higher areas. This soil is used mostly as range, mainly because the soil areas are so narrow that cultivation is not feasible. A few areas are in crops, which grow well when rainfall is adequate. Cotton and grain sorghum are the main crops. Small grains and forage sorghum are grown for protective cover and grazing in some areas.

Management is needed that controls erosion, conserves moisture, and maintains tilth. Terraces help to control water erosion and to conserve moisture. Cropping systems that produce large amounts of residue are desirable, for the residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IIIe-3; Hardland Slopes range site)

Berthoud loam, 3 to 5 percent slopes (BeC).—This soil occurs on foot slopes just below escarpments and in alluvial fans. It is in areas that range from 10 to 50 acres in size. Most of them are long and narrow and extend around the slope. Ordinarily, these areas have gullies 300 to 1,000 feet apart and 2 to 10 feet deep. Except that the surface layer ranges from 6 to 10 inches in thickness and the subsoil ranges from 20 to 30 inches, this soil has a profile like the one described as typical.

Included with this soil in mapping were areas of Mansker loam, of Veal fine sandy loam, and of Potter soils. The Mansker and Veal soils occur in the higher areas near escarpments; the Potter soils occur as knolls less than 1 acre in size.

This soil is moderately permeable and is easily managed. Available water capacity is low, however, and water erosion is a hazard in cultivated areas.

Most of the acreage is range, for which this soil is well suited. Use for cultivated crops is limited by the moderate slopes and the lack of available moisture.

Careful management is needed to reduce erosion and to conserve moisture. Growing crops that produce large amounts of residue is an effective practice because residues left on the surface help to control erosion, and they permit more water to enter the soil. Also effective in controlling water erosion and conserving moisture are contour farming and terraces. (Capability unit IVe-4; Hardland Slopes range site)

[2] In this survey these soils were considered a part of the Berthoud series. In future surveys soils that have the same characteristics as these soils will be included with another similar soil series having higher mean annual soil temperatures than those of the Berthoud soils.

Brownfield Series

The Brownfield series consists of nearly level, well-drained, sandy soils in the central part of the county. The largest areas are northwest of Big Spring. These soils formed in deep sandy windblown deposits.

In a typical profile, the surface layer is brown, neutral, loose fine sand about 30 inches thick. The subsoil is yellowish-red and red, crumbly sandy clay loam that extends to a depth of about 72 inches. The underlying layer is yellowish-red, moderately alkaline fine sandy loam.

Most of the acreage of Brownfield soils is native grass, for which they are well suited. Some of the common grasses are sand bluestem, little bluestem, sand dropseed, and false buffalograss. Havard oak is common. A few areas are used for crops, but range is a better use. Unless these soils are protected, soil blowing is a serious hazard in cultivated areas because the topmost few inches of the surface layer is continually shifted by wind.

Profile of Brownfield fine sand, 0 to 3 percent slopes, 0.4 mile east and 0.1 mile south of the northwest corner of section 21, block A, of Bauer and Cockrell Survey; or 5 miles west and 2.1 miles south of Fairview gin, on county road, and 0.4 mile east; in a pasture:

A1—0 to 30 inches, brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) when moist; structureless; loose when dry, loose when moist; few fine roots; noncalcareous; neutral; clear boundary.

B21t—30 to 38 inches, yellowish-red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) when moist; moderate, coarse, prismatic structure that breaks to weak subangular blocky; hard when dry, friable when moist; common, fine roots, tubes, and pores; few insect burrows; neutral; clear boundary.

B22t—38 to 52 inches, red (2.5YR 4/8) sandy clay loam, dark red (2.5YR 3/8) when moist; moderate, coarse, prismatic and weak subangular blocky structure; hard when dry, friable when moist; few fine tubes and pores, few clay skins on faces of peds; mildly alkaline; clear boundary.

B3—52 to 72 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) when moist; very hard when dry, firm when moist; few films and threads of calcium carbonate; noncalcareous in soil mass; mildly alkaline; clear boundary.

C—72 to 82 inches +, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; hard when dry, friable when moist; few films and threads of calcium carbonate; calcareous; moderately alkaline.

The A horizon ranges from 20 to 36 inches in thickness. When dry, it ranges from brown to brownish yellow in hue of 10YR to 7.5YR, value of 5 to 6, and chroma of 3 to 6.

In some places a B1 horizon occurs. This horizon ranges from loamy fine sand to fine sandy loam in texture and from 3 to 10 inches in thickness. The B2t horizon is light or medium sandy clay loam. When dry, it has value of 4 to 5, chroma of 4 to 8, and hue of 2.5YR to 5YR. This horizon ranges from 16 to 30 inches in thickness. The B3 horizon is light or medium sandy clay loam that ranges from 12 to 28 inches in thickness. When dry, it has value of 4 to 6, chroma of 4 to 8, and hue of 2.5YR and 5YR. In places this horizon is calcareous.

The C horizon ranges from fine sandy loam to loamy fine sand.

From less than 1 percent to 20 percent of the C horizon, by volume, consists of calcium carbonate in soft lumps and strongly cemented concretions. This horizon is mildly alkaline to moderately alkaline. Depth to the C horizon ranges from 55 to 95 inches.

The surface layer of the Brownfield soils is thicker and more sandy than that of the Amarillo soils. Brownfield soils have a more clayey subsoil than the Springer and Tivoli soils.

Brownfield fine sand, 0 to 3 percent slopes (BfB).—This gently sloping soil occurs in broad upland areas that range from 50 to several hundred acres in size. The profile of this soil is the one described as typical for the series.

Included with this soil in mapping were small areas of Amarillo loamy fine sand less than 10 acres in size.

Available water capacity of this Brownfield soil is low because the surface layer is thick and sandy. The hazard of soil blowing is high, particularly in cultivated areas. Available water capacity is high in the moderately permeable subsoil. The surface layer is low in available water capacity.

This soil is not suitable for cultivation, and most of it is used for range. Growth of forage plants is fair to good when rainfall is adequate. A few areas are used for crops, but crops do not grow well. (Capability unit VIe–1; Deep Sand range site)

Brownfield fine sand, thin surface variant,[3] 0 to 3 percent slopes (BvB).—This gently undulating soil occupies upland areas, generally less than 200 acres in size. Except that the surface layer is about 14 inches thick, the profile of this soil is similar to the one described as typical for the Brownfield series.

Included with this soil in mapping were areas of Gomez loamy fine sand and Springer loamy fine sand. These included areas are less than 5 acres in size. The Gomez loamy fine sand is in the slightly lower concave areas.

The surface layer of this Brownfield soil has low available water capacity, but the moderately permeable subsoil can hold large amounts of water. Soil blowing is a serious hazard in cultivated fields.

Most of this soil is used as range. Growth of range plants is fair to good when rainfall is adequate. A few areas are cultivated, mainly to grain sorghum and forage sorghum. Crops are successful in years when moisture is adequate. On a few farms small grains are grown mostly for grazing.

Cropping systems that produce large amounts of residues are beneficial. Residues left on the surface help to control erosion and, if they are plowed under, to maintain tilth. Deep plowing is effective in controlling erosion. (Capability unit IVe–5; Sandyland range site)

Clayey Alluvial Land

Clayey alluvial land (Ca) consists of deposits of clayey alluvium derived from Triassic marine clay and shale red beds. This land type occurs in the eastern part of the county on broad, nearly level flood plains along Beals Creek, Morgan Creek, and Wildhorse Creek. Slopes range from 0 to 1 percent. In most places this land is deeply cut by meandering streams and their many small tributaries. Frequent flooding is likely. Because the layer beneath the surface layer is slowly permeable and runoff is rapid from surrounding areas, water erosion is likely in many places.

Areas of this land are used mainly as range. Use for cultivated crops is limited by frequent flooding, the dense, compact subsoil, and runoff from higher places. Some areas can be cultivated during long, dry periods or where runoff is controlled. (Capability unit VIw–1; Clay Flat range site)

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[3] In future surveys, soils similar to this soil, which has a surface layer less than 20 inches thick will be classified in a soil series other than the Brownfield series.

Cobb Series

The Cobb series consists of moderately deep, neutral, loamy soils that are well drained and gently sloping to moderately sloping. These soils are in broad upland areas in the northern part of the county. The largest areas are near Vealmoor.

In a typical profile, the plow layer is dark-brown, neutral, crumbly fine sandy loam about 10 inches thick. The subsoil is yellowish-red sandy clay loam about 28 inches thick. It is underlain by pink, weakly cemented sandstone.

The gently sloping Cobb soils are farmed to cotton and grain sorghum, but the moderately sloping areas are mostly native range. Cropland is susceptible to wind and water erosion.

In this county Cobb soils were mapped only with Amarillo soils in undifferentiated soil groups.

Profile of a Cobb fine sandy loam 0.5 mile west of the northeast corner of section 39, block 25, T–3–N, Texas and Pacific Railroad Survey; 0.5 mile east from a point on a county road; 4 miles east and 4 miles north of Luther Bethel Church; in a field:

Ap—0 to 10 inches, dark-brown (7.5YR 4/4) fine sandy loam, dark brown (7.5YR 3/4) when moist; structureless; slightly hard when dry, very friable when moist; noncalcareous; neutral; clear boundary.

B2t—10 to 26 inches, yellowish-red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) when moist; moderate, medium, prismatic and moderate, medium, subangular blocky structure; hard when dry, friable when moist, few fine roots, tubes, and pores; noncalcareous; mildly alkaline; clear boundary.

B3—26 to 38 inches, yellowish-red (5YR 4/8) sandy clay loam, yellowish red (5YR 3/8) when moist; moderate, medium, prismatic and moderate, medium, subangular blocky structure; hard when dry, friable when moist; calcareous; moderately alkaline.

Rca—38 to 60 inches +, pink (5YR 7/4), weakly cemented sandstone, light reddish brown (5YR 6/4) when moist; calcareous; thin coating of calcium carbonate on the upper surface and in the crevices.

The A horizon ranges from 8 to 15 inches in thickness. When dry, the A horizon has value of 3 to 5, chroma of 2 to 4, and hue of 7.5YR and 5YR.

The B2t horizon ranges from loam to sandy clay loam. When this horizon is dry, its value ranges from 3 to 5, chroma from 4 to 8, and hue is 5YR and 7.5YR. Depth to sandstone ranges from 22 to 48 inches.

Cobb soils are moderately deep over sandstone, whereas the Arvana soils are moderately deep over indurated caliche and the Amarillo soils are deep over soft caliche. Cobb soils have a more clayey subsoil than the Spade and Berthoud soils and are less alkaline.

Dalby Series

The Dalby series consists of deep, very slowly permeable heavy clays that are nearly level to gently sloping. These soils are on uplands in the eastern part of the county. They formed over heavy red-bed clays.

In a typical profile, the surface layer is reddish-brown, calcareous, very firm clay about 6 inches thick. The layer beneath the surface layer is reddish-brown, calcareous clay about 36 inches thick. It is underlain by massive, yellowish-red, calcareous clay.

These heavy clays have high shrink-swell properties. They crack during dry weather, and the cracks remain open most of the year. The water intake is very slow, and runoff is rapid.

Most of the acreage is used as native range. The soils are so droughty that their use for crops is limited.

In this county the Dalby soils were mapped only with the Stamford soils in undifferentiated soil groups.

Profile of Dalby clay, 0 to 1 percent slopes, 0.5 mile south and 50 feet east of the northwest corner of section 32, block 27, H&TC Railroad Survey; or 0.97 mile west of a county road from a point 2.5 miles south of Vincent; in a pasture:

A1—0 to 6 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; weak, very fine and fine, blocky and subangular blocky structure; upper 2 inches is a mass of discrete peds when dry; extremely hard and very firm when dry, very sticky and plastic when wet; few cracks 1 to 5 centimeters wide that extend into horizon below; a few worm casts; moderately alkaline; calcareous; gradual boundary.

AC—6 to 42 inches, reddish-brown (5YR 4/4) clay, reddish brown (5YR 4/4) when moist; few parallelepipeds that have long axes tilting more than 10 degrees from horizontal; few slickensides that intersect; extremely hard and extremely firm when dry; few cracks 1 to 5 centimeters wide; moderately alkaline; calcareous; soft masses of calcium carbonate make up less than 1 percent of the lower part, by volume; clear boundary.

C—42 to 58 inches +, yellowish-red (5YR 5/6) clay, yellowish red (5YR 4/6) when moist; massive; extremely firm when dry; moderately alkaline; moderately calcareous.

The A horizon ranges from 4 to 10 inches in thickness. Clay makes up more than 50 percent of this horizon, by volume. When dry, the A horizon has color value of 4 to 6, chroma of 2 to 6, and hue of 2.5YR, 5YR, and 7.5YR. In places the A horizon has color value of 3.5 or less when moist. The A horizon is nonsaline to moderately saline. When dry, Dalby soils have cracks 1 to 5 centimeters wide that extend to a depth of 36 to 50 inches. Slickensides in the AC horizon are strongly to weakly expressed. Salinity ranges from slight to strong in the AC and C horizons. Depth to the C horizon ranges from about 36 to 50 inches; texture ranges from clay to heavy clay loam.

The surface layer of the Dalby soils is thinner than that of the Stamford soils. Dalby soils are deeper than the Vernon soils and are more alkaline and reddish than the Randall and Roscoe soils.

Drake Series

In the Drake series are well-drained loamy soils that are moderately sloping to steep. These soils formed in eolian dunes that border playas, ancient drainageways, and salt lakes.

In a typical profile, the surface layer is pale-brown, crumbly loam about 10 inches thick. The subsoil is also crumbly loam, but it is very pale brown and about 20 inches thick. It is underlain by very pale brown loam that contains very few roots or pores. Drake soils are calcareous throughout the profile.

The Drake soils are used mainly as range, but the stands of native grass are thin. Sideoats grama, blue grama, plains bristlegrass, and annual grasses are common. The hazard of wind and water erosion is high in cultivated areas.

Profile of a Drake loam, 3 to 5 percent slopes, 0.5 mile south and 0.1 mile east of the northwest corner of section 18, block 34, T–1–S, Texas and Pacific Railroad Survey; or 1 mile south of U.S. Highway 80, from a point 12 miles west of Howard County Courthouse; range:

A1—0 to 10 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak granular structure; slightly hard when dry, friable when moist; few fine roots and tubes; few insect burrows and worm casts; calcareous; moderately alkaline; clear boundary.

B2—10 to 30 inches, very pale brown (10YR 7/3) loam, pale brown (10YR 6/3) when moist; weak granular and weak subangular blocky structures; slightly hard when dry, friable when moist; few fine tubes and pores; calcareous; moderately alkaline; gradual boundary.
C—30 to 60 inches, very pale brown (10YR 7/3) loam, hard when dry, friable when moist; very few fine roots and pores; calcareous; moderately alkaline.

The A horizon ranges from fine sandy loam to sandy clay loam or loam in texture and from 6 to 12 inches in thickness. When this horizon is dry, color ranges from brown to pink; value is 5 to 7, chroma is 2 to 4, and hue is 10YR to 7.5YR.

The B2 horizon ranges from loam to clay loam in texture and from 8 to 36 inches in thickness. When this horizon is dry, its value is 6 to 8, chroma is 3 to 4, and hue is 10YR and 7.5YR.

Depth to the C horizon ranges from 15 to 42 inches. Color is very pale brown or ranges from pink to white.

The Drake soils have lower organic matter content and are lighter colored than the Reagan and Portales soils. Drake soils are more clayey than the Gomez soils and are deeper than the Mansker and Potter soils.

Drake soils, 3 to 5 percent slopes (DrC).—These soils occur on low dunes on the leeward side of playas, ancient waterways, and salt lakes. Most areas range from about 20 to 50 acres in size. The profile of this soil is the one described as typical for the series.

Because these soils have a high content of lime, they are deficient in iron and other nutrients in a form available to plants. In addition, much of the rainfall never enters the soil but runs off the sloping areas. The hazard of wind and water erosion is high.

All the acreage is native grass, for which these soils are well suited. Growth of range plants is fair in years when rainfall is adequate. These soils are not suitable for cultivated crops. (Capability unit VIe–2; High Lime range site)

Drake soils, 5 to 20 percent slopes (DrD).—These soils are in narrow upland areas on the leeward side of ancient waterways and salt lakes. Most areas are oblong and range from 10 to 20 acres in size. Except that surface layer is fine sandy loam that ranges from 6 to 8 inches in thickness, the profile of these soils is similar to that described as typical for the series.

Because these soils have a high content of lime, they are deficient in iron and other nutrients in a form that plants can use. The hazard of water and wind erosion is very high.

All the acreage is rangeland, but range plants do not grow well during most years. (Capability unit VIe–2; High Lime range site)

Ector Series

The Ector series consists of stony, calcareous, loamy soils that are very shallow and nearly level to steep. These soils are in the southern part of the county. The largest areas extend from Big Spring to Forsan. These soils formed in limestone areas, many of which have a benched appearance.

In a typical profile, the surface layer of this soil is brown, calcareous, and loamy. It is about 7 inches thick. About 55 percent of the soil mass, by volume, consists of fragments of limestone. Below this layer is a layer of fractured limestone in which the fracture planes are covered with calcium carbonate.

All the acreage of Ector soils is used for range. These soils are too shallow and stony for cultivation. Some common grasses are little bluestem, silver bluestem, blue grama, slim tridens, tobosa, and buffalograss. Common woody plants are mesquite, cedar, and javelina brush.

Profile of an Ector stony loam, 0.2 mile north of the northeast corner of section 132, block 29, Waco and Northwestern Railroad Co. Survey; or 1.2 miles north of a county road 2 miles west of Forsan; range:

A1—0 to 7 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak, subangular blocky, and granular structure; slightly hard when dry, friable when moist; few fine roots, tubes, and pores; about 55 percent, by volume, is limestone fragments coated with calcium carbonate; the fragments are 2 millimeters to 10 inches across the long axes; calcareous; moderately alkaline; abrupt boundary.
Rca—7 to 12 inches +, fractured limestone coated with calcium carbonate; the fragments are 6 to 12 inches across the long axes; at a depth of 12 inches the limestone is fractured; 12 inches to 3 feet or wider between the fractures.

The A1 horizon ranges from 4 to 10 inches in thickness. Texture ranges from gravelly loam to clay loam. About 35 to 50 percent of this horizon is coarse fragments of pebbles or flagstone. When this horizon is dry, its color has a hue of 7.5YR or 10YR, value of 4 to 5, and chroma of 2 to 3.

In some places the Rca layer is less fractured in the upper few inches than the Rca in the profile described. In places the cracks in this layer have seams of loamy soil about 1/8 inch thick.

Ector soils are underlain by harder, more dense limestone than the Potter soils. Ector soils are less clayey than the Vernon soils and contain more rock fragments. They are not so deep as the associated Ozona and Uvalde soils.

Ector soils (Ec).—These nearly level to gently sloping soils occur in upland areas that range from 200 to 1,000 acres in size. The surface is generally convex. About 20 percent of the surface area is covered by limestone fragments.

The surface layer varies in texture from gravelly loam to clay loam. Ector soils have a profile similar to the one described as typical for the series. Slopes range from 1 to about 5 percent.

Available water capacity is low because limestone is within 10 inches of the surface. The limestone also limits the depth to which plant roots can penetrate.

Ector soils are so shallow that they are not suitable for cultivation. They are used mainly as range. (Capability unit VIIs–1; Shallow Divide range site)

Ector-Rock outcrop complex (Er).—The soils in this complex are so intermingled that it was not practical to map them separately. About 65 percent of this complex consists of brown Ector soil that has a stony loam surface layer, and the rest is Rock outcrop. The Ector soil is about 5 inches thick; about 55 to 70 percent of the volume is limestone fragments. The Ector soil is in bands about 5 to 20 feet wide. Rock outcrop is approximately on the contour in narrow strips of clayey soil material. Because of these outcrops, areas have a stairstep appearance. The outcrops are 1 to 3 feet in diameter and about 6 to 8 feet apart. Slopes are generally about 15 percent but range from 5 to 20 percent.

Because this complex is gently sloping to steep and the soil material is less than 10 inches deep, cultivated crops are not suited. Areas of rock outcrop are almost bare; areas of the Ector soil are used as range. In the vegetated areas, this complex is suitable as wildlife habitat. (Capability unit VIIs–1 and Low Stony Hill range site)

Gomez Series

The Gomez series consists of deep, calcareous, well-drained, sandy soils that are nearly level to gently sloping. These soils occur on uplands in the western part of the county. They developed in calcareous, sandy eolian and lacustrine sediments.

In a typical profile, the surface layer is brown, calcareous loamy fine sand about 16 inches thick. The subsoil is very pale brown, calcareous, fine sandy loam about 22 inches thick. The underlying layer consists of very pale brown fine sandy loam and lime that makes up 15 to 20 percent.

Much of the acreage is native range. Some of the common grasses are cane and silver bluestem, Arizona cottontop, blue grama, black grama, and hooded windmillgrass. The woody plants are mostly mesquite, yucca, and catclaw. A few areas are cultivated to cotton and grain sorghum. Soil blowing is a severe hazard in unprotected areas.

Profile of Gomez loamy fine sand, 1 mile east and 0.25 mile south of the northwest corner of section 24, block 34, T-1-N, Texas and Pacific Railroad Survey; or 100 feet west of county road from a point 7 miles west of Big Spring Post Office on U.S. Highway 80 and 2 miles north on the county road; range:

A1—0 to 16 inches, brown (10YR 5/3) loamy fine sand, dark brown (10YR 4/3) when moist; very weak subangular blocky structure; soft when dry, very friable when moist; common fine tubes and pores, few fine roots and organic stains; moderately alkaline; calcareous; gradual boundary.

B2—16 to 38 inches, very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) when moist; weak subangular blocky structure; soft when dry, very friable when moist; few fine roots, tubes, and pores and organic stains; few soft lumps of segregated calcium carbonate; calcareous; moderately alkaline; gradual boundary.

C1ca—38 to 50 inches, very pale brown (10YR 8/3) fine sandy loam, very pale brown (10YR 7/3) when moist; structureless; about 15 to 20 percent, by volume, is calcium carbonate; calcareous; moderately alkaline; clear boundary.

C2—50 to 70 inches +, very pale brown (10YR 7/3) fine sandy loam, pale brown (10YR 6/3) when moist; structureless; calcareous but is about 5 to 10 percent less calcium carbonate than horizon above.

The A1 horizon ranges from 10 to 20 inches in thickness. When this horizon is dry, it ranges from dark grayish brown to pale brown in hue of 10YR, value of 4 to 6, and chroma of 2 to 4.

The B2 horizon ranges from loam to heavy loamy fine sand in texture and from 10 to 34 inches in thickness. Color ranges from brown to very pale brown in hue of 10YR to 7.5YR, value of 4 to 8, and chroma of 2 to 4.

Depth to the Cca horizon ranges from 20 to 50 inches. The Cca horizon ranges from 10 to 30 inches in thickness and from very pale brown to white in color. From 15 to 30 percent, by volume, is calcium carbonate.

In the C2 horizon, from 5 to 10 percent, by volume, is calcium carbonate.

The Gomez soils are lighter colored and more sandy than the Portales soils but are more alkaline than the Springer and Brownfield soils. Gomez soils are sandier than the Drake soils and contain less free lime in the upper part of the profile.

Gomez loamy fine sand (Go).—This nearly level to gently sloping soil occurs in slightly convex and plane upland areas that range from 30 to 200 acres in size. These areas are irregular but elongated in shape. Slopes range from 0 to 3 percent. The profile of this soil is the one described as typical for the series.

Included in mapping were areas of Portales fine sandy loam and of Reagan loam. The included areas occur in slightly lower parts of the landscape than this soil and are less than 5 acres in size.

This Gomez soil is moderately permeable. Available water capacity is low because the surface layer is sandy. Soil blowing is a severe hazard in unprotected areas.

Most of this soil is rangeland, but cotton and grain sorghum are grown in a few areas. Forage sorghum and small grains are grown in some fields, chiefly for grazing.

Management is needed that controls erosion and maintains or improves tilth. Crops should be grown that produce large amounts of residues, and the residues should be left on the surface. This practice helps to control soil blowing. If the residues are plowed under, they help to maintain or improve tilth. (Capability unit IVe-2; Sandy Plains range site)

Gypsum Outcrop

Gypsum outcrop (Gy), a land type, consists of white gypsum overlain by little or no soil material. The surface layer is only a crust about one-half inch thick. This land occurs in upland areas and is nearly level to strongly sloping. The average slope is about 4 percent, but the slopes range from 0 to 30 percent.

A typical area of this land is about 80 percent gypsum outcrops, 7 percent Reeves loam, and 13 percent soil that has a calcareous loam surface layer about 6 to 10 inches thick.

Gypsum outcrop is not suitable for cultivation and is used only as range. Stands of native grasses are thin. (Capability unit VIIs-2; Gyp range site)

Latom Series

The Latom series consists of very shallow, calcareous, loamy soils that are gently sloping to sloping. These soils formed on uplands in the eastern part of the county.

In a typical profile, the surface layer is brown, calcareous fine sandy loam about 8 inches thick. It is underlain by a layer of strongly cemented sandstone that has thin, discontinuous coatings of lime on its surface.

The Latom soils are used only as range. Some common grasses are little bluestem, sideoats grama, silver bluestem, slim tridens, hairy grama, fall witchgrass, and perennial three-awns. Woody plants are javelinabrush and broom snakeweed. Because of sandstone outcrops and the underlying rock, these soils are unsuitable for cultivation.

Profile of Latom fine sandy loam, 1 to 8 percent slopes, 200 feet south of Texas Highway 350, 0.5 mile south and 3.5 miles southwest of Vincent; in range:

A1—0 to 8 inches, brown (7.5YR 5/3) fine sandy loam, dark brown (7.5YR 4/3) when moist; weak granular structure; soft when dry, very friable when moist; common, strongly cemented sandstone fragments, up to one-half inch in diameter; calcareous; moderately alkaline; abrupt boundary.

R&Cca—8 to 20 inches +, very pale brown (10YR 8/3), coarse-grained, strongly cemented sandstone; thin, discontinuous coatings of calcium carbonate in crevices and on the upper surface.

The A horizon ranges from 4 to 10 inches in thickness. This horizon, when dry, has a hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 to 5.

The R&Cca layer consists of reddish-brown to very pale-brown to pale-olive sandstone or sandy conglomerate that ranges from strongly cemented to indurated.

The Latom soils contain less rock fragments than the Ector and Potter soils and are shallower than the Spade soils. Latom soils are more sandy than both the Vernon and Mansker soils and are less limy than the Mansker.

Latom fine sandy loam, 1 to 8 percent slopes (LaD).—The profile of this soil is the one described as typical for the series. Below the surface layer is strongly cemented sandstone. The more sloping areas of this soil are rough. Most areas are less than 100 acres in size, but a few are larger. Sandstone crops out in about 10 percent of the surface area in most places, and in about 35 percent in a few places.

Latom fine sandy loam is used only as range. Because slopes are gentle, rock is near the surface, and sandstone crops out, this soil is not suitable for cultivation. (Capability unit VIIs-1; Very Shallow range site)

Mansker Series

The Mansker series consists of well-drained, loamy soils that are nearly level to moderately sloping. These soils have a layer rich in lime within 20 inches of the surface. They occur on the upland plain, where they formed from calcareous outwash.

In a typical profile, the plow layer is dark-brown, crumbly, calcareous loam about 8 inches thick. The subsoil also is about 8 inches thick and consists of light-brown, calcareous loam. It is underlain by pink, calcareous material consisting of clay loam and hard and soft masses of lime. This lime makes up 30 percent of the upper part of the underlying material, but it decreases with depth.

Mansker soils are somewhat droughty. Most areas are used for native range. Common grasses are sideoats grama, silver bluestem, black grama, sand dropseed, and buffalograss.

Profile of Mansker loam, 1 to 3 percent slopes, 0.25 mile west of the northeast corner of section 39, block 33, T-2-N, Texas and Pacific Railroad Survey; or 0.25 mile west of road from a point 2 miles west and 2 miles north of Fairview gin; in a field:

Ap—0 to 8 inches, dark-brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; structureless; slightly hard when dry, friable when moist; calcareous and mildly alkaline; few fine roots; clear boundary.

Bca—8 to 16 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 5/4) when moist; weak subangular blocky structure; hard when dry, friable when moist; about 10 percent, by volume, is whitish and pinkish powdery calcium carbonate and strongly and weakly cemented concretions; few fine roots, tubes, and pores; few insect burrows; calcareous; moderately alkaline; clear boundary.

C1ca—16 to 32 inches, pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) when moist; up to 30 percent, by volume, is soft lumps and hard concretions of calcium carbonate; calcareous; moderately alkaline; gradual boundary.

C2—32 to 48 inches +, pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) when moist; calcareous; about 10 percent, by volume, is calcium carbonate.

The A horizon ranges from 7 to 10 inches in thickness. When dry, this horizon ranges from dark grayish brown to light brown in hue of 10YR or 7.5YR, value of 4 to 5, and chroma of 2 to 4. In undisturbed fields the structure of the A1 horizon is weak to moderate subangular blocky and granular.

The Bca horizon ranges from clay loam to sandy clay loam or loam in texture and from 0 to 10 inches in thickness. This horizon has color value of 5 to 6, chroma of 2 to 6, and hue of 10YR or 7.5YR. Content of visible calcium carbonate ranges from about 5 to 15 percent.

Depth to the Cca horizon ranges from 10 to 20 inches; its thickness ranges from 10 to 25 inches. About 15 to 60 percent of this horizon consists of soft lumps and strongly and weakly cemented concretions.

Mansker soils are deeper and darker than the Potter and Ector soils and contain less rock fragments. They are darker than the Veal soils and contain more organic matter. The layer of accumulated lime is nearer the surface layer in the Mansker soils than in the Portales.

Mansker loam, 0 to 1 percent slopes (MkA).—This nearly level soil occurs in areas that range from about 10 to 50 acres in size. Surfaces are slightly convex or plane. The areas are oblong and are slightly higher in the landscape than the adjoining areas of more sloping Mansker loam. Except that the subsoil is about 10 inches thick, this soil has a profile like that described as typical for the series. The layer with the greatest accumulation of lime begins at a depth of about 18 inches.

Included in mapping were areas of Portales loam, in about the same topography as this soil, and of Potter soils on small knolls. These included areas are less than 5 acres in size.

This Mansker soil is moderately permeable, but use for cultivation is limited by the caliche near the surface. Only a small amount of water is held for the use of plants, though available water capacity is high above the caliche.

Most of the acreage is rangeland. The rest is cultivated, mainly to cotton and grain sorghum. Range plants grow well when rainfall is adequate. In some fields small grains and forage sorghum are grown, chiefly for grazing.

Management is needed for controlling erosion, conserving moisture, and maintaining tilth. Terraces and contour farming help to conserve moisture and control erosion. Cropping systems that supply large amounts of residues are preferable, because residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IVe-6; Hardland Slopes range site)

Mansker loam, 1 to 3 percent slopes (MkB).—This soil occurs in somewhat elongated, convex areas that range from 20 to 80 acres in size. A few narrow, shallow gullies have cut into some areas. The profile of this soil is the one described as typical for the series.

Included in mapping were small areas of Portales loam and of Potter soils. The Portales loam is in about the same topography as this Mansker soil, and the Potter soils are on small knolls. These included areas are about 5 acres in size.

Although this Mansker soil is moderately permeable, the available water capacity is low because caliche is near the surface. Use for cultivation is limited, for water erosion is a greater hazard on this soil than on Mansker loam, 0 to 1 percent slopes.

Most of the acreage is range; growth of range forage is fair in years when rainfall is adequate. Cotton and grain sorghum are grown in a few areas. In some fields forage sorghum and small grains are grown chiefly for grazing.

Cropping systems that include crops that produce large amounts of residues are beneficial. Contour farming and terraces help to control erosion and conserve moisture. (Capability unit IVe-6; Hardland Slopes range site)

Mansker loam, 3 to 5 percent slopes (MkC).—This soil occurs in irregular, elongated areas just above draws and escarpments. The areas range from 15 to 200 acres in size. Generally, most areas are cut by shallow, narrow gullies. The surface layer and the subsoil each are about 7 inches thick. Hard lime concretions are on the surface and in the surface layer. The layer where lime accumulation is greatest begins at a depth of about 14 inches.

Included in mapping were areas of Potter soils less than 5 acres in size. These areas are mainly in bands 100 to 200 feet wide, but a few are on small knolls.

Available water capacity is low, and the subsoil is moderately permeable. Because runoff is rapid, this Mansker soil is susceptible to water erosion.

This soil is used only as range. (Capability unit IVe-4; Hardland Slopes range site)

Mobeetie Series

The Mobeetie series consists of well-drained, calcareous, loamy soils that are gently sloping to moderately sloping. These soils are on foot slopes below escarpments.

The surface layer is brown, crumbly, calcareous fine sandy loam about 9 inches thick. The subsoil is pale-brown, crumbly, calcareous fine sandy loam about 15 inches thick. The underlying layer is very pale brown fine sandy loam and common films and threads of lime.

The Mobeetie soils are used for native range. Among the common grasses are sideoats grama, blue grama, silver bluestem, black grama, hooded windmillgrass, buffalograss, and perennial three-awns. Mesquite, catclaw, and yucca are common woody plants. These soils could be farmed, but most areas are long and narrow and would make odd-shaped fields. Also, runoff water from steeper areas would be a hazard.

Profile of Mobeetie fine sandy loam, 1 to 3 percent slopes, 0.5 mile south and 0.8 mile west of the northeast corner of section 7, block 33, T-1-S, Texas and Pacific Railroad Survey; 0.8 mile west of a road from a point 5.5 miles west of Big Spring Post Office on U.S. Highway 80, then 1.5 miles south of county road; in range:

A1—0 to 9 inches, brown (10YR 5/3) fine sandy loam, brown (10YR 4/3) when moist; moderate, fine and medium, granular structure; slightly hard when dry, friable when moist; many fine roots; few insect burrows and worm casts; calcareous; mildly alkaline; clear boundary.

B2—9 to 24 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 4/3) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; common fine roots; many insect burrows and worm casts; calcareous; moderately alkaline; gradual boundary.

Cca—24 to 56 inches +, very pale brown (10YR 7/4) fine sandy loam, light yellowish brown (10YR 6/4) when moist; moderate, fine, granular structure; slightly hard when dry, friable when moist; common number of films and threads of calcium carbonate and a few concretions; contains slightly more sand than B2 horizon; calcareous; moderately alkaline.

The A horizon ranges from 8 to 20 inches in thickness. When this horizon is dry, its color ranges from brown to light brownish gray; hue is 10YR or 7.5YR, value 4 to 5, and chroma 2 to 4. The A horizon is less than 10 inches thick where it is darker colored than normal.

The Bt horizon ranges from light sandy clay loam to fine sandy loam in texture and from 12 to 30 inches in thickness. Its content of clay is about the same as that of the A horizon. When dry, this horizon ranges from dark brown to light yellowish brown in hue of 10YR to 7.5YR, value of 4 to 6, and chroma of 2 to 6.

Depth to the Cca horizon ranges from 24 to 50 inches. Calcium carbonate is in a few small concretions or films and threads. It makes up about 1 percent of the horizon, by volume.

Mobeetie soils are deeper than the Spade and Latom soils, both of which are underlain by sandstone. Mobeetie soils have a lighter colored surface layer and less distinct layers of accumulated lime than the Mansker soils. The underlying layer of the Mobeetie soils contains less lime than that of the Spade soils.

Mobeetie fine sandy loam, 1 to 3 percent slopes (MoB).—This soil is in slightly convex areas below escarpments and on alluvial fans. Most areas range from 20 to 250 acres in size. The profile of this soil is the one described as typical for the series.

Included with this soil in mapping, on slightly more sloping relief, were areas of Latom fine sandy loam and of Potter soils. The included areas are less than 5 acres in size.

This Mobeetie soil has moderate available water capacity. Permeability is moderate to moderately rapid in the subsoil.

Most of this soil is range. Use for cultivation is limited, chiefly because the soil areas are narrow. A small acreage is cultivated. Cotton and grain sorghum are the main crops. Forage sorghum and small grains are also grown, chiefly for surface cover and grazing.

Management is needed to control erosion and maintain or improve tilth. Contour farming and terraces help control water erosion. Crops that produce large amounts of residue are also helpful in controlling water erosion, and, if they are plowed under, they help maintain tilth as well. (Capability unit IIIe-5; Mixedland Slopes range site)

Mobeetie fine sandy loam, 3 to 5 percent slopes (MoC).—This soil occurs on foot slopes below escarpments and above the flood plains of streams. Most areas range from 20 to 40 acres in size, but some areas are only 100 acres. The surface layer of this soil is light brownish-gray fine sandy loam about 13 inches thick. The subsoil is loamy, very pale brown, and moderately permeable. It is about 20 inches thick. Below the subsoil is an indistinct layer of lime.

Included in mapping were areas of Spade fine sandy loam and of Potter soils. The Spade fine sandy loam is in about the same topography as this soil, and the Potter soils are on small knolls. These included areas are less than 5 acres in size.

This Mobeetie soil is used only as range. Cultivation is not feasible, because soil areas are narrow, available water capacity is low, and erosion is likely. (Capability unit IVe-7; Mixedland Slopes range site)

Olton Series

In the Olton series are deep, well-drained, loamy soils that are nearly level to gently sloping. These soils formed in calcareous outwash on upland plains. The largest areas are in the northern part of the county.

In a typical profile, the surface layer is dark-brown, crumbly clay loam about 10 inches thick. The subsoil, about 30 inches thick, is reddish-brown, neutral, firm clay loam. The underlying layer is pink loam that is about 50 percent lime.

Most of the acreage of Olton soils is cultivated, mainly to cotton and sorghums. These soils are excellent for farming. A few areas are used as range. Surface runoff is moderate to slow, and the subsoil is slowly permeable. Some of the common grasses are sideoats grama, silver bluestem, tobosa, sand dropseed, and buffalograss.

Profile of an Olton clay loam, 0.1 mile south of a county road from a point 0.7 mile west of Luther; range:

A1—0 to 10 inches, dark-brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) when moist; moderate, medium and fine, subangular blocky structure; hard when dry, friable when moist; many fine roots, tubes, and pores; few insect burrows and worm casts; noncalcareous; neutral; abrupt boundary.

B21t—10 to 16 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium to fine, subangular blocky and blocky structure; hard when dry, friable when moist; many fine roots; few insect burrows and worm casts; noncalcareous; neutral; gradual boundary.

B22t—16 to 30 inches, reddish-brown (5YR 4/4) heavy clay loam, dark reddish brown (5YR 3/4) when moist; moderate, medium to fine, blocky structure; very hard when dry, firm when moist; few fine roots; few concretions of calcium carbonate; calcareous; moderately alkaline; gradual boundary.

B3t—30 to 40 inches, yellowish-red (5YR 5/6) clay loam, yellowish red (5YR 4/6) when moist; weak blocky structure; calcareous; moderately alkaline; many soft lumps of calcium carbonate, 5 to 10 millimeters in diameter; clear boundary.

Cca—40 to 72 inches +, pink (5YR 8/4) loam, pink (5YR 7/4) when moist; as much as 50 percent is calcium carbonate; calcareous.

The A horizon ranges from 8 to 12 inches in thickness. When it is dry, its color ranges from dark brown to reddish brown in hue of 7.5YR and 5YR, value of 3 to 4, and chroma of 2 to 4. Value is less than 3.5 when the A horizon is moist.

The clay content of the upper 20 inches of the B2 horizon ranges from about 35 to 40 percent. In thickness, the B21t horizon ranges from 4 to 10 inches and the B22t horizon ranges from 8 to 20 inches. When dry, the B22 horizon ranges from reddish brown to yellowish red in hue of 7.5YR and 5YR. The B3t horizon ranges from light to medium clay loam in texture and from 5 to 15 inches in thickness. This horizon, when dry, ranges from reddish brown to yellowish red in hue of 5YR.

Soft lumps and hard concretions of calcium carbonate make up 30 to 60 percent of the Cca horizon. Depth to the Cca horizon ranges from 30 to 50 inches.

The subsoil of Olton soils is more clayey than that of the Acuff or Portales soils. Olton soils are less alkaline than the Portales soils. The surface layer of the Olton soils is more clayey and contains more organic matter than that of the Amarillo or Arvana soils. Olton soils are more loamy and lighter colored than the Roscoe soils.

Olton clay loam, 0 to 1 percent slopes (OcA).—This soil occurs in broad upland areas that range from 75 to 500 acres in size. Surfaces are plane and slightly convex. The surface layer is noncalcareous, dark-brown clay loam about 10 to 12 inches thick. The subsoil is reddish heavy clay loam about 30 inches thick. A layer of accumulated lime occurs at about 40 inches below the surface.

Included with this soil in mapping were areas of Portales loam, Randall clay, and Roscoe clay. The Randall and Roscoe soils are in slight depressions. The Portales soils are in very slight depressions that have weakly concave to plane surfaces. These included areas are less than 5 acres in size.

This Olton soil is slowly permeable to moderately permeable. Available water capacity and natural fertility are high.

A few areas within large ranches are used as range, but this soil is suitable for large-scale farming. It is used mainly for cotton and grain sorghum. Forage sorghum and small grains are grown in a few areas, chiefly for grazing. Crops grow well to fairly well when soil moisture is adequate.

Management is needed that conserves moisture, controls erosion, and maintains or improves tilth. Contour farming helps to control water erosion and conserve moisture. Cropping systems that produce large amounts of residue are beneficial. The residues left on the surface help to control erosion and, if they are plowed under, to maintain or improve tilth. (Capability unit IIIce–1; Deep Hardland range site)

Olton clay loam, 1 to 3 percent slopes (OcB).—This soil occurs in upland areas and around playas. Areas range from about 20 to 400 acres in size. The surface layer is dark-brown, noncalcareous clay loam about 8 inches thick. The subsoil is heavy clay loam about 25 inches thick. It is underlain by a layer of lime.

Included with this soil in mapping were areas of Roscoe clay. The included areas occur in slight depressions and are less than 5 acres in size. Shallow gullies have cut into a few areas.

This Olton soil holds large amounts of available water. Permeability is moderate to slow. Water erosion is more likely on this Olton soil than on Olton clay loam, 0 to 1 percent slopes.

This soil is mainly cropland that is suitable for farming on a large scale. Cotton and grain sorghum are the main crops. Some small grains and forage sorghum are grown, chiefly for grazing. Crops grow fairly well when rainfall is adequate. A few areas remain in range.

Contour farming and terraces aid in controlling water erosion and conserving moisture. Crops should be grown that supply large amounts of residues for controlling erosion and improving tilth. (Capability unit IIIe–4; Deep Hardland range site)

Ozona Series

The Ozona series consists of well-drained, gently sloping soils that have a clayey subsoil. These soils are in broad upland areas in the southern part of the county. They are moderately deep over limestone.

The surface layer is about 8 inches thick and consists of dark-brown, firm, calcareous clay loam. The subsoil is brown, calcareous clay about 10 inches thick. At a depth of about 18 inches are pale-brown clay loam and soft and strongly cemented particles of lime that make up 60 percent of the layer, by volume. A layer of hard platy caliche is at a depth of 24 inches. It grades to fractured limestone at a depth of 28 inches.

These soils are used entirely for native range. Among the common grasses are cane and silver bluestems, sideoats grama, blue grama, plains bristlegrass, tobosa, buffalograss, and perennial three-awns. Common woody plants are mesquite and tarbush.

Profile of Ozona clay loam, 1 to 3 percent slopes, 0.4 mile east of the northeast corner of section 6, block 32, T–2–S, Texas and Pacific Railroad Survey; or 50 feet south of a road from a point 3.6 miles west of Forsan; range:

A1—0 to 8 inches, dark-brown (10YR 4/3) heavy clay loam, dark brown (10YR 3/3) when moist; compound weak subangular blocky and angular blocky structure; hard when dry, firm when moist; few fine roots, tubes, and pores; few insect burrows and worm casts; few fragments of caliche coated limestone; calcareous; moderately alkaline; clear boundary.

B2—8 to 18 inches, brown (10YR 5/3) light clay, dark brown (10YR 4/3) when moist; moderate, fine and medium, angular blocky structure; hard when dry, firm when moist; few fine roots, tubes, and pores; few insect burrows and worm casts; calcareous and moderately alkaline; abrupt boundary.

C1ca—18 to 24 inches, pale-brown (10YR 6/3) heavy clay loam or light clay, brown (10YR 5/3) when moist; about 60 percent, by volume, is soft and strongly cemented concretions of calcium carbonate; abrupt boundary.

C2cam—24 to 28 inches +, white indurated calcium carbonate that has laminar bands in the upper one-half inch; platy and fractured; bedrock of fractured limestone at a depth of 28 inches.

The A horizon ranges from 7 to 12 inches in thickness. When this horizon is dry, color ranges from dark brown to dark grayish brown in a hue of 10YR, value of 3 to 4, and chroma of 2 to 3.

The B2 horizon ranges from heavy clay to light clay in texture, and from 6 to 16 inches in thickness. When dry, this horizon has hue of 10YR or 7.5YR, value of 5 to 6, and chroma of 3 to 4. Structure of the B2 horizon ranges from weak prismatic to weak, fine and medium, subangular blocky. The Cca horizon ranges from 1 to 8 inches in thickness. Depth to the Cca horizon ranges from 14 to 28 inches.

The Ozona soils are more clayey and deeper than the Ector soils. Ozona soils are shallower than the Uvalde and Tobosa soils and less clayey than the Tobosa soils. The Ozona soils are more clayey than the Mansker soils and are underlain by harder caliche and limestone.

Ozona clay loam, 1 to 3 percent slopes (OzB).—This soil occupies the lower part of the uplands. It is lower in the landscape than large areas of Ector soils and higher than large areas of Uvalde and Tobosa soils. In about 50 percent of the acreage, there is a layer of accumulated lime rather than a layer of indurated caliche. The accumulated lime is in the form of concretions and powdery masses. The profile of this soil is similar to the one described as typical for the Ozona series.

Included with this soil in mapping were areas of Uvalde silty clay loam that has a surface layer about 12 inches thick. The subsoil is silty clay loam about 20 inches thick. Also included, and making up about 10 percent of the mapping unit, were soils that have a light brownish-gray light clay surface layer. The layer beneath is about 10 to 14 inches thick over 2 inches of indurated broken caliche. The caliche overlies fractured limestone. Other included areas have a grayish-brown, loamy, calcareous surface layer about 8 inches thick and a pale-brown sandy clay loam subsoil about 26 inches thick. These areas make up about 5 percent of the acreage mapped. Also included, and totaling about 5 percent of the acreage mapped, is a dark-brown calcareous clay loam. The surface layer is about 6 inches thick over a brown clay loam subsoil.

This Ozona soil is naturally fertile and has moderate to high available water capacity. All the acreage is native range, which occurs in only large ranches in the southern part of the county. (Capability unit IVe-6; Valley range site)

Portales Series

The Portales series consists of deep, well-drained, loamy soils that are nearly level to gently sloping and have plane to weakly concave surfaces. These soils formed on upland plains in limy sediments, mostly in the central and southwestern parts of the county.

In a typical profile, the surface layer consists of fine sandy loam about 15 inches thick (fig. 8). In cultivated areas, it is brown in the upper part and dark grayish brown in the lower. The subsoil is brown, crumbly sandy clay loam about 21 inches thick. It is underlain by a layer that is very pale brown sandy clay loam in the upper part and pink clay loam in the lower part. Soft masses and strongly cemented particles of lime make up about 50 percent of this layer. The accumulated particles of lime decrease with depth. These soils are calcareous throughout.

Most of the acreage of Portales soils is planted to cotton and sorghums. Gently sloping areas are susceptible to water erosion, and soil blowing is a slight hazard in cultivated areas.

Profile of Portales fine sandy loam, 0 to 1 percent slopes, 0.2 mile west of the northeast corner of section 25, block 24, T-2-N, Texas and Pacific Railroad Survey; or 0.2 mile west of a point on a country road, the point 7 miles west and 2 miles north of Fairview; in a field:

Ap—0 to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; structureless; slightly hard when dry, very friable when moist; moderately alkaline; calcareous; few hard concretions of calcium carbonate; abrupt boundary.

A1—8 to 15 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak subangular blocky and granular structure; slightly hard when dry, friable when moist; few fine roots, tubes, and pores; few insect burrows and worm casts; moderately alkaline; calcareous; gradual boundary.

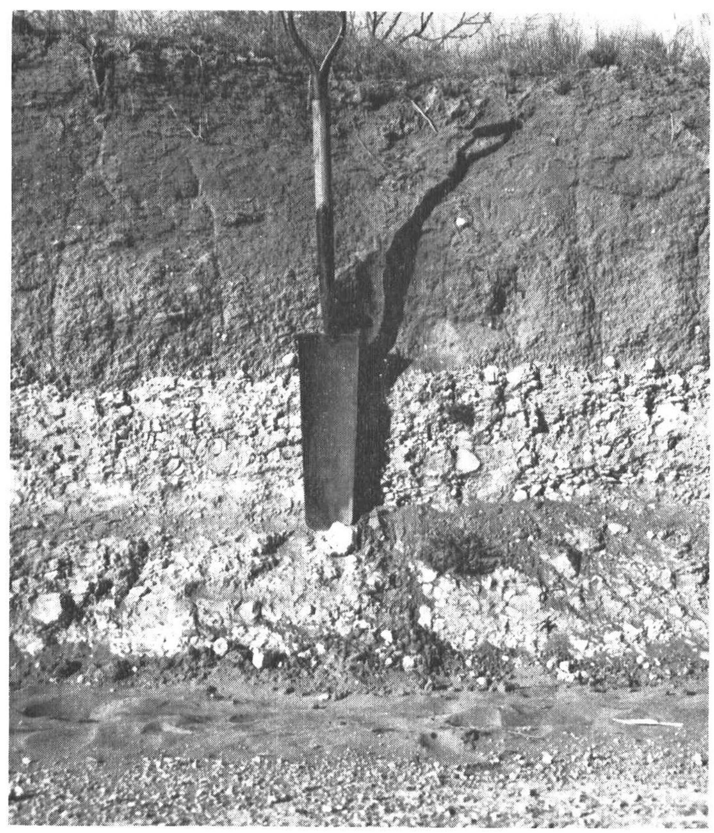

Figure 8.—**Typical profile of Portales fine sandy loam.**

B2—15 to 36 inches, brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) when moist; moderate, medium and weak, subangular blocky and granular structure; hard when dry, friable when moist; few fine tubes, pores, and worm casts: moderately alkaline: calcareous; clear boundary.

C1ca—36 to 48 inches, very pale brown (10YR 8/4) sandy clay loam, very pale brown (10YR 7/4) when moist; about 50 percent of horizon, by volume, is soft lumps and strongly cemented concretions of calcium carbonate.

C2—48 to 60 inches +, pink (7.5YR 8/4) clay loam, pink (7.5YR 7/4) when moist; content of calcium carbonate is about 15 percent less than in the horizon above.

The A horizon ranges from loam to fine sandy loam in texture and from 10 to 22 inches in thickness. When dry, this horizon ranges from dark grayish brown to brown in color that has value of 4 to 5, chroma of 2 to 3, and hue of 10YR and 7.5YR. Value is less than 3.5 when the A horizon is moist.

The B2 horizon ranges from loam to sandy clay loam in texture and from 10 to 30 inches in thickness. When dry, this horizon ranges from dark brown to light brown in hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 to 4.

Depth to the C1ca horizon ranges from 20 to 48 inches. Soft lumps and hard concretions of calcium carbonate make up about 30 to 60 percent of this horizon, by volume. In the C2 horizon, clay content is about 10 to 20 percent less than in the C1ca horizon. Depth to the C2 horizon ranges from 40 to 75 inches.

The Portales soils are grayer and more alkaline than the Amarillo soils and are deeper to the layer of accumulated lime than the Mansker soils. Portales soils have a more loamy surface layer and a more clayey subsoil than have the Gomez soils. Layers of accumulated lime are more distinct in the Portales soils than in the Zita.

Portales fine sandy loam, 0 to 1 percent slopes (PfA).—This soil occurs in broad upland areas that range from about 50 to 250 acres in size. Surfaces are plane to weakly concave. The profile of this soil is the one described as typical for the Portales series.

Included with this soil in mapping, in about the same kind of landscape, were areas of Amarillo fine sandy loam and of Veal fine sandy loam. These included areas are less than 5 acres in size. Other included areas, totaling 15 percent of the acreage mapped, have a lighter colored surface layer than this Portales soil but are otherwise similar.

This Portales soil holds a moderate amount of available water. Permeability is moderate to moderately rapid.

This soil is suitable for large-scale farming. Most areas are used for crops, mainly cotton and grain sorghum, but small grains and forage sorghum are also grown, chiefly for grazing. Crops grow well or fairly well when rainfall is adequate. A few areas are native range.

Contour farming and terraces are used to control erosion and conserve moisture. Grain sorghum or other crops that produce large amounts of residue are needed in the cropping system, for residues left on the surface help to control erosion. If the residues are plowed under, they help to maintain or improve tilth. (Capability unit IIIe–5; Mixed Plains range site)

Portales fine sandy loam, 1 to 3 percent slopes (PfB).—This soil is in irregular upland areas that range from 10 to 150 acres in size. Surfaces are plane. This soil has a dark-brown, calcareous surface layer of fine sandy loam about 10 inches thick. The subsoil consists of about 20 inches of brown, calcareous sandy clay loam.

Included with this soil in mapping, in about the same kind of landscape, were areas of Amarillo fine sandy loam and of Veal fine sandy loam. These included areas are less than 5 acres each in size.

Water erosion is slightly greater on this soil than on Portales fine sandy loam, 0 to 1 percent slopes. Available water capacity is moderate, and permeability is moderate to moderately rapid.

This soil is suitable for large-scale farming. Most of it is cultivated, and a few small areas are in native grasses. Cotton and grain sorghum are the main crops. Forage sorghum and small grains are grown in a few areas, chiefly for grazing and surface cover. Crops grow fairly well if soil moisture is adequate.

Contour farming and terraces aid in controlling water erosion and conserving moisture. Cropping systems that produce large amounts of residue are beneficial, for the residues left on the surface help to control erosion. If the residues are plowed under, they help to maintain or improve tilth. (Capability unit IIIe–5; Mixed Plains range site)

Portales loam, 0 to 1 percent slopes (PoA).—This soil occupies broad upland areas that range from 20 to 250 acres in size. Surfaces are plane and weakly concave. The surface layer is calcareous, dark-brown loam about 15 inches thick. The subsoil is dark-brown sandy clay loam about 20 inches thick. A layer of accumulated lime occurs at about 35 inches below the surface.

Included with this soil in mapping were areas of Mansker loam, 1 to 3 percent slopes, and areas of Olton clay loam, 0 to 1 percent slopes. These included areas are less than 5 acres in size.

Permeability is moderate, and available water capacity is high.

This Portales soil is desirable for farming and is used mainly as cropland that is suitable for farming on a large scale. Cotton and grain sorghum are the principal crops. Some small grains and forage sorghum are grown, chiefly for grazing. Crops grow well or fairly well when rainfall is adequate. A few areas are native range.

Contour farming and terraces are used to control erosion and conserve moisture. Cropping systems that include grain sorghum or other crops that produce large amounts of residue are beneficial. The residues are useful in controlling erosion and in maintaining or improving tilth. (Capability unit IIIce–2; Mixed Plains range site)

Portales loam, 1 to 3 percent slopes (PoB).—This soil is in upland areas that have plane surfaces and range from 10 to 200 acres in size. The surface layer of this soil is dark-brown, calcareous loam about 10 inches thick. The subsoil is brown, calcareous sandy clay loam about 18 inches thick. A layer of accumulated lime occurs at a depth of about 28 inches.

Included with this soil in mapping were areas of Mansker loam and of Olton clay loam less than 5 acres in size. These included areas occupy about the same relief as this Portales soil. A few areas are cut by shallow gullies.

Water erosion is slightly greater on this soil than on Portales loam, 0 to 1 percent slopes. This soil has moderate permeability.

This soil is suitable for large-scale farming and is used mostly as cropland. The main crops are cotton and grain sorghum, though forage sorghum and small grains are grown in some fields, chiefly for grazing and soil cover. A few areas remain in range.

Terraces are needed for controlling water erosion and conserving moisture. Cropping systems that leave large amounts of residue on the surface are beneficial, for the residues help to control erosion. If they are plowed under, they help to improve tilth. (Capability unit IIIe-3; Mixed Plains range site)

Potter Series

In the Potter series are very shallow, calcareous, loamy soils that are gently sloping to steep. These soils contain many fragments and concretions of caliche. They are on uplands along escarpments and natural drains.

In a typical profile, the surface layer is brown, calcareous loam about 6 inches thick. It is underlain by white, calcareous, loamy material that is weakly cemented in the upper 3 or 4 inches and contains many pebbles coated with caliche. This layer extends for many feet.

These soils are used only as native range for they are too shallow and steep for cultivation. Common grasses are sideoats grama, silver bluestem, slim tridens, hairy grama, fall witchgrass, and perennial three-awns. Broom snakeweed and javelinabrush are also common. Runoff is moderate to rapid, and erosion is likely if the plant cover is thin.

Profile of a Potter loam, 0.3 mile west of the northeast corner of section 7, block 30, T-1-N, Texas and Pacific Railroad Survey; then south 150 yards or about 6 miles north of Coahoma on Highway 820 and 1.7 miles east of Highway; in range:

A1—0 to 6 inches, brown (10YR 5/3) loam, dark brown (10YR 4/3) when moist; weak subangular blocky structure; slightly hard when dry, friable when moist; calcareous and moderately alkaline; thin light-colored surface crust 1 to 5 millimeters thick; few fine roots; common concretions of calcium carbonate up to 20 millimeters in diameter on the surface and throughout the layer; a few caliche fragments up to 8 inches across the long axes; abrupt boundary.

C—6 to 16 inches +, white (10YR 8/2) loam, light gray (10YR 7/2) when moist; many hard and soft concretions and caliche coated pebbles; weakly cemented in upper 3 or 4 inches.

The A1 horizon ranges from 4 to 12 inches in thickness and from clay loam to fine sandy loam in texture. When this horizon is dry, it ranges from dark brown to very pale brown and has value of 4 to 7, chroma of 3 to 4, and hue of 10YR and 7.5YR

Indurated or hard fragments of caliche make up 80 to 90 percent of the C horizon and are weakly cemented in the upper 3 or 4 inches. These fragments extend to a depth of several feet in some places. Beneath the caliche is pinkish, calcareous material.

Potter soils are shallower to caliche, lighter colored, and more sloping than the Mansker or Portales soils. Potter soils contain more caliche fragments than the Latom soils, which are very shallow over sandstone. Layers underlying Potter soils are less hard than those underlying the Ector soils.

Potter soils (Ps).—These soils are gently sloping to steep. They are in long, narrow upland areas along escarpments and natural drains. Areas are 10 to 160 acres in size. Slopes range from 1 to 20 percent. The texture of the surface layer ranges from clay loam to fine sandy loam. Underlying the surface layer is white loam of which 80 to 90 percent is indurated fragments of caliche that are cemented. Cobble-sized fragments of hard caliche are common in some places.

Included with this soil in mapping were areas of Berthoud loam, Mansker loam, and Mobeetie fine sandy loam. These included areas are less than 5 acres in size. They are in spots near natural drains.

Cultivated crops are not suited to these soils, because caliche is near the surface and available water capacity is low. Also, the areas are so rough that farm machinery cannot be safely used. Water erosion is likely.

These soils are used only as rangeland and wildlife habitat. In most places the stands of native grass are thin. (Capability unit VIIs-1; Very Shallow range site)

Randall Series

The Randall series consists of nearly level, somewhat poorly drained heavy clays that are neutral to moderately alkaline. These soils are in the northern part of the county. They occupy the floors of enclosed depressions, or playas, which catch much of the runoff water.

In a typical profile, the upper 14 inches is gray, neutral, very firm clay. Below this is dark-gray, mildly alkaline, very firm clay to a depth of more than 70 inches.

These soils have high shrink-swell properties. When they are dry, cracks commonly extend to a depth of more than 2 feet.

Most of the acreage is range. Common grasses are tobosa and buffalograss. A few areas are in cultivated crops, but native grass is a better use. Water collects on these soils during periods of extended rainfall. Crop failures are common.

Profile of Randall clay, 0.5 mile north of the northeast corner of section 23, block 31, T-2-N, Texas and Pacific Railroad Survey; or 5 miles east and 0.5 mile south of Luther Post Office, 100 feet east of county road; in the center of a microdepression:

A11—0 to 14 inches, gray (10YR 5/1) clay, dark gray (10YR 3/1) when moist; weak angular blocky structure; surface mulch of fine, hard, discrete aggregates; extremely hard when dry, very firm when moist, very sticky and plastic when wet; many fine roots, tubes, and pores; few insect burrows and worm casts; noncalcareous; neutral; gradual boundary.

A12—14 to 40 inches, dark-gray (10YR 4/1) heavy clay, very dark gray (10YR 3/1) when moist; parallelepipeds that have axes tilted more than 10 degrees from the horizontal; few slickensides in the lower part; extremely hard when dry, very firm when moist, very sticky and plastic when wet; few fine roots that are more concentrated along ped faces; noncalcareous; mildly alkaline; clear boundary.

AC—40 to 70 inches +, dark-gray (2.5Y 4/1) heavy clay, very dark gray (2.5Y 3/1) when moist; few angular peds in the upper part; extremely hard when dry, very firm when moist; few small pockets of fine sand throughout the horizon; common, weakly cemented, black iron or ferromanganese concretions; noncalcareous; mildly alkaline.

The A horizon ranges from 4 to 44 inches in thickness. When dry, this horizon ranges from very dark gray to grayish brown; hue is 10YR, value is 3 to 5, and chroma is 1 to 2. The A horizon, when moist, has color value of 3.5 or less to a depth of more than 12 inches in more than half of the acreage. This horizon ranges from neutral to moderately alkaline.

The AC horizon ranges from light clay to heavy clay. When dry, this horizon ranges from very dark gray to gray; hue is 10YR and 2.5Y, value is 3 to 6, and chroma is 1 and 2. The AC horizon is noncalcareous or calcareous. In some places mottles of light gray and strong brown are evident.

Gilgai microrelief occurs in places that are not disturbed by cultivation. In such places the knolls are 4 to 12 inches higher than the depressions. The center of the knolls is 5 to 8 feet from the center of the depressions.

The Randall soils are in deeper depressions and remain covered with water for longer periods than the Roscoe soils. Randall soils are grayer and more poorly drained than the Dalby, Stamford, and Tobosa soils.

Randall clay (Rc).—This soil is on the floors of enclosed depressions, or playas. Slopes are less than 1 percent. The areas generally range from about 4 to 100 acres in size but average about 40 acres. The profile of this soil is the one described as typical for the Randall series. The surface layer ranges from 4 to 44 inches in thickness. A recent overburden of loamy sediments 2 to 4 inches thick occurs in places.

This soil has very slow to slow permeability in the subsoil and is covered with water for long periods. Cultivation is limited by frequent floods and runoff water from surrounding areas. Some fields associated with other cultivated fields are farmed, usually during long dry periods. Others can be cultivated in wet years if runoff is controlled.

This soil is used mostly for range. A small acreage is cultivated, but during wet years much replanting is necessary to establish stands. Crops frequently drown in wet years, and crop failures are common. (Capability unit VIw–1; range site not assigned)

Reagan Series

The Reagan series consists of nearly level, grayish-brown, loamy soils. These soils are in upland areas, where they formed in moderately deep, calcareous, silty and clayey sediments of plains outwash.

In a typical profile, the surface layer is about 8 inches thick and consists of grayish-brown, calcareous, crumbly loam. The subsoil is pale-brown, calcareous, crumbly clay loam about 24 inches thick. The underlying layer is light-gray to white clay loam and concretions of lime that make up 50 percent of the layer, by volume. With increasing depth the accumulated lime decreases and the gypsum crystals increase.

These soils are used entirely for range. Some of the common grasses are sideoats grama, cane bluestem, blue grama, vine-mesquite, black grama, tobosa, and buffalograss. Other plants are sand muhly, ring muhly, and broom snakeweed. Some areas of these soils could be used as cropland, for the soils are naturally fertile.

Profile of Reagan loam, 0 to 1 percent slopes, 0.5 mile east and 0.15 mile south from the northwest corner of section 17, block 34, T–1–S, Texas and Pacific Railroad Survey; or 4 miles north of Lomax along a county road; range:

A1—0 to 8 inches, grayish-brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) when moist; weak, subangular blocky and granular structure; slightly hard when dry, friable when moist; few fine roots; many fine tubes and pores; few nests of worm casts; calcareous; mildly alkaline; clear boundary.

B2—8 to 32 inches, pale-brown (10YR 6/3) clay loam, brown (10YR 5/3) when moist; very weak, subangular blocky and granular structure; hard when dry, friable when moist; calcareous; few fine roots, tubes, and pores; few insect burrows; mildly alkaline; gradual boundary.

C1ca—32 to 48 inches, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) when moist; hard when dry, friable when moist; calcareous; moderately alkaline; many fine concretions of calcium carbonate make up about 50 percent of horizon, by volume; clear boundary.

C2—48 to 62 inches +, white (10YR 8/2) clay loam, light gray (10YR 7/2) when moist; slightly hard when dry, friable when moist; about 20 percent of horizon is calcium carbonate; small amounts of gypsum.

The A horizon ranges from 4 to 14 inches in thickness and from loam to light silty clay loam in texture. It is loam in 90 percent of the acreage. When this horizon is dry, its color ranges from brown to pale brown in a hue of 10YR, value of 5 to 6, and chroma of 2 to 3.

The B2 horizon ranges from silty clay loam to clay loam in which less than 15 percent of the sand is coarser than very fine sand. This horizon ranges from 14 to 30 inches in thickness. When dry, the B2 horizon ranges from light gray to very pale brown in a hue of 10YR, value of 6 to 7, and chroma of 2 to 4.

The Cca horizon is 20 to 40 inches from the surface and is 10 to 24 inches thick. Soft lumps and hard concretions of calcium carbonate make up about 20 to 50 percent of this horizon. In places, light olive-brown mottles occur in the C2 horizon.

The Reagan soils occur closely with the Reeves and Portales soils. They are deeper and contain less gypsum than the Reeves soils and are lighter colored and more silty than the Portales soils. Reagan soils are deeper than the Mansker soils.

Reagan loam, 0 to 1 percent slopes (ReA).—This soil occurs in broad upland areas that range from 200 to 600 acres in size. The surface is plane. The profile of this soil is the one described as typical for the series.

Included with this soil in mapping were areas of Reeves loam less than 5 acres in size. The included areas are slightly higher than areas of this Reagan soil and have a slightly convex surface. Also included, in some places, were gypsum outcrops less than 2 acres in size.

Although this soil has high available water capacity, it is used only as range. Most areas occur within large ranches. (Capability unit IIIce–2; Mixed Plains range site)

Reagan-Gypsum outcrop complex (Rg).—The soils in this complex are nearly level and occur in upland areas. In an average area about 37 percent of the acreage is Reagan loam; 31 percent is Gypsum outcrop; 22 percent, Reeves loan; and 10 percent, other soils. Reagan loam is in level areas between the knolls and has a plane surface. Gypsum outcrop is on convex knolls 6 to 18 inches higher than the surrounding soils. Reeves loam occurs adjacent to the knolls of Gypsum outcrop and is in areas less than about 5 acres in size. It is surrounded by Reagan loam. The soils in this complex have a profile similar to the one described as typical for their respective series.

Included in the mapping were several large salt lakes that dry up each year. Other lakes hold water the year round.

This complex is used only as range. On the Reeves and Reagan soils, stands of range forage are usually thin. Gypsum outcrop is bare of vegetation suitable for livestock. Cultivation of the Reagan and Reeves soils is not feasible, because the areas are irregular in shape and generally are less than 10 acres in size. Also, knolls of gypsum interfere with tillage. (Capability unit IIIce–2; Mixed Plains range site)

Reeves Series

The Reeves series consists of well-drained, light-colored, loamy soils over gypsum beds. These soils formed in upland areas from calcareous, gypsiferous alluvium.

In a typical profile, the surface layer is pale-brown, crumbly, calcareous loam about 6 inches thick. The subsoil is pale-brown, calcareous loam about 12 inches thick. The underlying layer is white loam of which 30 to 40 percent is gypsum crystals.

The Reeves soils are used entirely for native range. Some of the common grasses are sideoats grama, blue grama, and plains bristlegrass, and broom snakeweed grows in some areas. These soils could be farmed, though they are droughty.

Profile of Reeves loam, 1 to 3 percent slopes, 0.1 mile south of the northwest corner of section 9, block 34, T–1–S, Texas and Pacific Railroad Survey; or 4.9 miles north of Lomax; range:

A1—0 to 6 inches, pale-brown (10YR 6/3) loam, brown (10YR 4/3) when moist; weak granular structure; slightly hard when dry, friable when moist; few fine roots; common insect burrows and worm casts; few water-worn pebbles up to 5 millimeters in diameter; calcareous; moderately alkaline; clear boundary.

B2—6 to 18 inches, pale-brown (10YR 6/3) loam, grayish brown (10YR 5/2) when moist; weak granular structure; slightly hard when dry, very friable when moist; few fine roots; few insect burrows and worm casts; calcareous; moderately alkaline; abrupt boundary.

Ccs—18 to 34 inches +, white (10YR 8/2) loam, light gray (10YR 7/2) when moist; about 30 to 40 percent, by volume, is soft and hard gypsum crystals and some powdery calcium carbonate; few fine roots in the upper part; calcareous.

The A horizon ranges from 4 to 7 inches in thickness. Its texture ranges from heavy fine sandy loam to loam. When dry, this horizon ranges from brown to pale brown in a hue of 10YR, value of 6 to 7, and chroma of 3.

The B2 horizon ranges from 6 to 25 inches in thickness. Its texture ranges from loam to clay loam. When dry, this horizon ranges from light brownish gray to pinkish gray in hue of 10YR and 7.5YR.

Depth to the Ccs horizon ranges from 12 to 30 inches. In many places about 20 to 60 percent of this horizon is gypsum crystals and powdery masses of calcium carbonate.

The Reeves soils are lighter colored than the Mansker soils and are shallower over layers of accumulated lime and gypsum than the Reagan soils. The Reeves soils are similar to the Drake soils, which do not have an underlying layer of gypsum.

Reeves loam, 1 to 3 percent slopes (RmB).—This soil occurs on narrow ridges in areas that range from about 10 to 75 acres in size. Its profile is the one described as typical for the Reeves series.

Included with this soil in mapping, in slightly lower positions, were areas of Reagan loam. These included areas are less than about 5 acres in size.

This Reeves loam is poorly suited to cultivation, because it is shallow, is low in available moisture capacity, and contains too much lime. Range is the only use. (Capability unit IVes–1; High Lime range site)

Roscoe Series

Soils of the Roscoe series are deep, neutral, nearly level clays that have slow surface drainage. These soils are on uplands and are in slight depressions in some places. They developed from calcareous, clayey, old alluvium or plains outwash.

In a typical profile, the surface layer consists of dark-gray, neutral, firm clay about 18 inches thick. Beneath the surface layer is very dark grayish-brown, mildly alkaline, firm clay about 18 inches thick. To a depth of 60 inches the underlying layer is calcareous, firm clay.

Water stands on these soils for a day or two following periods of heavy rain, and it moves into these soils very slowly. Shrink-swell properties are high. The soils crack when dry, but water runs into the cracks rapidly and they seal. Natural fertility is high. Most areas of Roscoe soils are farmed to cotton and grain sorghum.

Profile of Roscoe clay, 100 feet west of a point 1 mile west and 2 miles south of Luther; range:

A1—0 to 18 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) when moist; moderate, medium and coarse, subangular blocky structure in the upper 4 inches and angular blocky structure in the lower 14 inches; upper 4 inches consists of dark grayish-brown heavy clay loam; hard when dry, firm when moist; many fine roots; few tubes and pores; noncalcareous; neutral; clear boundary.

AC1—18 to 36 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) when moist; moderate, medium, blocky structure; few parallelepipeds that have axes tilted more than 10 degrees from the horizontal; very hard when dry, firm when moist; few fine roots; noncalcareous; mildly alkaline; gradual boundary.

AC2—36 to 60 inches +, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; few slickensides; many wedge-shaped peds and parallelepipeds that are tilted more than 10 degrees from the horizontal; very hard when dry, firm when moist; calcareous; moderately alkaline; few small concretions of calcium carbonate.

The A1 horizon ranges from 12 to 24 inches in thickness and from clay to heavy clay loam in texture. The clay loam is in the upper 2 to 6 inches and represents overwash of loamy material. When this horizon is dry, it has a hue of 10YR, value of 3 to 5, and chroma of 1 to less than 1.5.

Depth to the AC horizon ranges from 12 to 36 inches, depending on the weak microrelief that is noticeable only in native range. When dry, this horizon has a hue of 10YR or 2.5Y, value of 2 to 6, and chroma of 1 to 3. Reaction of the AC horizon ranges from mildly alkaline to moderately alkaline. The soil matrix is calcareous in the lower part of the AC horizon in all places and in the upper part in some places. This horizon contains concretions of calcium carbonate, mainly in the lower part.

The Roscoe soils are in slighter depressions than the Randall soils and are covered with water for shorter periods. They have a grayer, more clayey surface layer than the Rowena soils and are grayer and less alkaline than the Dalby and Stamford soils. Roscoe soils are grayer and more clayey throughout the profile than the Acuff and Olton soils.

Roscoe clay (Ro).—This soil is nearly level to slightly depressional. In slight depressions it is surrounded by large areas of Olton and Acuff soils. It is in uplands in areas ranging from 5 to 40 acres in size. Slopes are generally less than 1 percent.

The surface layer is dark-gray clay that ranges from 12 to 36 inches in thickness. It grades to a very dark grayish-brown clay that is noncalcareous in the upper part and calcareous in the lower part. Included in mapping were areas that have a surface layer of clay loam 4 inches thick.

This soil is slowly permeable but is capable of holding a large amount of available water.

Most areas of this soil are used for crops; the rest is range. Use for cultivation, however, is limited, for most areas remain under water 1 or 2 days after an extended rainy period, though crops usually are not damaged. In years when moisture is favorable, crops common in the county grow well to fairly well. Cotton and grain sorghum are the main crops. Forage sorghum is grown in a few areas, chiefly for grazing.

Management is needed that controls excess water and maintains or improves tilth. Waterways or outlets from the depressions help to control excess water. Cropping systems that produce large amounts of residue are beneficial. The residues should be turned under to maintain or improve tilth. (Capability unit IIIw-1; Deep Hardland range site)

Rough Stony Land

Rough stony land (Rs) occupies the steep escarpment in the eastern and southern parts of the county. The terrain is rough and is steeply sloping in most places. Slopes are normally more than 30 percent but range from 16 to 70 percent. About 58 percent of the surface is covered with limestone and caliche fragments 3 to 10 inches in diameter; 30 percent is covered by large limestone boulders as much as 20 feet across; and most of the rest is a very shallow, loamy Ector soil. At the base of the steep slopes raw red beds of clay are exposed. The Ector soil occurs only in pockets about 2 to 4 feet wide. It has a surface layer of calcareous loam or clay loam about 4 to 6 inches thick.

Cultivated crops are not suited to this land, for it is highly susceptible to wind and water erosion and is very shallow and steep. This land is mainly used as wildlife habitat. Use for grazing is limited. (Capability unit VIIs-3; Rough Breaks range site)

Rowena Series

The Rowena series consists of deep, calcareous soils that occur on uplands and are nearly level to gently sloping. These soils have a clayey subsoil and slow surface drainage and internal drainage. They formed in slight depressions or on small knolls in old alluvial sediments that are calcareous and clayey. The soils on the small knolls make up 35 to 40 percent of the acreage.

The Rowena soils are variable in color over a short distance. Many plowed areas have a streaked appearance.

In a typical profile, the plow layer is dark-brown to dark grayish-brown, calcareous, crumbly clay loam about 10 inches thick. The subsoil is reddish-brown to dark grayish-brown, calcareous, very firm clay about 28 inches thick. The underlying layers consist of light reddish-brown clay loam to clay and soft masses of lime. The lime makes up about 40 percent of the layers, but it decreases with increasing depth. The accumulated lime decreases with depth.

Most areas of Rowena soils are farmed to cotton and sorghums. A few areas are used as native range.

Profile of a Rowena clay loam, 1 mile west and 100 feet north of Luther, in a slight microdepression that has been partly obliterated by cultivation:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) heavy clay loam, very dark grayish brown (10YR 3/2) when moist; structureless; slightly hard when dry, friable when moist; common fine roots and tubes; few worm casts; calcareous; moderately alkaline; abrupt boundary.

A1—8 to 10 inches, very dark grayish-brown (10YR 3/2) heavy clay loam, very dark brown (10YR 2/2) when moist; moderate, medium, subangular blocky and granular structure; hard when dry, firm when moist; many fine roots and common worm casts; few shiny pressure faces on peds; noncalcareous; moderately alkaline; clear boundary.

B21t—10 to 28 inches, dark grayish-brown (10YR 4/2) clay, very dark grayish brown (10YR 3/2) when moist; moderate; fine and medium, angular and subangular blocky structure; shiny pressure faces on peds; hard when dry, very firm when moist; few fine roots and pores; few waterworn pebbles up to 10 millimeters in diameter; noncalcareous; moderately alkaline; gradual boundary.

B22t—28 to 38 inches, dark yellowish-brown (10YR 4/4) clay, dark yellowish brown (10YR 3/4) when moist; moderate, fine, angular blocky structure; shiny pressure faces on peds; very hard when dry, very firm when moist; few fine roots and pores; few insect burrows and worm casts; few, small, strongly cemented concretions of calcium carbonate; calcareous; moderately alkaline; clear boundary.

C1ca—38 to 52 inches, light reddish-brown (5YR 6/3) clay, reddish brown (5YR 4/3) when moist; about 40 percent is calcium carbonate; few worm casts and waterworn pebbles; calcareous; moderately alkaline; gradual boundary.

C2—52 to 62 inches, reddish-brown (5YR 5/3) heavy clay loam, reddish brown (5YR 4/3) when moist; about 5 percent is calcium carbonate in the form of powdery masses and weakly cemented concretions.

The A horizon ranges from 6 to 12 inches in thickness. When dry, this horizon ranges from very dark grayish brown to reddish brown in hue of 10YR and 7.5YR, value of 3 to 5, and chroma of 2 to 4. This horizon, when moist, has a color value of 2 to 3 to a depth of more than 10 inches. In some places an A1 horizon is not present.

The B21t horizon ranges from 9 to 21 inches in thickness and from heavy clay loam to clay in texture. This horizon, when dry, has a hue of 10YR and 5YR, value of 3 to 5, and chroma of 2 to 4. It ranges from calcareous to noncalcareous and from moderately alkaline to mildly alkaline.

The B22t horizon ranges from 10 to 32 inches in thickness and from heavy clay loam to clay in texture. When dry, this horizon ranges from reddish brown to light brown in hue of 7.5YR and 5YR, value of 4 to 6, and chroma of 3 to 6. This horizon is calcareous throughout in all areas.

Depth to the Cca horizon ranges from 24 to 50 inches. This horizon is calcareous. Content of visible calcium carbonate ranges from about 30 to 60 percent and is in the form of white or pink powdery masses and weakly and strongly cemented concretions as much as one-half inch in diameter.

When dry, the Rowena soils are cracked below the surface mulch. The cracks are 1 to about 5 centimeters wide, and they extend to a depth of more than 20 inches.

Rowena soils are more clayey in the surface layer than the Acuff and Olton soils. The surface layer of the Rowena soils is browner and more alkaline than that of the Roscoe soils. Rowena soils are more clayey throughout than the Portales soils.

Rowena clay loam, 0 to 1 percent slopes (RwA).—This soil occurs in broad upland areas that range from 40 to 500 acres in size. Surfaces are plane. A slight microrelief can be seen in areas of native range. The surface layer is brownish, calcareous heavy clay loam about 8 inches thick. The subsoil ranges from 26 to 28 inches in thickness. A layer of accumulated lime occurs at about 36 to 38 inches below the surface.

Included with this soil in mapping were areas of Roscoe soils and of Randall clay. These included areas are in slightly lower relief than the Rowena soil and are less than 5 acres in size.

Available water capacity and natural fertility are high, but permeability is slow.

This Rowena soil is suitable for large-scale farming, and about 70 percent of it is cultivated, mainly to cotton and grain sorghum. Forage sorghum and small grains are grown, chiefly for grazing. Crops grow well to fairly well when soil moisture is adequate. A few areas in large ranches are used as range.

Management is needed that conserves moisture, controls erosion, and maintains or improves tilth. Contour farming and terraces help to control water erosion and to conserve moisture. Cropping systems that produce large amounts of residue are beneficial. The residues should be left on the surface so as to help control erosion. If they are plowed under, they help to maintain or improve tilth. (Capability unit IIce–1; Deep Hardland range site)

Rowena clay loam, 1 to 3 percent slopes (RwB).—This soil occurs in oblong, upland areas that range from 10 to 100 acres in size. The areas are slightly higher than adjoining areas of Rowena clay loam, 0 to 1 percent slopes. The surface layer consists of about 7 inches of dark-brown clay loam. The subsoil is brownish clay about 24 inches thick. A layer of accumulated lime occurs about 32 inches below the surface.

This soil is slowly permeable to moderately permeable. Natural fertility and available water capacity are high. Water erosion is more likely than on Rowena clay loam, 0 to 1 percent slopes.

This soil is suitable for large-scale farming, though a few areas are used as range. Most areas are used for crops, principally cotton and grain sorghum. Forage sorghum and small grains are grown in a few fields, chiefly for grazing. Crops grow fairly well when rainfall is adequate.

Management is needed that conserves moisture, controls erosion, and maintains or improves tilth. Cropping systems should include crops that produce large amounts of residue. Contour farming and terraces help to control erosion and to conserve moisture. (Capability unit IIIe–4; Deep Hardland range site)

Saline Alluvial Land

Saline alluvial land (Sa) occurs on the flood plains along Mustang and Beals Creeks, Sulphur Draw, and in some places adjoining salt lakes. These areas have slopes of less than 2 percent. The soil material is fine sandy loam to light clay that is underlain by clayey red beds at a depth of 3 to 20 feet. The water table fluctuates, depending on the amount of rainfall. Average depth is about 8 feet, but depth ranges from 2 to 20 feet. Crystals of salt and gypsum occur throughout the profile.

These areas are often flooded and may remain under water for several weeks. Cultivated crops are not suited, because the salt content is high as a result of the fluctuating water table. A white crust of salt covers some bare areas.

All of the acreage is native range. Stands of native grass are moderate. (Capability unit VIw–2; range site not assigned)

Sandy Alluvial Land

Sandy alluvial land (Sd) occurs on flood plains in narrow, intermittent stream valleys, mostly in the eastern part of the county on Wildhorse Creek and Sandy Hollow. Areas of this land range from 20 to 150 acres in size. Slopes are less than 1 percent. Stream channels are shallow and meandering. Generally, two or more channels occur in a valley. The surface layer consists of sandy to medium-textured, very stratified alluvial deposits of brown and reddish-brown loamy fine sands and fine sandy loams.

This land is used mainly for range and as wildlife habitat. Cultivated crops are not suited, for areas are narrow and are flooded about twice each year when rainfall is average. The floods deposit materials that may damage future crops. (Capability unit VIw–3; Bottomland range site)

Simona Series

The Simona series consists of shallow, well-drained, gently sloping, loamy soils on uplands. These soils formed in calcareous moderately sandy sediments and are shallow over caliche.

In a typical profile, the plow layer is brown, calcareous fine sandy loam about 6 inches thick. The underlying layer consists of concretions of indurated, platy caliche that are smooth on the upper side and nodular on the underside.

The Simona soils are used mainly as range. Some of the common grasses are sideoats grama, blue grama, black grama, tobosa, buffalograss, and perennial three-awns. These soils can be farmed, but they are droughty.

Profile of Simona fine sandy loam, 1 to 3 percent slopes, 2.5 miles north and 0.75 mile east of Knott Post Office; in field:

Ap—0 to 6 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; structureless; slightly hard when dry, friable when moist; few concretions of calcium carbonate up to 20 millimeters in diameter; few fine roots; calcareous; abrupt boundary.

B2—6 to 18 inches, pale-brown (10YR 6/3) fine sandy loam, brown (10YR 5/3) when moist; weak, prismatic to weak, subangular blocky and granular structure; slightly hard when dry, friable when moist; common concretions of calcium carbonate and few, rounded caliche pebbles; few fine roots and pores; calcareous; abrupt boundary.

Ccam—18 to 24 inches +, plates of whitish caliche 2 to 3 inches thick and 3 to 25 inches in diameter; indurated and laminar in the upper part; pale-brown fine sandy loam and concretions of calcium carbonate mixed between the plates; undersides of plates are nodular.

The A horizon ranges from loam to fine sandy loam in texture and from 4 to 6 inches in thickness. Color ranges from pale brown to grayish brown in a hue of 10YR, value of 5 to 6, and chroma of 2 to 3.

The B2 horizon ranges from 8 to 12 inches in thickness. Its color ranges from dark brown to pale brown in a hue of 10YR, value of 5 to 6, and chroma of 2 to 3. Depth to indurated caliche ranges from 12 to 20 inches.

Simona soils are lighter colored than the Mansker soils and are underlain by more indurated caliche. This caliche is also more indurated than that underlying the Veal soils. Simona soils are shallower and more alkaline than the Arvana soils and have a sandier subsoil. They are shallower and grayer than the Spade soils, which are underlain by sandstone.

Simona fine sandy loam, 1 to 3 percent slopes (SfB).—This soil occurs in upland areas that range from 10 to 60 acres in size. Its profile is the one described as typical for the series.

Permeability is moderate to moderately rapid. Available water capacity is low.

Most of the acreage is range, though some forage sorghum and small grains are grown in a few fields, chiefly for grazing. This soil is not desirable for crops, and it is cultivated only when adjacent to other cultivated soils. Grain sorghum and cotton are the main crops.

Use of cropping systems that leave large amounts of residue is advisable because residues left on the surface help to control erosion and to maintain fertility. Contour farming and terraces are needed for controlling water erosion and conserving moisture. (Capability unit IVe–3; Mixed Plains range site)

Spade Series

The Spade series consists of moderately deep, well-drained, loamy soils. These soils are in upland areas and are gently sloping to moderately sloping. They are in the northeastern part of the county, where they formed over sandstone and sandy conglomerate.

In a typical profile, the surface layer is reddish-brown, calcareous fine sandy loam about 6 inches thick. The subsoil is reddish-brown, calcareous fine sandy loam about 16 inches thick. It is underlain by strongly cemented sandstone coated with a thin layer of lime.

The Spade soils are used mainly as native range. Some of the common grasses are sideoats grama, blue grama, Arizona cottontop, black grama, hooded windmillgrass, buffalograss, and perennial three-awns. Mesquite, catclaw, and yucca are also common.

Profile of a Spade soil that has a fine sandy loam surface layer, 50 feet west of the road that is 0.5 mile west and 0.5 mile south from the northeast corner of section 46, block 30, T–1–S, Texas and Pacific Railroad Survey; or 0.5 mile south from a point 4.5 miles east of Coahoma on U.S. Highway 80; range:

A—0 to 6 inches, reddish-brown (5YR 5/3) fine sandy loam, reddish brown (5YR 4/3) when moist; very weak, subangular blocky and granular structure; slightly hard when dry, friable when moist; common fine roots; few sandstone fragments on surface of and throughout layer; few calcium carbonate concretions; few waterworn pebbles; calcareous; moderately alkaline; clear boundary.

B2—6 to 22 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) when moist; weak subangular blocky structure; slightly hard when dry, friable when moist; few fragments of sandstone; few fine roots; calcareous; moderately alkaline; clear boundary.

Rca—22 to 28 inches +, strongly cemented sandstone coated with a thin layer of calcium carbonate; calcareous.

The A horizon ranges from 5 to 8 inches in thickness and from loam to fine sandy loam in texture. When it is dry, the A horizon has a hue of 10YR or 5YR, value of 5 or 6, and chroma of 3 to 6. It is calcareous or noncalcareous.

The B2 horizon ranges from 15 to 25 inches in thickness and from fine sandy loam to heavy loam in texture. When dry, the B2 horizon has a hue of 10YR or 5YR, value of 5 or 6, and chroma of 3 to 6. The B2 horizon ranges from moderately alkaline to mildly alkaline and is calcareous or noncalcareous.

The R horizon is weakly to strongly cemented sandstone that is 20 to 30 inches below the soil surface. Calcium carbonate coats this layer and extends into its crevices. The R horizon is calcareous or noncalcareous.

The Spade soils occur closely with the Cobb, Latom, and Weymouth soils. Spade soils are more alkaline and less clayey in the subsoil than the Cobb soils. They are deeper to sandstone than the Latom soils and are sandier than the Weymouth soils.

Spade-Latom sandy loams, 1 to 3 percent slopes (SIB).—These soils have a convex surface. In most places they are on small ridges or knolls. Areas are about 10 to 50 acres in size. The Latom soil is mainly on narrow ridgetops, and the Spade soil is in lower areas. This complex is about 80 percent Spade soil and 20 percent Latom soil.

The surface layer of the Spade soil is fine sandy loam about 6 inches thick. The subsoil is fine sandy loam about 16 inches thick. It is underlain by sandstone. A few standstone fragments occur throughout the surface layer and on the surface. The Latom soil has a profile similar to the one described as typical for the Latom series. The surface layer is brown, calcareous fine sandy loam that is about 8 inches thick and is underlain by strongly cemented sandstone.

Included with these soils in mapping, in lower positions, were small areas of Weymouth clay loam, 1 to 3 percent slopes. Also included were areas that have a few small outcrops of sandstone.

The soils in this complex have low available water capacity, mainly because sandstone is near the surface. Permeability is moderate to moderately rapid.

Most of the acreage of these soils is range, but a few small areas, mainly of the Spade sandy loam, are cultivated. Cotton and grain sorghum are the main crops, but some forage sorghum and small grains are grown chiefly for grazing. In most years crops do not grow well.

Cropping systems that produce maximum amounts of residue are needed. Crop residues kept on the surface aid in controlling erosion and, if plowed under, improve soil tilth. Contour farming and terraces help to control erosion and to conserve moisture as well. (Spade soil is in capability unit IVe–3 and Mixedland Slopes range site; Latom soil is in capability unit VIIs–1 and Very Shallow range site)

Spade-Latom sandy loams, 3 to 5 percent slopes (SIC).—The soils in this complex are on low, narrow ridges and knolls on uplands. The areas range from about 10 to 30 acres in size. About 75 percent of this complex consists of Spade soil, and the rest is Latom soil.

Many sandstone fragments are on and in the surface layer of the Spade soil. The surface layer is calcareous fine sandy loam about 6 inches thick. The subsoil is loamy, calcareous material about 16 inches thick. It is underlain by sandstone. The Latom soil has a brown, calcareous fine sandy loam surface layer that is about 8 inches thick and is underlain by sandstone.

Included in mapping, in lower positions, were some areas of Vernon soils, 1 to 3 percent slopes. Also included were a few sandstone outcrops in the more sloping areas.

These soils are used only for range. Cultivated crops are not suited, mainly because of the low available water capacity. (Spade soil is in capability unit IVe–7 and Mixedland Slopes range site; Latom soil is in capability unit VIIs–1 and Very Shallow range site)

Springer Series

Soils of the Springer series are deep, well drained, and sandy or loamy. These soils are on uplands and are nearly level to gently sloping. They formed from reddish, calcareous, eolian deposits.

In a typical profile, the surface layer is dark-brown, crumbly, neutral loamy fine sand about 12 inches thick. The subsoil is crumbly fine sandy loam about 36 inches thick. It is reddish brown in the upper part and yellowish red in the lower. The subsoil is underlain by reddish-yellow, mildly alkaline loamy fine sand.

The Springer soils absorb most of the rain that falls. They have moderate to low available water capacity. The hazard of soil blowing and water erosion is high.

Springer soils are farmed to cotton and sorghums and are used as native range.

Profile of a Springer soil that has a loamy fine sand surface layer, 0.8 mile west and 0.2 mile south of the northeast corner of section 2, block A of Bauer and Cockrell Survey;

or 0.8 mile north of highway from a point 6.5 miles west of Big Spring Post Office; range:

A1—0 to 12 inches, dark-brown (7.5YR 4/4) loamy fine sand, dark brown (7.5YR 3/4) when moist; massive; soft when dry, friable when moist; few fine roots; noncalcareous; neutral; clear boundary.

B2t—12 to 24 inches, reddish-brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) when moist; weak subangular blocky structure; soft when dry, friable when moist; few fine roots and worm casts; noncalcareous; neutral; gradual boundary.

B3—24 to 48 inches, yellowish-red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) when moist; weak subangular blocky structure; soft when dry, very friable when moist; few fine tubes and pores; noncalcareous; mildly alkaline; gradual boundary.

C—48 to 70 inches +, reddish-yellow (5YR 6/6) loamy fine sand, yellowish red (5YR 5/6) when moist, loose when dry, very friable when moist; noncalcareous; mildly alkaline.

The A horizon ranges from 6 to 20 inches in thickness and from fine sandy loam to loamy fine sand in texture. This horizon, when dry, has a hue of 7.5YR or 5YR, value of 4 to 6, and chroma of 2 to 5.

The B2t horizon ranges from 8 to 20 inches in thickness. When dry, this horizon has a hue of 5YR or 2.5YR, value of 4 or 5, and chroma of 4 to 8. The B2t horizon ranges from loam or heavy fine sandy loam to light fine sandy loam.

The B3 horizon ranges from 15 to 30 inches in thickness and from fine sandy loam to light fine sandy loam in texture. When the B3 horizon is dry, its hue is 5YR or 2.5YR, value is 4 or 5, and chroma is 4 to 8. In the lower part, the B3 horizon is calcareous or noncalcareous.

In a few places, mainly areas where the A horizon is fine sandy loam, a weak Cca horizon occurs at a depth of 48 to 65 inches. Depth to the C horizon ranges from 35 to 70 inches. In some places, a few soft lumps and strongly cemented concretions of calcium carbonate are in this horizon.

Springer soils occur closely with the Amarillo, Brownfield, Gomez, and Tivoli soils. The surface layer of the Springer soils is thinner than that of the Brownfield soils, which consists of fine sand. Beneath the surface layer, the material in the Springer soils is sandier than that in the Amarillo soils and more loamy than that in the Tivoli soils. Springer soils are redder and less limy than the Gomez soils.

Springer fine sandy loam, 0 to 1 percent slopes (SpA).—This soil occurs in broad upland areas that range from about 40 to 150 acres in size. Surfaces are plane or weakly complex. The surface layer is dark-brown fine sandy loam about 12 inches thick. The subsoil is heavy fine sandy loam about 36 inches thick. A layer of weak accumulated lime occurs about 48 inches below the surface.

Included with this soil in mapping were areas of Portales fine sandy loam, 0 to 1 percent slopes. Also included were some small areas that have a surface layer of loamy fine sand. These included areas are less than 5 acres in size.

This Springer soil absorbs most of the rain that falls. Available water capacity is moderate. Permeability is moderate to rapid.

This soil is suited to large-scale farming, and about one-half of the acreage is farmed. Cotton and grain sorghum are the main crops. Other areas within large ranches are native range. Forage sorghum and small grains are grown in a few fields, mainly for soil cover and grazing. In years when moisture is adequate, crops grow well to fairly well.

Management is needed for controlling soil blowing and water erosion and for maintaining or improving tilth. Cropping systems that produce large amounts of residue are beneficial. The residues kept on the surface help to control soil blowing and water erosion and, if plowed under, to maintain tilth. Contour farming and terraces help to control water erosion and to conserve moisture. (Capability unit IIIe–2; Sandy Loam range site)

Springer fine sandy loam, 1 to 3 percent slopes (SpB).—This soil is gently sloping or undulating. It occupies upland areas about 20 to 150 acres in size. The surface layer is fine sandy loam about 10 inches thick. The subsoil is noncalcareous heavy fine sand about 35 inches thick. It is underlain by a loamy layer that contains a weak accumulation of lime. The lime begins at a depth of about 45 inches and extends to more than 60 inches.

Included with this soil in mapping were areas of Gomez loamy fine sand. These included areas are in slight depressions and are less than 5 acres in size. Also included were a few small spots of Springer soils that have a loamy fine sand surface layer.

Available water capacity is moderate, but permeability is moderately rapid. Water erosion is slightly more likely than on the Springer fine sandy loam, 0 to 1 percent slopes.

This soil is mostly range, but a few areas are suited to large-scale farming and are used chiefly for grain sorghum and cotton. In a few fields, forage sorghum and small grain are grown, chiefly for soil cover and grazing. Common crops generally grow well when moisture is available.

Management is needed that controls erosion and maintains soil tilth. Cropping systems that produce large amounts of residue are beneficial, for residues left on the surface help to control erosion. Plowed under residues help to maintain tilth. (Capability unit IIIe–6; Sandy Loam range site)

Springer loamy fine sand, undulating (Sr).—This undulating soil is in broad upland areas that range from 200 to 350 acres in size. Slopes range from 0 to 3 percent. This soil has a profile similar to the one described for the series, but its subsoil is only 24 inches thick.

Included with this soil in mapping were areas of Tivoli fine sand that occur in stabilized dunes along fence rows and in the more undulating areas. The included areas are less than about 10 acres in size.

This Springer soil is used mainly as range, but a few areas are cultivated. Row crops are not suited, mainly because the surface layer is sandy and highly susceptible to soil blowing. Also, this soil is droughty, for available water capacity is low. Permeability is moderately rapid. (Capability unit VIe–4; Sandyland range site)

Springer soils, severely eroded (Ss3).—These soils are undulating and occur in severely eroded fields on uplands. Much of the surface layer has been removed or altered by soil blowing and water erosion.

These soils occur in one area about 165 acres in size. In about 48 percent of this acreage, the reddish fine sandy loam subsoil is exposed in small, scattered areas. In about 40 percent of the acreage, the surface layer is fine sand and loamy fine sand that have accumulated in dunes and were shifted by wind. The dunes are low, about 50 to 100 feet wide, and 100 to 400 feet long. Some dunes are oval, though shape varies from place to place. The surface layer of the dunes is 20 to 50 inches thick over a fine sandy loam subsoil. About 10 percent of the acreage has a surface layer of loamy fine sand that is 10 to 20 inches thick and is underlain by fine sandy loam. About 2 percent of the acreage is gullied. The gullies are about 2 to 3 feet deep and 5 feet wide.

Range is the main use, for these soils are too sandy for cultivation. Areas that were cultivated have been seeded to introduced grasses in most places, but stands are thin. (Capability unit VIe-4; Sandyland range site)

Spur Series

The Spur series consists of nearly level, deep, loamy soils that are well drained. These soils formed in loamy alluvial sediments on flood plains that are flooded about once every 2 years.

In a typical profile, the surface layer is dark grayish-brown, calcareous, crumbly clay loam about 26 inches thick. The subsoil, about 19 inches thick, is brown calcareous clay loam. The underlying layer is light yellowish-brown calcareous clay loam.

Most of the acreage of Spur soils is native range. Some common grasses are sideoats grama, white tridens, vine-mesquite, blue grama, tobosa, and buffalograss. A few areas are cultivated to cotton and sorghums.

Profile of Spur clay loam, 1 mile west and 200 feet south of Elbow School on county road; in section 33, block 33, T-1-S, Texas and Pacific Railroad Survey; in range:

A1—0 to 26 inches, dark grayish-brown (10YR 4/2) clay loam, weakly stratified with slightly less clayey materials; very dark grayish brown (10YR 3/2) when moist; weak subangular blocky and moderate, medium, granular structure; hard when dry, friable when moist; many fine roots; common worm casts; calcareous; moderately alkaline; gradual boundary.

B2—26 to 45 inches, brown (10YR 5/3) clay loam, very dark brown (10YR 4/3) when moist; moderate, medium, subangular blocky and granular structure; few films and threads of calcium carbonate; many fine roots, tubes, and pores; common worm casts; mildly alkaline; calcareous; diffuse boundary.

C—45 to 60 inches +, light yellowish-brown (10YR 6/4) clay loam, yellowish brown (10YR 5/4) when moist; moderate, fine and medium, subangular blocky structure; hard when dry, friable when moist; few fine roots and worm casts; calcareous; mildly alkaline; few faint threads of calcium carbonate.

The A horizon ranges from 7 to 26 inches in thickness and from loam to clay loam in texture. When dry, this horizon ranges from dark grayish brown to brown in hue of 10YR, value of 4 or 5, and chroma of 2 or 3.

The B2 horizon ranges from light clay loam to sandy clay loam in texture and from 18 to 30 inches in thickness. When dry, this horizon ranges from dark grayish brown to brown in a hue of 10YR or 7.5YR.

Depth to the C horizon ranges from 30 to 56 inches. A few threads and concretions of calcium carbonate are visible.

Spur soils occur closely with the Portales and Zita soils but are more stratified. Spur soils lack the distinct layer of lime accumulation that occurs in the Portales and Zita soils.

Spur clay loam (St).—This soil is on flood plains in slightly concave areas. Slopes range from 0 to 2 percent but are less than 1 percent in most places. Most areas of this soil are about 1,000 feet wide and several miles long. Included with this soil in mapping were a few small areas of Zavala fine sandy loam.

Spur clay loam is moderately permeable. It has high available water capacity and natural fertility.

This soil is used mainly as range. Use for cultivation is limited by stream channels that are difficult to cross with farm machinery. In the areas that are cultivated, however, crops grow well in most years. Cotton and grain sorgum are the main crops, but forage sorgum and small grains are also grown. Flooding is likely about once in every 2 years, but it does little damage, because generally it does not come during the growing season.

Management is needed to conserve moisture, control erosion, and maintain tilth. Cropping systems that produce large amounts of residue are needed. Contour farming and terraces help to reduce erosion and to conserve moisture. (Capability unit IIe-1; Bottomland range site)

Stamford Series

The Stamford series consists of deep, well-drained, clayey soils that are nearly level or gently sloping. These soils formed in reddish, calcareous clay in the eastern part of the county. They are saline in some places.

In a typical profile, the surface layer is about 14 inches thick. It is reddish-brown clay. The next layer is also reddish-brown, calcareous, very firm clay, but it is about 26 inches thick. The underlying layer is massive red clay that is streaked and pocketed with gray shale.

Visible in areas of range is a weak gilgai microrelief in which the knolls are 3 to 8 inches higher than the depressions. The centers of the tops of the knolls are about 4 to 10 feet apart.

Stamford soils have high shrink-swell properties. Cracks that form during dry periods extend to a depth of 2 feet or more. The cracks remain open for a total of 150 days in most years. Although the natural fertility is high, these soils are difficult to work.

Most of the acreage of these soils is native range. Common grasses are sideoats grama, blue grama, white tridens, tobosa, and buffalograss. Mesquite and pricklypear are common woody plants.

Profile of a Stamford clay, 1 mile south and 100 feet east of the northeast corner of section 12, block 31, T-1-N, Texas and Pacific Railroad Survey; or 5 miles north of Coahoma on Highway 820, then east 1 mile; in range:

A1—0 to 14 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; moderate, fine, blocky and subangular blocky structure; very hard when dry, very firm when moist; common fine roots, tubes, and pores; few waterworn pebbles on the surface and in the horizon; calcareous; mildly alkaline; clear boundary.

AC—14 to 40 inches, reddish-brown (5YR 4/4) clay, dark reddish brown (5YR 3/4) when moist; parallelepipeds that have axes tilting more than 10 degrees from the horizontal; few slickensides in the lower part; moderate, medium, angular blocky structure in the upper part; very hard when dry, very firm when moist; common fine roots; some darker material in partly sealed cracks; few small crystals of gypsum and waterworn pebbles; calcareous; mildly alkaline; diffuse boundary.

C—40 to 60 inches +, weak-red (2.5YR 4/2) clay, dusky red (2.5YR 3/2) when moist; Triassic sediments; pockets and streaks of gray shale.

The A horizon ranges from 8 to 20 inches in thickness. When this horizon is dry, it ranges from dark reddish brown to red in a hue of 5YR or 2.5YR, value of 3 to 5, and chroma of 3 to 6. When wet, the A horizon has a value of 3.5 or less to a depth of more than 12 inches.

The AC horizon ranges from 14 to 32 inches in thickness and from medium to heavy clay in texture. When dry, the AC horizon ranges from dark reddish brown to red in a hue of 5YR or 2.5YR. Slickensides are strongly or weakly expressed. In saline areas, the AC horizon is more saline than the A.

Depth to the C horizon ranges from 22 to 40 inches. When the C horizon is dry, it ranges from red to pale red in a hue of 2.5YR or 10YR, value of 4 to 6, and chroma of 2 to 6. A weak Cca horizon occurs in a few areas.

The Stamford soils occur closely with the Dalby, Olton, and Vernon soils. They are deeper than the Vernon soils and have a thicker surface layer than the Dalby. Stamford soils are more clayey and more alkaline than the Olton soils.

Stamford and Dalby clays, 0 to 1 percent slopes (SuA).—These soils occupy broad upland areas that, in many places, are more than 500 acres in size. Of the total acreage, about 60 percent is the Stamford soil, and 40 percent is the Dalby soil. Both soils occur together in some parts of the landscape, but in other parts only one is present. Each soil has a profile similar to the one described as typical for its respective series.

Included in the mapping were areas of Olton clay loam, 0 to 1 percent slopes, and of Vernon soils, 1 to 3 percent slopes. The Olton soils have plane surfaces, but surfaces of the Vernon soils are convex. The included areas are less than 5 acres in size.

Stands of crops are difficult to establish because these soils are hard to work and surface crusting is likely after heavy rains. These soils are droughty. Available water capacity is variable and depends on content of soluble salts. It is moderate in most areas of Stamford soil and is low in the Dalby soil. Because the subsoil is heavy clay, both soils are very slowly permeable.

Most of the Stamford soil and all of the Dalby soil are used as range. A few areas of the Stamford soil are farmed to grain sorghum and forage sorghum; stands are generally thin. (Stamford soil is in capability unit IIIs–1; Dalby soil is in capability unit IVe–8; both soils are in Clay Flat range site)

Stamford and Dalby clays, 1 to 3 percent slopes (SuB).—These soils occur in upland areas that range from about 10 to 75 acres in size. They are higher in the landscape than are Stamford and Dalby soils, 0 to 1 percent slopes. The surface layer of the Stamford soil is about 14 inches thick; that of the Dalby soil ranges from 4 to 8 inches in thickness. In some areas, waterworn pebbles are scattered on the surface. The Stamford soil makes up half of the acreage, and the Dalby soil most of the rest.

Included in mapping were areas of Vernon soils and of Weymouth-Vernon clay loams, 1 to 3 percent slopes. These included areas are on the higher, more elongated knolls. They make up not more than 10 percent of any area mapped.

These Stamford and Dalby soils are droughty. Available moisture ranges from low to high and depends on the content of soluble salts. Water erosion is a severe hazard in areas not protected by a cover of plants.

All of the acreage of these soils is used for range. Crops do not grow well. If crops are grown, they should be the kind that produces large amounts of residue. Contour tillage and terraces are also needed in tilled areas. (Capability unit IVe–8; Clay Flat range site)

Tivoli Series

The Tivoli series consists of deep, neutral, loose sands that have rapid internal drainage. These soils are nearly level to undulating. They developed from sandy eolian deposits on uplands in the central part of the county.

In a typical profile, the surface layer is pale-brown loose fine sand about 15 inches thick. It is underlain by reddish-yellow loose fine sand that extends to a depth of more than 60 inches.

The Tivoli soils are used only as range and are well suited to that use. Some common grasses are sand bluestem, giant dropseed, little bluestem, sand dropseed, false buffalograss, and perennial three-awns. Havard oak is also common. Soil blowing is likely in the overgrazed areas.

Profile of Tivoli fine sand, 0.85 mile north of Texas Highway 176, from a point 7.5 miles west of the Big Spring Field Station in Big Spring; in range:

A1—0 to 15 inches, pale-brown (10YR 6/3) fine sand, brown (10YR 5/3) when moist; structureless; loose when dry, loose when moist; noncalcareous; neutral; few fine roots and hairs; clear boundary.

C—15 to 60 inches +, reddish-yellow (7.5YR 6/6) fine sand, strong brown (7.5YR 5/6) when moist; structureless; loose when dry, loose when moist; noncalcareous; neutral; few fine roots and hairs in the upper part.

The A horizon ranges from 8 to 20 inches in thickness. This horizon, when dry, ranges from pale brown to grayish brown in a hue of 10YR, value of 5 or 6, and chroma of 2 or 3.

The C horizon ranges from a reddish yellow to strong brown in a hue of 7.5YR and 10YR.

Tivoli soils occur closely with the Amarillo, Brownfield, Gomez, and Springer soils. The Tivoli soils have a sandier subsoil than have the Brownfield soils and are sandier throughout the profile than the Amarillo, Gomez, and Springer soils.

Tivoli fine sand (Tf).—This soil is nearly level to undulating. It occurs in broad upland areas that range from 200 to 1,500 acres in size. Slopes range from 1 to 5 percent. In this soil fine sand extends from the surface to a depth of several feet.

Included in mapping were areas of Brownfield fine sand, 0 to 3 percent slopes, and of Springer loamy fine sand, undulating. These included areas are slightly below this Tivoli soil. They are less than about 15 acres in size.

Little water runs off the higher areas of this soil, because the soil is rapidly permeable and takes in water well. The sandy surface layer is highly erodible, however, and soil blowing is likely in overgrazed areas. Available water capacity is low.

All of the acreage of this soil is range. (Capability unit VIIe–1; Deep Sand range site)

Tobosa Series

Soils of the Tobosa series are deep, nearly level to gently sloping, firm clays. These soils are in upland valleys in the southeastern part of the county.

In a typical profile, the surface layer is very dark grayish-brown clay about 30 inches thick. The next layer is a brown, calcareous, very firm clay about 22 inches thick. It is underlain by hard limestone. These soils are calcareous throughout the profile.

The Tobosa soils are used mainly as native range. A few of the common grasses are cane and silver bluestems, sideoats grama, blue grama, tobosa, buffalograss, and perennial three-awns. Mesquite and tarbush are common woody plants.

Profile of Tobosa clay, 0 to 2 percent slopes, 0.5 mile west of the northeast corner of section 128, block 29, Waco and Northwestern Railroad Survey; or 0.5 mile west of a point 2 miles east and 1 mile north of Forsan on oilfield road; in a microdepression on range:

A1—0 to 30 inches, very dark grayish-brown (10YR 3/2) clay, very dark brown (10YR 2/2) when moist; thin mulch of very fine, very hard, discrete peds on surface; moderate, fine, angular blocky structure; pressure faces evident; parallelepipeds below a depth of about 20 inches; very hard when dry, firm when moist; common fine roots, tubes, and pores; few insect burrows and worm casts; calcareous; moderately alkaline; gradual boundary.

AC1—30 to 44 inches, brown (10YR 4/3) clay, dark brown (10YR 3/3) when moist; parallelepipeds that have axes tilting 10 to 60 degrees from the horizontal; strong slickensides; some darker material in old partly sealed crevices; extremely hard when dry, very firm when moist; calcareous; moderately alkaline; few very fine roots, tubes, and pores; clear boundary.

AC2—44 to 52 inches, brown (10YR 5/3) clay, dark brown (10YR 4/3) when moist; extremely hard when dry, very firm when moist; parallelepipeds that have axes tilting more than 10 degrees from the horizontal; fewer slickensides than in horizon above; calcareous.

R—52 to 54 inches +, bedrock of hard limestone.

The A1 horizon ranges from 6 to 40 inches in thickness. In undisturbed areas the microknolls are about 4 inches to 1 foot higher than the microdepressions. The A1 horizon is thicker in the center of the microdepressions than in the center of the microknolls. The centers of the microknolls are about 4 to 12 feet apart.

When dry, the A1 horizon ranges from very dark grayish brown to dark brown in a hue of 10YR, value of 3 or 4, and chroma of 2 or 3. In more than half the acreage, the A1 horizon, when moist, has color value of 3.5 or less to a depth of 12 inches.

The AC horizon ranges from about 15 to 40 inches in thickness. When dry, the AC horizon is dark brown to light brown and has hue of 10YR or 7.5YR, value of 4 to 6, and chroma of 3 or 4. Depth to limestone ranges from 40 to 82 inches. A faint ca horizon occurs just above the limestone where the R horizon is more than 60 inches from the soil surface.

Tobosa soils occur closely with the Ozona, Uvalde, and Ector soils but are deeper and more clayey. Tobosa soils are more limy and less gray than the Roscoe soils.

Tobosa clay, 0 to 2 percent slopes (ToA).—This soil is in upland areas below large areas of Ector soils that range from 20 to 150 acres in size. The calcareous dark-colored clay surface layer ranges from about 6 to 40 inches in thickness and is underlain by slightly lighter colored clay.

Included with this soil in mapping were areas of Uvalde silty clay loam. The included areas are slightly higher than areas of this Tobosa soil, and they total less than about 5 percent of any area mapped.

This soil is in range within large cattle ranches. It has high available water capacity and natural fertility and is suitable for large-scale farming. If it is cultivated, crops are needed that produce large amounts of residue for improving tilth. Contour farming and terraces will help to conserve moisture and control erosion. (Capability unit IVs–1; Valley range site)

Uvalde Series [4]

The Uvalde series consists of nearly level to gently sloping, well-drained, loamy soils. These soils are moderately deep over layers of accumulated lime. They formed on uplands in calcareous outwash sediments.

In a typical profile, the surface layer is dark-brown crumbly, calcareous silty clay loam about 15 inches thick. The subsoil is brown firm but crumbly silty clay loam about 17 inches thick. The underlying layer consists of pink to light-brown silty clay loam and soft masses and hard concretions of lime. The lime makes up 20 to 40 percent of this horizon, by volume. The amount of concretions decreases with increasing depth.

All of the acreage of Uvalde soils is used for native range. Some common grasses are sideoats grama, blue grama, plains bristlegrass, Arizona cottontop, tobosa, buffalograss, and perennial three-awns. Mesquite and tarbush are common woody plants.

Profile of Uvalde silty clay loam, 0 to 1 percent slopes, 0.3 mile north of the southeast corner of section 138, block 29, Waco and Northwestern Railroad Survey; or 0.1 mile south from a point 1 mile west of Ross City on Texas Highway 821; range:

A1—0 to 15 inches, dark-brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) when moist; weak, subangular blocky and granular structure; hard when dry, friable when moist, sticky when wet; common fine roots, tubes, and pores; calcareous; mildly alkaline; clear boundary.

B2—15 to 32 inches, brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) when moist; moderate, fine, subangular blocky structure; hard when dry, firm but crumbly when moist, sticky when wet; few fine roots, tubes, and pores; calcareous; mildly alkaline; clear boundary.

C1ca—32 to 60 inches, pink (7.5YR 8/4) silty clay loam, mottled with light-brown (7.5YR 6/4) clay loam; pink (7.5YR 7/4) when moist; structureless; hard when dry, friable when moist, sticky when wet; calcareous; about 20 to 40 percent is soft masses and concretions of calcium carbonate.

C2—60 to 84 inches +, light-brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) when moist; some white, powdery concretions of calcium carbonate but less than in horizon above; few fragments of limestone coated with calcium carbonate; calcareous.

The A horizon ranges from 10 to 22 inches in thickness and from silty clay loam to clay loam in texture. This horizon, when dry, ranges from dark grayish brown to brown in a hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 2 or 3. The value of this horizon, when moist, is less than 3.5.

The B2 horizon ranges from 10 to 30 inches in thickness and from silty clay loam to clay loam in texture. The subsoil is slightly finer textured than the surface layer. Limestone fragments coated with caliche occur in places.

Depth to the C1ca horizon ranges from 20 to 40 inches. Its thickness ranges from about 10 to 30 inches. About 20 to 60 percent of this horizon is soft masses and hard concretions of calcium carbonate.

In the C2 horizon, the visible concretions of calcium carbonate are at least 5 percent less than in the C1ca horizon. In most areas, this horizon contains a few limestone fragments and a few hard calcium carbonate concretions.

Uvalde soils occur closely with the Portales, Ozona, and Tobosa soils. The Uvalde soils are more silty and slightly more clayey than the Portales soils. In the Uvalde soils the hard layers of caliche-coated limestone common to the Ozona soils are lacking. Uvalde soils are less clayey than the Tobosa soils.

Uvalde silty clay loam, 0 to 1 percent slopes (UsA).—This soil is in upland areas that range from about 100 to 350 acres in size. These areas occur below large areas of Ector soils. The surface layer of this Uvalde soil is about 15 inches thick. The subsoil is silty clay loam about 17 inches thick and is underlain by soft, pinkish silty clay loam.

Included with this soil in mapping were small areas of Tobosa clay. The included areas are in slightly lower positions than this Uvalde soil and make up less than 5 percent of any area mapped.

Although cultivated crops are well suited, this soil is used entirely as range. Available water capacity and natural fertility are high.

If this soil were cultivated the main concerns would

[4] In this survey the soils here described were considered a part of the Uvalde series. In future surveys soils that have the same characteristics as these soils will be included in another similar soil series that consists of soils having lower average soil temperatures than those of the Uvalde soils.

be conserving moisture and maintaining tilth. Effective management would include practices, such as contour farming and terraces. Also beneficial would be use of cropping systems that produce large amounts of residue. (Capability unit IIIc–1; Valley range site)

Uvalde silty clay loam, 1 to 3 percent slopes (UsB).—This soil is in upland areas that range from 10 to 100 acres in size. The surface layer is about 12 inches thick. The subsoil is brown, calcareous silty clay loam about 15 inches thick over lime.

Included with this soil in mapping were areas of an Ozona clay loam and of a Tobosa clay. The Ozona soil is in slightly higher parts of the landscape, and the Tobosa soil is in slightly lower parts. These included areas make up less than 10 percent of any area mapped.

This soil is desirable as rangeland and all of it is range within large ranches. Available water capacity is high, but permeability is moderate to slow. This soil is more susceptible to water erosion than the nearly level Uvalde silty clay loam, 0 to 1 percent slopes.

This soil could be cultivated if cropping systems that produce large amounts of residue are used and if cultivation is on contoured terraces. (Capability unit IIIe–4; Valley range site)

Veal Series

The Veal series consists of calcareous, well-drained, loamy soils that are shallow over layers of accumulated lime. These soils formed on uplands and are gently sloping to sloping.

In a typical profile, the surface layer is brown, crumbly fine sandy loam about 8 inches thick. The subsoil is pale-brown, crumbly sandy clay loam about 9 inches thick. The underlying layer is mostly pink to brown clay loam. About 30 percent of the upper part of this layer is accumulated lime in soft masses and hard concretions. The percentage of lime decreases with increasing depth.

Most of the acreage of the Veal soils is native range, though some of the gently sloping areas are farmed to cotton and sorghums. Common grasses are sand dropseed, blue grama, and sideoats grama. Soil blowing and water erosion are likely in cultivated areas.

Profile of Veal fine sandy loam, 1 to 3 percent slopes, 0.7 mile west-southwest of the southeast corner of section 22, block 33, T–3–N, 100 feet north; or 100 feet north of Farm Road 1785 from a point 2.7 miles south of Vealmoor; range:

A1—0 to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; weak subangular blocky and granular structure; slightly hard when dry, friable when moist; common fine roots and pores; a few fine fragments of cemented calcium carbonate; calcareous; gradual boundary.

B2—8 to 17 inches, pale-brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) when moist; weak subangular blocky structure; slightly hard when dry, friable when moist; few fine roots and pores; few fine concretions of calcium carbonate; calcareous; clear boundary.

C1ca—17 to 36 inches, pink (7.5YR 8/4) light clay loam, pink (7.5YR 7/4) when moist; weak subangular blocky structure; friable; soft masses and hard concretions of calcium carbonate make up about 30 percent of horizon, by volume; calcareous; gradual boundary.

C2—36 to 60 inches +, light-brown (7.5YR 6/4) light clay loam, brown (7.5YR 5/4) when moist; weak subangular blocky structure; friable; calcareous; about 10 percent, by volume, is soft masses and hard concretions of calcium carbonate.

The A horizon ranges from fine sandy loam to loam or sandy clay loam. Coarse fragments make up less than 15 percent of this horizon, by volume. Structure is very weak in some places. When dry, this horizon ranges from light brownish gray to brown in hue of 10YR or 7.5YR, value of 5 or 6, and chroma of 2 to 4. When moist, the A horizon has value of more than 3.5. In places where this horizon is darker than normal, it is less than 7 inches thick and overlies a lighter colored B2 horizon.

The B2 horizon is loam, sandy clay loam, or heavy fine sandy loam that is about 18 to 35 percent clay. Coarse fragments make up less than 15 percent of this horizon, by volume. Structure is moderate in some places. The B2 horizon is similar to the A horizon in range of color, but generally value is 1 unit higher in the B2 and in a few places hue is 5YR.

Depth to the C1ca horizon ranges from 10 to about 20 inches. This horizon is weakly cemented in some places. About 10 to 50 percent of the C1ca horizon is made up of concretions and soft masses of calcium carbonate.

The Veal soils occur closely with the Mansker, Portales, and Potter soils. They are lighter colored and contain less organic matter than the Mansker and Portales soils. The layer of accumulated lime is nearer the surface in the Veal soils than in the Portales. Veal soils are deeper than the Potter soils.

Veal fine sandy loam, 1 to 3 percent slopes (VeB).—This soil occurs in upland areas below large areas of Amarillo and Portales soils. Most areas range from 15 to 60 acres in size. The profile of this soil is the one described as typical for the series.

Included with this soil in mapping, in about the same position, were areas of Amarillo fine sandy loam and of Portales fine sandy loam. These included areas make up less than about 10 percent of a mapped area.

Permeability is moderate, but this soil has a thin solum and low available water capacity. Water erosion is likely in cultivated fields.

This soil is used mainly as range; some forage sorghum and small grains are grown in a few fields, chiefly for forage. This soil is fairly well suited to crops, but it is cultivated only when adjacent to other, more suitable soils. Grain sorghum and cotton are the main crops.

Cropping systems that leave large amounts of residue are advisable because residues on the surface help to control erosion. If the residues are plowed under, they improve tilth. Terraces and contour farming help to control water erosion and to save moisture. (Capability unit IVe–3; Mixedland Slopes range site)

Veal fine sandy loam, 3 to 5 percent slopes (VeC).—This soil lies in upland areas that range from about 10 to 40 acres in size. The areas are along natural drains and below escarpments of Potter soils. The surface layer of this soil is pale-brown, calcareous sandy loam about 6 inches thick. The subsoil is about 10 inches thick and is underlain by a layer of accumulated lime. Most areas of this soil have been cut by narrow, shallow gullies.

Included with this soil in mapping were areas of a Berthoud loam, a Mobeetie fine sandy loam, and Potter soils. The Mobeetie and Berthoud soils are on the lower side slopes, and the Potter soils are on small knolls. These included areas total less than 5 percent of any area mapped.

This sloping soil is low in available water capacity, susceptible to erosion, and not suitable for cultivation. Most of it is range, and it is fairly well suited to that use. (Capability unit VIe–5; Mixedland Slopes range site)

Vernon Series

The Vernon series consists of well-drained, calcareous, clayey soils that are shallow over shaly clay. These soils are gently sloping to sloping and are extensive in the eastern part of the county. They developed on uplands from compact, red-bed clay and shale.

In a typical profile, the surface layer and subsoil are reddish-brown, calcareous, very firm clay. The surface layer is about 6 inches thick, and the subsoil is about 10 inches thick. The underlying material is red shaly clay in distinct beds.

The Vernon soils are used mostly for range and are well suited to that use. Some of the common grasses are sideoats grama, blue grama, tobosa, alkali sacaton, buffalograss, and perennial three-awns. Water erosion is likely where the plant cover is thin.

Profile of a Vernon clay, 0.05 mile east of the northwest corner of section 29, block 29, T–1–N, Texas and Pacific Railroad Survey; or 50 feet south of county road, from a point 3 miles north and 8.95 miles east of Coahoma; in range:

A1–0 to 6 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; strong, medium, blocky structure; extremely hard when dry, very firm when moist; few fine roots, tubes, and pores; few concretions of calcium carbonate as much as 5 millimeters in diameter; calcareous; moderately alkaline; clear boundary.

B2—6 to 16 inches, reddish-brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) when moist; strong, fine, blocky structure; extremely hard when dry, very firm when moist; few concretions of calcium carbonate as much as 3 millimeters in diameter; calcareous; moderately alkaline.

R—16 to 48 inches +, weak-red (10R 5/4) shaly clay in distinct beds, weak red (10YR 4/4) when moist; few thin seams and rounded pockets of gray (2.5Y 5/0) clay.

The A1 horizon ranges from clay to heavy clay loam in texture and from 4 to 15 inches in thickness. When dry, this horizon ranges from reddish brown to red in color; hue is 2.5YR or 5YR, value is 4 or 5, and chroma is 4 or 5. The content of organic matter is less than 1 percent. In some areas waterworn pebbles are on the surface.

The B2 horizon has the same range in color as the A1 horizon, but it ranges from about 6 to 12 inches in thickness.

The R horizon is dusky-red to red clay or shaly clay. Pockets of gray (2.5Y 5/0) clay or shaly clay are common.

The Vernon soils occur closely with Stamford, Dalby, and Weymouth soils and with areas of badland. Vernon soils are shallower than the Stamford and Dalby soils and are more clayey than the Weymouth soils. Unlike the Weymouth soils, Vernon soils do not have a layer of accumulated lime.

Vernon soils, 1 to 3 percent slopes (VsB).—These soils occur in upland areas that are usually less than 100 acres in size. Most areas have been cut by narrow, shallow gullies. These soils occur above large areas of Stamford and Dalby clays. The surface layer of the Vernon soils consists of about 6 inches of reddish-brown, calcareous clay or heavy clay loam. The subsoil is of the same color and texture and is underlain by shaly clay.

Included in mapping were areas of Stamford and Dalby clays, 0 to 1 percent slopes, less than 5 acres in size. Also included, in about the same landscape as Vernon soils, were areas of a Weymouth soil that has a clay loam surface layer. Sandstone crops out in a few areas. Typically, included areas make up less than 10 percent of this mapping unit.

Water erosion is likely where cover is lacking. Available water capacity is low, for these soils are shallow over shaly clay.

Vernon soils are used only as range. Stands of native grass are thin. (Capability unit VIe–6; Shallow Redland range site)

Vernon-Badland complex (Vx).—The soils in this complex occur in upland areas where slopes range from 3 to 12 percent. Typically, about 40 percent of this complex is Vernon soils; 35 percent, areas of badland; 15 percent, Weymouth clay loam; and 10 percent, Stamford and Dalby clays. The Vernon soils and Weymouth clay loam occur together in the less sloping areas. Stamford and Dalby clays are near natural drainageways and are gently sloping to nearly level. Badland is highly erodible, is dissected by gullies, and has bald ridges and knobs consisting of red-bed shaly clay. Waterworn pebbles are strewn over about 90 percent of the surface.

The surface layer of the Vernon soils is reddish, calcareous clay. The subsoil is like the surface layer and is underlain by rocklike shaly clay. The Weymouth clay loam and Stamford and Dalby clays have profiles similar to the one described as typical for their respective series.

The soils in this complex are used only for range and as wildlife habitat. (Capability unit VIe–6; Shallow Redland range site)

Weymouth Series

The Weymouth series consists of well-drained, gently sloping, loamy soils that are shallow over layers of accumulated lime underlain by loamy red beds. These soils developed from weakly consolidated material of the red beds. Weymouth soils occur on uplands in the eastern part of the county.

In a typical profile, the surface layer is reddish-brown and dark reddish-brown, calcareous, crumbly clay loam about 10 inches thick. The subsoil is reddish-brown, calcareous, crumbly clay loam about 8 inches thick. The next layer is clay loam and accumulated lime in which calcium carbonate makes up 10 percent of the soil mass. Below this layer, at a depth of 40 inches, are unconsolidated loamy red beds.

The Weymouth soils are used mainly as range. Common grasses are hairy grama, blue grama, and buffalograss. A few areas are farmed to cotton and sorghums. Water erosion is a moderate risk in cultivated areas.

Profile of Weymouth clay loam, 1 to 3 percent slopes, 0.3 mile southwest of the northeast corner of section 14, block 26, Houston and Texas Central Railroad Survey; or 0.3 mile southwest of a road, from a point 2 miles east and 1 mile south of Vincent; in range:

Ap—0 to 6 inches, reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; weak granular structure; slightly hard when dry, friable when moist; common waterworn pebbles on and near the surface; calcareous; moderately alkaline; abrupt boundary.

A1—6 to 10 inches, dark reddish-brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) when moist; weak subangular blocky and granular structure; slightly hard when dry, friable when moist; few fine roots; few fine waterworn pebbles; calcareous; moderately alkaline; clear boundary.

B2—10 to 18 inches, reddish-brown (2.5YR 5/4) clay loam, dark reddish brown (2.5YR 4/4) when moist; weak subangular blocky and granular structure; hard when dry, friable when moist; few concretions of calcium carbonate; few very fine roots; calcareous; moderately alkaline; clear boundary.

C1ca—18 to 40 inches, reddish-brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) when moist; about 10 percent, by volume, is calcium carbonate; calcareous; moderately alkaline; gradual boundary.

C2—40 to 50 inches +, unconsolidated, red loamy red beds; calcareous; structureless; few fragments of weakly cemented sandstone.

The A horizon ranges from 8 to 14 inches in thickness. When dry, this horizon has a hue of 7.5YR, 5YR, or 2.5YR, value of 4 or 5, and chroma of 4 or 5.

The B2 horizon ranges from 6 to 10 inches in thickness. It has a value of 4 or 5, a hue of 5YR or 2.5YR, and chroma of 3 to 6. The content of organic matter is less than 1 percent.

The C1ca horizon ranges from 12 to 20 inches below the surface. About 5 to 30 percent of this horizon consists of soft lumps and hard concretions of calcium carbonate. Sandstone fragments occur below the C1ca horizon in some places.

Weymouth soils occur closely with the Stamford, Dalby, Spade, and Vernon soils. Weymouth soils contain less clay than the Vernon soils, which do not have a layer of accumulated lime. They are not so deep as the Stamford, Dalby, and Spade soils. Weymouth soils contain more organic matter than the Spade soils, which are underlain by sandstone.

Weymouth-Vernon clay loams, 1 to 3 percent slopes (WvB).—This complex occurs along natural drains and in small knolls or ridges on uplands. Of the total acreage, Weymouth clay loam makes up about 70 percent, and Vernon clay loam, 30 percent. The Weymouth soil occupies small points of ridges between small side drains on the highest parts of the knolls. The Vernon soil is gently sloping and is adjacent to natural drainageways.

The Weymouth soil has a reddish-brown, calcareous, clay loam surface layer about 10 inches thick. The subsoil is about 8 inches thick. Vernon clay loam has a reddish-brown, calcareous clay loam surface layer about 8 inches thick. The subsoil is calcareous clay about 10 inches thick.

These soils are used mostly as range. They have low available water capacity, and water erosion is a moderate hazard in cultivated areas. A few areas are in forage sorghum and grain sorghum. Small grains are grown chiefly for grazing.

The main concerns of management are conserving moisture, controlling erosion, and maintaining tilth. Cropping systems that leave large amounts of residue on the surface are needed. Residues help to control erosion and, if plowed under, to improve tilth. Contour farming and terraces also help to control erosion, and they conserve moisture as well. (Weymouth soil is in capability unit IIIe-7 and Deep Hardland range site; Vernon soil is in capability unit IVe-8 and Shallow Redland range site)

Zavala Series[5]

The Zavala series consists of nearly level, well-drained, loamy soils that developed from neutral alluvium on flood plains. Flooding is likely about once every 2 years.

In a typical profile, the surface layer is dark grayish-brown, neutral, crumbly fine sandy loam about 18 inches thick. The next layer is dark-brown, neutral fine sandy loam about 18 inches thick. The underlying layer is dark-brown, mildly alkaline sandy clay loam in which there are pockets and thin layers of fine sandy loam.

The Zavala soils are used mostly as range. Some of the common grasses are sideoats grama, white tridens, vine-mesquite, blue grama, tobosa, and buffalograss. Natural fertility is high and a few areas are cultivated.

Profile of Zavala fine sandy loam (0 to 1 percent slopes) 0.5 mile southeast of the northeast corner of section 24, block A, Bauer and Cockrell Survey; or along a natural drain, 0.5 mile southwest of road, from a point 7 miles west and 1 mile south of Fairview gin; in range:

A1—0 to 18 inches, dark grayish-brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak subangular blocky and granular structure; slightly hard when dry, very friable when moist; noncalcareous; neutral; few fine roots and hairs; many fine tubes and pores; few insect burrows and worm casts; gradual boundary.

AC—18 to 36 inches, dark-brown (10YR 4/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak subangular blocky structure; slightly hard when dry, friable when moist; few fine roots, few fine tubes and pores, few insects burrows and worm casts; noncalcareous; neutral; gradual boundary.

C—36 to 62 inches +, dark-brown (10YR 4/3) sandy clay loam, dark brown (10YR 3/3) when moist; weak subangular blocky structure; hard when dry, friable when moist; few small pockets and lenses of fine sandy loam; noncalcareous; mildly alkaline.

The A horizon ranges from 10 to 20 inches in thickness. When dry, this horizon ranges from very dark grayish brown to pale brown in hue of 10YR, value of 3 to 6, and chroma of 2 or 3. The content of organic matter is less than 1 percent.

The AC horizon ranges from 18 to 30 inches in thickness and from light loam to fine sandy loam in texture. When dry, this horizon ranges from dark grayish brown to pale brown in hue of 10YR or 7.5YR.

Depth to the C horizon ranges from 30 to 60 inches. Texture of the C horizon ranges from fine sandy loam to sandy clay loam.

Zavala soils occur closely with the Spur soils. They are less alkaline and more sandy than the Spur soils.

Zavala fine sandy loam (Za).—This soil is on flood plains adjoining intermittent streams. Most areas are 300 to 600 feet wide, but a few are wider than 1,200 feet. Slopes are less than 1 percent.

Included with this soil in mapping were areas of Spur clay loam. These included areas are less than 5 acres in size.

Most of this soil is used for range because stream channels cut large areas into parts that are too narrow for efficient farming. Also, this soil is flooded about once every 2 years, though flooding generally does not occur during the growing season. Cotton and grain sorghum are grown in a few areas. In most years cultivated crops and range plants grow well.

Cropping systems should include crops that leave large amounts of residue on the surface. Terracing and contour farming help to control water erosion and save moisture. (Capability unit IIIe-2; Bottomland range site)

Zita Series

Soils of the Zita series are nearly level, deep, loamy, and neutral to mildly alkaline. They formed on uplands from calcareous, loamy outwash.

In a typical profile, the surface layer is about 15 inches thick and consists of fine sandy loam and loam. In cul-

[5] In this survey the soils here described were considered to be within the range of characteristics of the Zavala series. In future surveys soils having annual soil temperatures like the temperatures of these soils will be included with another soil series.

tivated fields, it is brown in the upper part and dark grayish brown in the lower. The subsoil is pale-brown loam about 19 inches thick. It is underlain by light-gray clay loam. These soils are calcareous in the lower layers.

Most of the Zita soils are farmed to cotton and grain sorghum. Drainage is good, and natural fertility is high.

Profile of Zita fine sandy loam, 0 to 1 percent slopes, 0.05 mile north of the southeast corner of section 9, block 34, T-1-N, Texas and Pacific Railroad Survey; or 0.95 mile south of Texas Highway 176, from a point 10.5 miles west of the Big Spring Field Station in Big Spring; cropland:

Ap—0 to 8 inches, brown (10YR 5/3) fine sandy loam, dark brown (10YR 4/3) when moist; structureless; slightly hard when dry, friable when moist; noncalcareous; neutral; clear boundary.

A1—8 to 15 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak prismatic and weak subangular blocky structure; slightly hard when dry, friable when moist, few fine roots, common insect burrows and worm casts; noncalcareous; mildly alkaline; clear boundary.

B2—15 to 34 inches, pale-brown (10YR 6/3) loam, brown (10YR 5/3) when moist; weak prismatic and weak subangular blocky and granular structure; hard when dry, friable when moist; few fine roots, many insect burrows and worm casts; calcareous; mildly alkaline; gradual boundary.

Cca—34 to 60 inches +, light-gray (10YR 7/2) clay loam, light brownish gray (10YR 6/2) when moist; hard when dry, firm when moist; few concretions of calcium carbonate; calcareous.

The A horizon ranges from 8 to 25 inches in thickness and from light loam to fine sandy loam in texture. This horizon, when dry, ranges from very dark grayish brown to brown; hue is 10YR, value is 3 to 5, and chroma is 2 or 3.

The B2 horizon ranges from 10 to 25 inches in thickness and from loam or sandy clay loam to clay loam. When dry, this horizon ranges from pale brown to dark grayish brown in a hue of 10YR.

Depth to the Cca horizon ranges from 20 to 40 inches. An estimated 20 to 60 percent, by volume, is soft lumps and hard concretions of calcium carbonate.

Zita soils occur closely with the Amarillo, Portales, and Spur soils. The Zita soils have a less clayey, browner subsoil than have the Amarillo soils. The surface layer of Zita soils is less alkaline than that of the Portales soils and the layer of accumulated lime is less distinct. Zita soils are not so alkaline nor so stratified as the Spur soils.

Zita fine sandy loam, 0 to 1 percent slopes (ZfA).—This soil occurs in upland areas that range from 10 to 80 acres in size. The surface layer is brownish, calcareous fine sandy loam about 15 inches thick. The subsoil is about 20 inches thick. A layer of accumulated lime occurs about 35 inches below the surface.

Included with this soil in mapping were a few small areas of Portales fine sandy loam, 0 to 1 percent slopes. These included areas are calcareous throughout the profile.

This soil is suitable for large-scale farming of locally grown crops. Natural fertility and available water capacity are high, and crops grow well to fairly well when moisture is adequate. Grain sorghum and cotton are the main crops, but forage sorghums and small grains are grown in a few fields for soil cover and grazing. A few areas are used for range.

Cropping systems that leave large amounts of residue are beneficial. Residues left on the surface help to reduce wind and water erosion, and if plowed under, they help to increase the organic-matter content. Where water erosion is a hazard, terraces and contour farming may be needed. (Capability unit IIIe-2; Sandy Loam range site)

Use and Management of the Soils

The soils of Howard County are used for native grass range and, to a less extent, for dryfarming. This section tells how the soils may be used as range, and also how crop yields can be obtained under two levels of management. It also tells how the soils can be used in building roads, dikes and levees, and other structures. The system of capability classification adopted by the Soil Conservation Service is briefly explained. The capability classification of any soil in the county can be obtained by referring to the "Guide to Mapping Units" at the back of the survey. Suggestions for managing each of the arable soils in the county are given in the section "Descriptions of the Soils."

Management and Predicted Yields on Dryfarmed Soils

This section mentions some of the general practices of management needed in Howard County and gives predicted yields of dryfarmed soils under two levels of management. Suggestions for managing each of the arable soils in the county are given in the section "Descriptions of the Soils."

Yields of crops depend chiefly on the tilth and fertility of the soils and on a sufficient supply of moisture at the time of planting and throughout the growing season. In Howard County, lack of sufficient moisture commonly is the most limiting factor of the growth of crops.

Consistent high yields on any soil indicates that the soil has been managed well; that is, fertility has been kept at a high level, good tilth has been maintained, and rainwater has been held and stored in the soils. Consistent low yields indicate that the soil has not been managed well; water and soil have been lost, fertility is low, and tilth is poor.

In managing the dryfarmed soils in the county, more intensive practices are needed to reduce soil blowing on the sandy, calcareous soils than are needed on the noncalcareous loams. Soil blowing can be reduced by providing plant cover or by plowing so as to leave the surface rough and cloddy.

The hazard of water erosion increases as steepness and length of the slopes increase and the rate of water intake decreases. Among practices that control erosion are contour tillage and terraces, crop residue left on the surface, and protecting the soil with a plant cover after a crop is harvested.

Table 2 gives predicted yields of cotton and grain sorghum, the two main crops in the county, on arable dryfarmed soils under a low level and a high level of management. In management at a low level (yields in columns A), (1) soil-improving crops, cover crops, or crops that produce a large amount of residue are not used; (2) crop residue is destroyed or turned under quickly; (3) water is only partly conserved; (4) fertilizer is not used; and (5) tillage alone is used to control soil blowing.

In a high level of management (yields in columns B), (1) soil-improving crops, cover crops, and crops that pro-

TABLE 2.—*Predicted average yields per acre for dryfarmed cotton and grain sorghum, on arable soils under two levels of management*

[Yields in columns A are those obtained under a low level of management; yields in columns B are those to be expected under a high level of management]

Soil	Cotton (lint)		Grain sorghum	
	A	B	A	B
	Lb.	*Lb.*	*Bu.*	*Bu.*
Acuff loam, 0 to 1 percent slopes	170	205	19	24
Acuff loam, 1 to 3 percent slopes	145	175	15	22
Amarillo fine sandy loam, 0 to 1 percent slopes	170	240	17	22
Amarillo fine sandy loam, 1 to 3 percent slopes	170	240	17	22
Amarillo fine sandy loam, 3 to 5 percent slopes	150	225	13	18
Amarillo loamy fine sand, 0 to 3 percent slopes	150	200	12	17
Amarillo and Cobb fine sandy loams, 1 to 3 percent slopes	170	240	17	22
Amarillo and Cobb fine sandy loams, 3 to 5 percent slopes	150	225	13	18
Arvana fine sandy loam, 1 to 3 percent slopes	120	200	12	17
Arvana fine sandy loam, shallow, 1 to 3 percent slopes	55	65	8	10
Berthoud loam, 1 to 3 percent slopes	100	150	10	17
Berthoud loam, 3 to 5 percent slopes	75	85	7	10
Brownfield fine sand, 0 to 3 percent slopes	75	85	10	13
Brownfield fine sand, thin surface variant, 0 to 3 percent slopes	120	150	12	16
Drake soils, 3 to 5 percent slopes	50	60	7	9
Gomez loamy fine sand	80	95	9	13
Mansker loam, 0 to 1 percent slopes	105	150	12	17
Mansker loam, 1 to 3 percent slopes	105	130	12	17
Mansker loam, 3 to 5 percent slopes	75	100	11	14
Mobeetie fine sandy loam, 1 to 3 percent slopes	100	150	10	17
Mobeetie fine sandy loam, 3 to 5 percent slopes	100	115	6	9
Olton clay loam, 0 to 1 percent slopes	170	205	19	24
Olton clay loam, 1 to 3 percent slopes	145	175	15	22
Portales fine sandy loam, 0 to 1 percent slopes	140	200	15	20
Portales fine sandy loam, 1 to 3 percent slopes	140	190	15	20
Portales loam, 0 to 1 percent slopes	125	170	19	22
Portales loam, 1 to 3 percent slopes	125	170	15	22
Randall clay	160	175	13	20
Roscoe clay	130	165	17	22
Rowena clay loam, 0 to 1 percent slopes	170	205	19	24
Rowena clay loam, 1 to 3 percent slopes	145	175	15	22
Springer fine sandy loam, 0 to 1 percent slopes	170	225	17	22
Springer fine sandy loam, 1 to 3 percent slopes	170	200	17	22
Springer loamy fine sand, undulating	100	130	8	11
Spur clay loam	200	300	18	23
Stamford and Dalby clays, 0 to 1 percent slopes:				
Stamford soil	120	145	15	19
Dalby soil	110	140	13	15
Stamford and Dalby clays, 1 to 3 percent slopes:				
Stamford soil	85	105	12	15
Dalby soil	85	105	12	15
Veal fine sandy loam, 1 to 3 percent slopes	105	130	15	19
Weymouth-Vernon clay loams, 1 to 3 percent slopes	100	150	12	17
Zavala fine sandy loam	200	275	18	23
Zita fine sandy loam, 0 to 1 percent slopes	200	250	17	22

duce a large amount of residue are used; (2) crop residue is kept on the surface to help control soil blowing; (3) water is conserved by using all necessary practices; including terraces and contour farming; and (4) fertilizer is applied according to requirement of the crop and as indicated by soil tests.

Because only a small acreage is used for irrigated crops in Howard County, management and predicted yields of crops on irrigated soils are not given. If needed, information on irrigation can be obtained from the local representative of the Soil Conservation Service.

Capability Classification

In the "Guide to Mapping Units" at the back of this survey, the soils of Howard County have been classified according to their suitability for most kinds of farming. This classification is based on limitations of the soils, the risk of damage when they are used, and the way they respond to treatment. The classification does not apply to most horticultural crops, or to rice and other crops having special requirements. The soils are classified according to degree and kinds of permanent limitation, but without consideration of major and generally expensive landforming that would change the slope, depth, or other characteristics of the soils; and without consideration of possible major reclamation.

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

CAPABILITY CLASSES, the broadest grouping, 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. (None in Howard County.)

Class II soils have some limitations that reduce the choice of plants or require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV soils have very severe limitations that restrict the choice of plants, require very careful management, or both.

Class V soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover. (None in Howard County.)

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

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Howard County.)

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

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only subclasses indicated by *w*, *s*, and *c*, because the soils in it are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIce-1, or IIIce-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation, and the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph. The Arabic numeral specifically identifies the capability unit within each subclass.

Range Management [6]

Discussed in this section are the use of native grassland in Howard County, range sites and condition classes, and the kinds of plants in the climax vegetation on each range site. Also given are potential yields of herbage on each range site.

Raising livestock, mainly cows and calves, is one of the main agricultural enterprises in Howard County. Some sheep are also raised, and generally there are considerable numbers of winter stockers, or carry-over calves. Most of the livestock is grazed on range, but some cropland, chiefly that in small grains and sorghums, is used for supplemental grazing.

About 60 percent of the county is range. Of this rangeland, about 50 percent consists of nearly level to moderately sloping, deep and shallow soils on undulating uplands; 40 percent, nearly level to steep, very shallow and shallow, stony soils on hills; and 10 percent, nearly level, deep and moderately deep soils in the valleys and on bottom land.

Mid and short grasses cover most of the rangeland in the county. On the sandy loams and loams the main original grasses are sideoats grama, Arizona cottontop, blue grama, and buffalograss. Growing on the clayey soils are vine-mesquite, sideoats grama, Arizona cottontop, tobosa, and buffalograss in a good stand. On the shallow soils is a fair stand of sideoats grama, black grama, slim tridens, and perennial three-awns. Because of overstocking, drought, or both, mesquite, annuals, and other undesirable plants have invaded in many areas.

The climate of the county markedly influences the production of forage. Most of the rainfall occurs from April through September, but it is erratically distributed. Droughts, which are common in midsummer, retard plant growth and prevent the spread of range vegetation. They may last 30 to 90 days, and they are intensified by hot, high winds that increase evaporation.

The native grasses grow best from the middle of April through October, but almost every year they are partly dormant in July and early in August. If enough moisture is available, the grasses start growing again about the middle of August. They continue to grow through October when cool weather makes them semidormant. At the end of winter and early in spring, growth is frequently retarded by lack of moisture.

Range sites and condition classes

Different kinds of rangeland produce different kinds and amounts of grass. In order to manage rangeland properly, a rancher should know the different kinds of soil on his ranch and the plants that will grow on each range site.

A range site is a kind of rangeland that differs significantly from other rangeland in its capacity to produce about the same kinds and amounts of climax, or original vegetation. The difference between two range sites must be enough to require different use and management to maintain or improve the grasses. Throughout most of the prairie and the plains, the climax vegetation consists of the combination of plants that were growing there when the region was first settled. Generally, it is the most productive combination of forage plants that will grow on the site.

On the range sites, native plants are referred to as decreasers, increasers, and invaders. *Decreasers* are plants in the climax vegetation that normally decrease under continuous, heavy grazing. They generally are the most productive perennial grasses and forbs and the most palatable to livestock. *Increasers* are plants in the climax vegetation that normally increase as the decreasers decline. They normally are smaller, less productive, and generally are less palatable to livestock than decreasers. *Invaders* are plants that normally are insignificant or lacking in the climax vegetation, but that will invade if increasers are heavily grazed continuously. They are annual weeds and shrubs that have little or no value for grazing.

A rancher can estimate the condition of his range if he knows the composition of the climax vegetation. If soils are placed in range sites, the grasses that make up the climax vegetation in each site can be named. Then the condition of the range can be determined by comparing the existing vegetation with the climax vegetation. Rangeland is in *excellent* condition if 76 to 100 percent of the present vegetation is of the same kind as in the original stand. It is in *good* condition if the percentage is between 51 to 75; in *fair* condition if the percentage is between 26 to 50; and in *poor* condition if the percentage is less than 25.

The key to keeping range in excellent or good condition is recognizing important changes in the kind of cover on a range site. Changes take place gradually and can be overlooked or misinterpreted. Growth encouraged by heavy rainfall may indicate that the range is in good condition when actually the cover is weedy and production

[6] By ALTON T. WILHITE, range conservationist, Soil Conservation Service.

of palatable grasses is decreasing. On the other hand, some rangeland that has been closely grazed for relatively short periods may have a degraded appearance that conceals its quality and its capacity to recover.

Descriptions of range sites

In the following pages, groups of soils, or range sites, are described and the climax plants and principal invaders on the sites are named. Also given is an estimate of the potential annual yield of air-dry herbage for each site when it is in excellent condition. The soils in each site can be determined by referring to the "Guide to Mapping Units" at the back of this soil survey. Saline alluvial land and Randall clay occupy such a small acreage that they were not placed in range sites.

LOW STONY HILL RANGE SITE

Only Ector-Rock outcrop complex is in this range site. The soils in this complex occur on hills, are rolling to steep, and are very shallow to limestone. Limestone crops out in many places. Available water capacity is limited, but the moisture absorbed by the soils is highly beneficial to plants. Water erosion is severe where cover is lacking.

About 70 percent of the climax vegetation consists of decreasers, mainly little bluestem, cane bluestem, sideoats grama, green sprangletop, and plains bristlegrass. The main increasers are hairy grama, black grama, slim tridens, and perennial three-awns. Cedars and annuals commonly invade.

In most places the condition of this site has declined to fair (fig. 9) and will decline further unless woody plants are controlled and excessive grazing is prevented. Under good management, however, this site recovers rapidly.

On this site the estimated yield of air-dry herbage ranges from 800 pounds per acre in unfavorable years to 1,400 pounds per acre in favorable years.

SHALLOW DIVIDE RANGE SITE

Only the Ector soils are in this range site. These shallow and very shallow soils are on mesas or the foot slopes of limestone hills. Although they hold limited amounts of moisture, these soils make efficient use of it and rainfall is very effective. Where cover is lacking, thick crusts form on the surface, and the hazard of water erosion is severe.

On this site the climax vegetation consists of about 60 percent decreasers, mainly sideoats grama, cane and silver bluestems, blue grama, and vine-mesquite. The main increasers are slim tridens, black grama, tobosa, perennial three-awns, and buffalograss. Common invaders are mesquite, javelinabrush, cedars, and annuals.

In most places the condition of this site has declined to fair and will decline further unless excessive grazing is prevented and the woody plants are controlled. Under good management, however, this site recovers rapidly.

On this site the estimated yield of air-dry herbage ranges from 1,000 pounds per acre in unfavorable years to 2,400 pounds in favorable years.

***Figure 9.*—Low Stony Hill range site. The mapping unit is Ector-Rock outcrop complex.**

VALLEY RANGE SITE

This site consists of fine-textured and moderately fine textured soils that are nearly level to gently sloping. These soils are deep and moderately to slowly permeable. They are in broad valleys at the foot of limestone hills. In unprotected areas, thick crusts form on these soils, and water erosion is a serious hazard. Stands of short and mid grasses are good, however, where the soils are well managed.

On this site the climax vegetation is mostly warm-season bunch grasses that occur with browse plants and forbs. The climax vegetation consists of approximately 60 percent decreasers. The major decreasers are cane and silver bluestems, sideoats grama, blue grama, plains bristlegrass, and Arizona cottontop. The main increasers are tobosa, buffalograss, and perennial three-awns. Common invaders are mesquite, tarbush, and annuals.

In most areas the condition of this site has declined to fair (fig. 10), and it will decline further unless woody plants are controlled and excessive grazing is prevented. Under good management, however, this site recovers rapidly.

On this site the estimated yield of air-dry herbage ranges from 1,600 pounds per acre in unfavorable years to 2,600 pounds in favorable ones.

BOTTOMLAND RANGE SITE

This range site consists of nearly level, deep, loamy soils in narrow draws. Range plants grow well because these soils are naturally fertile, and even when rainfall is light, they receive runoff from adjacent sites. In dry periods the forage may be green on this site when it is not on any of the other range sites in the county.

About 60 to 70 percent of the climax vegetation consists of decreasers, mainly sideoats grama, cane bluestem, white tridens, vine-mesquite, and plains bristlegrass. The increasers are mostly blue grama, tobosa, and buffalograss. Common invaders are mesquite and annuals.

In most places the condition of this site has declined to fair, and it will decline further unless woody plants are controlled and excessive grazing is prevented. Under good management, however, this site recovers rapidly (fig. 11).

On this site the estimated yield of air-dry herbage ranges from 1,900 pounds per acre in unfavorable years to 3,100 pounds per acre in favorable years.

Figure 10.—**Valley range site on which the major grass is sideoats grama. The soil is Uvalde silty clay loam.**

DEEP HARDLAND RANGE SITE

This site consists of deep, medium-textured to fine-textured soils that are nearly level to gently sloping. These soils are on wide plains interspersed with large and small playas. Drainage is generally into playas. Permeability is moderate to slow. Thick crusts form on the surface if these soils are not protected. In areas where crusts form, water erosion is a severe hazard. Stands in mid and short grasses are good if these soils are properly managed.

The climax vegetation on this site is about 60 percent decreasers, mainly sideoats grama, cane and silver bluestems, blue grama, Arizona cottontop, vine-mesquite, and plains bristlegrass. The main increasers are tobosa, buffalograss, sand dropseed, and perennial three-awns. Annuals and mesquite are the most common invaders.

In most areas the condition of this site has declined to fair. Further deterioration is likely unless brush is controlled and excessive grazing is prevented. Even if management is good, this site recovers slowly (fig. 12).

On this site the estimated yield of air-dry herbage ranges from 1,300 pounds per acre in unfavorable years to 2,100 pounds per acre in favorable years.

DEEP SAND RANGE SITE

This range site consists of deep, coarse-textured soils that are moderately to rapidly permeable. These soils are mostly in the west-central part of the county. They form large sand dunes and are in the level to gently sloping areas between the dunes. In many places the dunes are as much as 20 feet high and have choppy slopes of about 40 percent.

These soils have low capacity for holding water and plant nutrients. Soil blowing is likely where the soils are not protected. Stands of mid and tall grasses are good, however, if the soils are properly managed.

About 60 percent of the climax vegetation consists of decreasers, mainly little bluestem, sand bluestem, and giant dropseed. The main increasers are sand dropseed, perennial three-awns, and Havard oak. Common invaders are false buffalograss and annuals.

In most areas the condition of this site has declined to poor (fig. 13). The site will remain in poor condition unless brush is controlled and excessive grazing is prevented. Under good management, however, this site recovers very rapidly.

Figure 11.—**Bottomland range site on which the major grasses are plains bristlegrass and sideoats grama. The soil is Spur clay loam.**

On this site the estimated yield of air-dry herbage ranges from 1,200 pounds per acre in unfavorable years to 3,200 pounds per acre in favorable years.

GYP RANGE SITE

This range site is made up of very shallow and shallow soils and outcrops of gypsum. It is on flats or low rolling hills or ridges. The soils in this site hold only small amounts of moisture or plant nutrients. The outcrops of gypsum are numerous. They are in areas as large as 15 acres. Edible range plants grow on the very shallow and shallow soils, but none of the vegetation on the areas of gypsum is for livestock. Soil blowing and water erosion are severe in barren areas.

On this site the kinds of forage plants vary, depending on soil depth. Where the soil material is 3 to 5 inches deep, about 75 percent of the climax grasses consists of decreasers, mainly black grama, blue grama, chino grama, alkali sacaton, and fourwing saltbush. The increasers include sand dropseed, buffalograss, and perennial threeawns. Common invaders on this site are burrograss, rough coldenia, and annuals.

In most areas the condition of this site has declined to poor (fig. 14). Deterioration is rapid where grazing is excessive, and even if range management is good, recovery is slow.

On this site estimated yield of air-dry herbage ranges from 500 pounds per acre in unfavorable years to 1,100 in favorable years.

HIGH LIME RANGE SITE

The site consists of highly calcareous soils on eolian convex dunes and lower lying sloping areas between the dunes. The dunes generally lie on the eastern and northeastern sides of ancient salt lakes.

About 60 percent of the climax vegetation consists of decreasers, mainly sideoats grama, blue grama, vine-mesquite, and plains bristlegrass. Common invaders are annuals and broom snakeweed. Next to the lakes only salt-tolerant plants grow, but away from the lakes the plants are less tolerant of salt.

In most areas the condition of this site has declined to poor (fig. 15). The site will remain in poor condition un-

Figure 12.—**Deep Hardland range site on which the major grasses are tobosa and buffalograss. The soil is Olton clay loam.**

less management is good and grazing is controlled. Under good management this range site recovers slowly.

On this site the estimated yield of air-dry herbage ranges from 1,100 pounds per acre in unfavorable years to 1,800 pounds per acre in favorable years.

SANDY LOAM RANGE SITE

This site occurs throughout the county as nearly level to gently sloping fine sandy loams on gently rolling uplands. These soils have moderate permeability and moderate capacity for holding water.

About 70 percent of the climax vegetation is decreasers, mainly sideoats grama, blue grama, cane and silver bluestems, and Arizona cottontop. The main increasers are black grama, hooded windmillgrass, buffalograss, and perennial three-awns. Common invaders are mesquite and annuals.

In most areas the condition of this site has declined to fair (fig. 16). Further deterioration is likely unless brush is controlled and grazing is limited, but response to grass

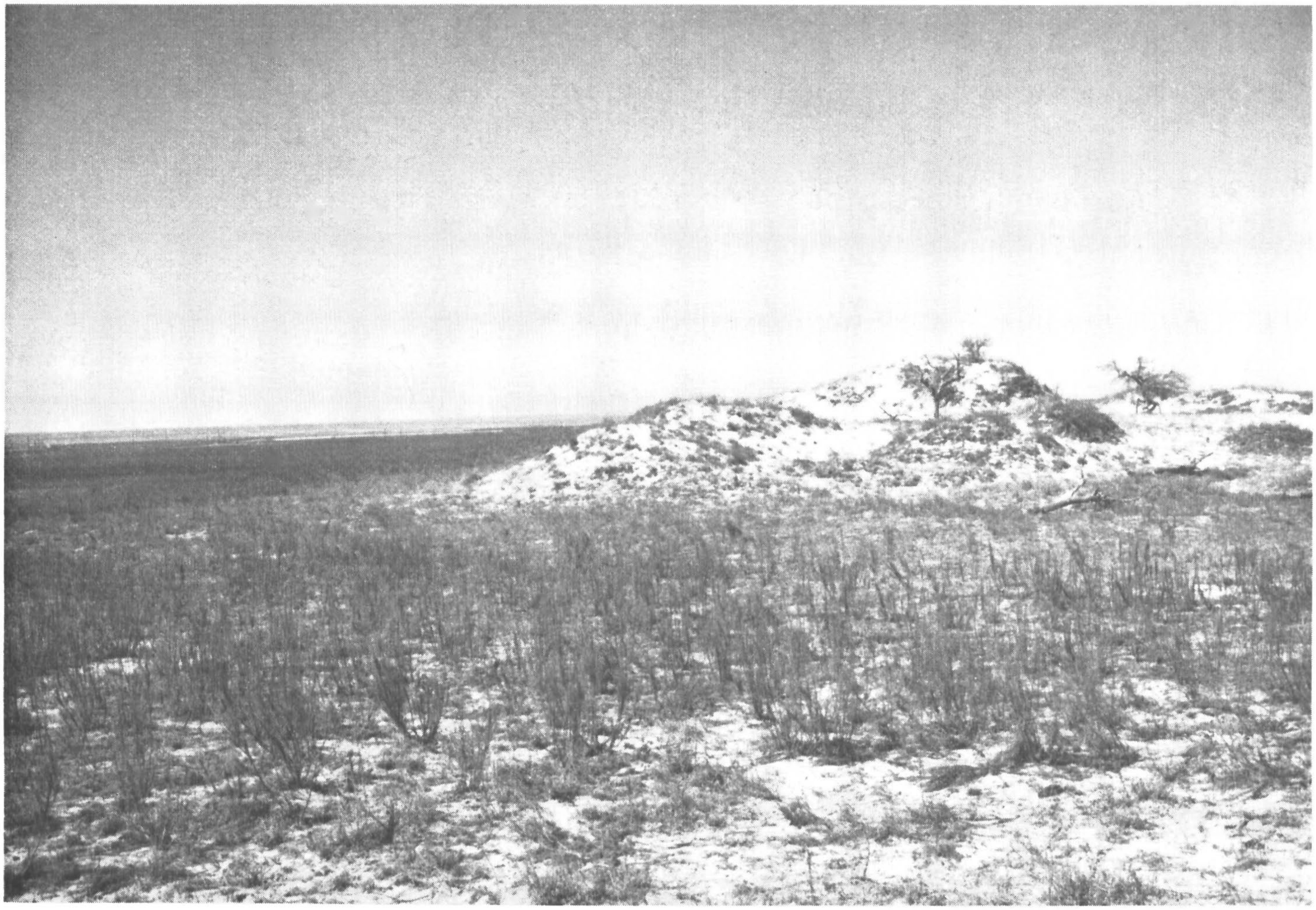

***Figure 13.*—Deep Sand range site. The soil is Brownfield fine sand.**

seeding is good, and the recovery under good management is rapid.

On this site the estimated yield of air-dry herbage ranges from 1,400 pounds per acre in unfavorable years to 2,250 pounds per acre in favorable years.

MIXED PLAINS RANGE SITE

This range site consists of broad areas of nearly level to level, moderately coarse textured or medium-textured soils on the plains throughout the county. These soils are deep, calcareous, and moderately to moderately rapidly permeable. Capacity for holding water is moderate. Drainage patterns are immature, and drainage is mostly into ancient lakes.

Approximately 60 percent of the climax vegetation is decreasers, mainly sideoats grama, cane bluestem, blue grama, and vine-mesquite. The main decreasers are black grama, sand dropseed, tobosa, buffalograss, and perennial three-awns. Common invaders are sand muhly, ring muhly, broom snakeweed, and annuals.

In most areas the condition of this range site has declined to poor (fig. 17), and it is not likely to improve unless woody plants are controlled and excessive grazing is prevented. Deterioration is rapid, but so is recovery under proper management. Response to the seeding of grass is good.

On this site the estimated yield of air-dry herbage ranges from 1,400 pounds per acre in unfavorable years to 2,200 pounds per acre in favorable years.

SANDYLAND RANGE SITE

This site consists of broad areas of nearly level to gently sloping, deep, coarse-textured soils that are moderately to rapidly permeable to water. Root penetration is deep, but these soils have little ability to hold water and plant nutrients. Stands of grasses are good, however, if these soils are properly managed.

On this site the climax vegetation is about 65 percent decreasers, mainly little bluestem, giant dropseed, cane and silver bluestems, and plains bristlegrass. The main increasers are hooded windmillgrass, fall witchgrass, sand dropseed, perennial three-awns, and shin oak. Annuals commonly invade.

The condition of this site has declined to fair in most places (fig. 18), and it is likely to decline further unless excessive grazing is prevented and woody plants are controlled. Under good management, however, this site recovers rapidly.

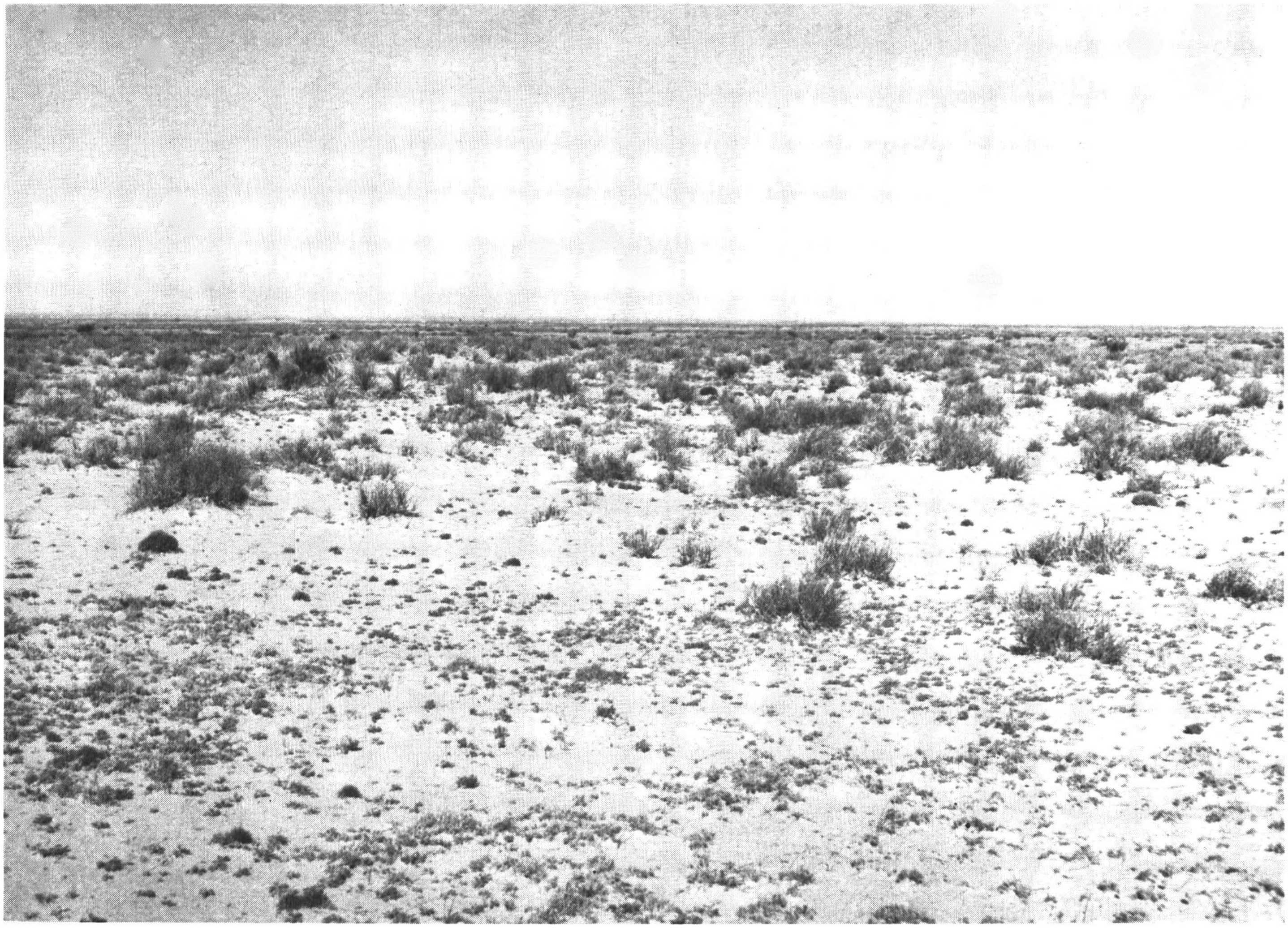

Figure 14.—**Gyp range site on which the major grass is burrograss. The land type is Gypsum outcrop.**

On this site the estimated yield of air-dry herbage ranges from 1,100 pounds per acre in unfavorable years to 2,400 pounds per acre in favorable years.

SANDY PLAINS RANGE SITE

Gomez loamy fine sand is the only soil in this site. This gently sloping soil occurs on broad undulating plains, mostly in the west-central part of the county. Capacity for holding moisture and plant nutrients is low, but this soil is deep and has moderately rapid permeability. Soil blowing is likely in areas not protected by plants. If properly managed, this soil produces good stands of mid grasses.

About 65 percent of the climax vegetation is decreasers, mainly sideoats grama, cane and silver bluestems, plains bristlegrass, Arizona cottontop, and blue grama. The main increasers are black grama, hooded windmillgrass, sand dropseed, and perennial three-awns. Common invaders are mesquite, yucca, catclaw, and annuals.

In most areas the condition of this site has declined to fair and is likely to continue to decline unless woody plants are controlled and excessive grazing is prevented. This site recovers rapidly under good management.

On this site the estimated yield of air-dry herbage ranges from 1,600 pounds per acre in unfavorable years to 2,400 pounds per acre in favorable years.

CLAY FLAT RANGE SITE

This site consists of broad areas of nearly level soils on flats, in valleys, and on alluvial fans. Surfaces are concave in most places. Slopes are less than 1 percent.

These soils are deep, but they take in water very slowly. Although extra water runs in from adjoining areas, range plants cannot make good use of it. The vegetation is of poor quality and consists mostly of grasses that need only small amounts of moisture.

On this site about 25 to 35 percent of the climax vegetation consists of decreasers, mainly sideoats grama, blue grama, white tridens, and vine-mesquite. The increasers are mostly tobosa and buffalograss. Common invaders are mesquite, pricklypear, and annuals.

In most areas the condition of this site has declined to fair (fig. 19), and it is likely to decline further unless woody plants are controlled and excessive grazing is prevented. This site recovers slowly under good management.

On this site the estimated yield of air-dry herbage ranges from 800 pounds per acre in unfavorable years to 2,000 pounds per acre in favorable years.

HARDLAND SLOPES RANGE SITE

This site consists of shallow, nearly level to gently sloping loams. These soils are in smooth areas below the Rough Breaks range site and are on isolated low ridges above the Deep Hardland range site. Slopes range from 0.5 to 3 percent.

Range plants make fair use of the moisture in these soils, but only a limited amount of moisture is available. Runoff is rapid, and water erosion is likely in sloping areas not protected by a grass cover.

On this site the climax vegetation is approximately 60 to 70 percent decreasers, mainly cane and silver bluestems, sideoats grama, little bluestem, plains bristlegrass, and Arizona cottontop. Black grama, sand dropseed, and buffalograss are the main increasers.

In most areas the condition of this site has declined to poor, and is likely to decline further unless woody plants are controlled and excessive grazing is prevented. If management is good, this site recovers slowly.

On this site the estimated yield of air-dry herbage ranges from 1,500 pounds per acre in unfavorable years to 2,400 pounds per acre in favorable years.

ROUGH BREAKS RANGE SITE

Only Rough stony land is in this range site. This land consists of steep escarpments and the severely eroded areas below them.

The plant cover is highly variable because of differences in soil material, slope, and geologic erosion. Many areas are almost inaccessible to livestock. Although the capacity for storing moisture and producing grass is limited, the moisture stored is effective and the percentage of decreasers in the climax vegetation is high.

On this site the climax vegetation is 70 to 80 percent decreasers, mainly little bluestem, sideoats grama, cane and silver bluestems, and vine-mesquite on the lower slopes. The main increasers are black grama, hairy grama, slim tridens, perennial three-awns, and tobosa on the lower slopes. Common invaders are cedar trees and annuals.

In most areas the condition of this site is good (fig. 20). Deterioration is slow where grazing is excessive, and recovery is rapid where management is good.

The estimated yield of air-dry herbage on this site

***Figure 15.*—Drake soils in the High Lime range site.**

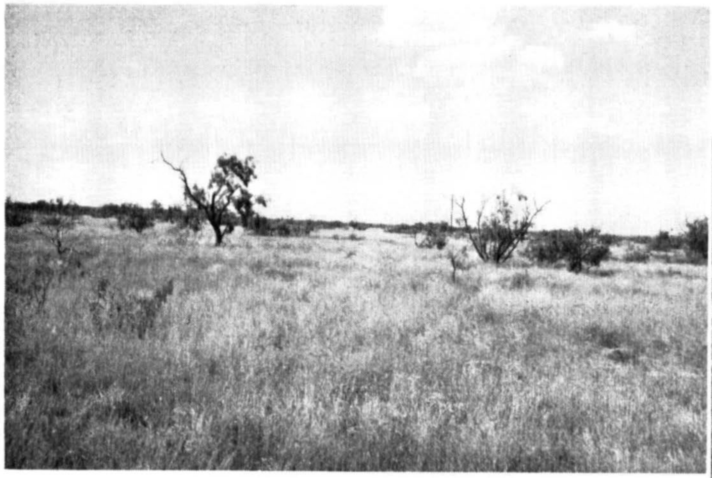

Figure 16.—Sandy Loam range site. The soil is Amarillo fine sandy loam.

Figure 17.—Mixed Plains range site. The soil is Portales loam.

Figure 18.—Sandyland range site. The soil is Amarillo loamy fine sand.

***Figure 19.*—Clay Flat range site on which the major grass is tobosa. The soils are Stamford and Dalby clays.**

ranges from 500 pounds per acre in unfavorable years to 900 pounds per acre in favorable years.

MIXEDLAND SLOPES RANGE SITE

This site consists of moderately coarse textured, nearly level to gently sloping soils on gently rolling uplands. These soils have moderate permeability and moderate water-holding capacity.

On this site the climax vegetation is about 60 to 65 percent decreasers, mainly sideoats grama, blue grama, cane and silver bluestems, Arizona cottontop, and plains bristlegrass. The main increasers are black grama, hooded windmillgrass, buffalograss, and perennial three-awns. Common invaders are mesquite, catclaw, yucca, and annuals.

In most areas the condition of this range site has declined to fair, and it is likely to decline further unless woody plants are controlled and excessive grazing is prevented. Plants of high quality grow where range condition is good. If the range deteriorates, however, recovery is slow because viable seeds of the better plants are lacking and, in some places, the surface is crusted.

On this site the estimated yield of air-dry herbage ranges from 1,800 pounds per acre in unfavorable years to 2,550 pounds per acre in favorable years.

SHALLOW REDLAND RANGE SITE

This site consists of moderately fine textured soils that are moderately permeable to very slowly permeable. Stones and gravel are common on the surface and throughout the soils. The site is on rolling hills and ridges. It is closely associated with the Rough Breaks and the Clay Flat range sites.

In many areas the soils on this site are eroded to such an extent that they support only rugged perennial and woody plants. A good plant cover is needed so as to reduce erosion and evaporation.

About 35 to 45 percent of the climax vegetation is decreasers, mainly sideoats grama, blue grama, vine-mesquite, and cane and silver bluestems. The main increasers are tobosa, alkali sacaton, buffalograss, and perennial three-awns. Mesquite and annuals are common invaders.

In most areas the condition of this site has declined to fair, and it is likely to decline further unless woody plants are controlled and excessive grazing is prevented. This site recovers very slowly under good management.

The estimated yield of air-dry herbage on this site ranges from approximately 900 pounds per acre in unfavorable years to 1,600 pounds per acre in favorable years.

Figure 20.—**A typical area in Rough Breaks range site. The mapping unit is Rough stony land.**

VERY SHALLOW RANGE SITE

This site consists of sloping, medium-textured and moderately coarse textured soils on smooth, convex hills of the Rolling Plains. These hills are remnants of outwash material from the High Plains. Many stones and pebbles are on the surface and within the soils of this range site.

These soils have little capacity for holding water, though they make effective use of most rain that falls. On many of the steep slopes, water erosion is severe where there is no plant cover.

About 65 to 75 percent of the climax vegetation consists of decreasers, mainly little bluestem, sideoats grama, plains bristlegrass, and cane and silver bluestems. The increasers are mainly slim tridens, hairy grama, fall witchgrass, and perennial three-awns. Common invaders are javelinabrush, broom snakeweed, and annuals.

In most areas the condition of this site has declined to fair (fig. 21). Further deterioration is likely unless woody plants are controlled and excessive grazing is prevented. Under good management, however, this site recovers rapidly.

On this site the estimated yield of air-dry herbage ranges from 400 pounds per acre in unfavorable years to 850 pounds per acre in favorable years.

Engineering Applications of Soils [7]

In engineering, soils are used primarily as building material or to support structures of various kinds. Engineers use soils in the construction of roads, airports, pipelines, building foundations, facilities for water storage, erosion control structures, drainage systems, and sewage disposal systems. They are therefore interested in the properties of a soil that determine its suitability or limitation if used for specified construction. The properties of soils most important in engineering are permeability, shear strength, compaction and shrink-swell characteristics, water-holding capacity, grain size, plasticity, and soil reaction.

The information in this survey can be used by engineers to—

1. Make soil and land use studies that will aid in selecting and developing industrial, business, residential, and recreation sites.
2. Make preliminary estimates of the engineering properties of soils in the planning of agricultural

[7] By LEE H. WILLIAMSON, engineer, Soil Conservation Service, Big Spring, Tex.

drainage systems, farm ponds, irrigation systems, and diversion terraces.
3. Make preliminary evaluations of soil and ground conditions that will aid in selecting highway, airport, pipeline, and cable locations and in planning detailed investigations at the selected locations.
4. Locate probable sources of gravel and other construction materials.
5. Correlate the performance of engineering structures with soil mapping units, and thus develop information for planning that will be useful in designing and maintaining the structures.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement the information obtained from other published maps and reports and from aerial photographs for the purpose of making maps and reports that can be used readily by engineers.
8. Develop other preliminary estimates of areas or sites that may require special construction methods or special design to insure a satisfactory structure.

With the use of the soil map for identification, the engineering interpretations in this subsection can be useful for many purposes. It should be emphasized that they may not eliminate the need for sampling and testing at the site of specific engineering works involving heavy loads and where the excavations are deeper than the depths of layers here reported. Even in these situations, the soil map is useful for planning more detailed field investigations and for suggesting the kinds of problems that may be expected.

Some of the terms used by the soil scientists may not be familiar to the engineer, and some terms may have a special meaning in soil science. Several of these terms are defined in the Glossary at the back of this survey.

Additional information useful to engineers can be found in other sections of this soil survey, particularly "Descriptions of the Soils" and "Formation and Classification of Soils."

Engineering classification systems

Agricultural scientists of the U.S. Department of Agriculture (USDA) classify soils according to texture, color, and structure. This system is useful only as the initial step in making engineering classifications of soils, for addi-

Figure 21.—**Typical area of the Very Shallow range site in fair condition. The soil is Latom fine sandy loam.**

tional properties important to engineering must be determined by tests or estimated. The two systems commonly used by engineers are the one adapted by the American Association of State Highway Officials (AASHO) and the Unified system. The brief explanations of these soils in the following paragraphs are taken largely from the PCA Soil Primer (*5*).[8]

AASHO classification system.—The AASHO system is based on actual performance of material used as a base for roads and highways (*1*). In this system all the soils are classified in seven groups. The soils most suitable for road subgrade are classed A–1, and the soils least suitable are classed A–7. Within rather broad limits, soils are classified numerically between these two extremes, according to their load-carrying ability. Three of the seven basic groups may also be divided into subgroups to designate within-group variations.

In the AASHO system the soil materials may be further divided into the following two major groups: (1) Granular materials in which 35 percent or less of the material passes a No. 200 sieve and (2) silt-clay materials in which more than 35 percent of the materials has a plasticity index of 10 or less, and the clayey material has a plasticity index greater than 10. The plasticity index refers to the numerical difference between the liquid limit and the plastic limit. The liquid limit is the moisture content, expressed as a percent of the ovendry weight of the soil, at which the soil material passes from a plastic to a liquid state. The plastic limit is the moisture content, expressed as a percent of the ovendry weight of the soil, at which the soil material passes from a semisolid to a plastic state.

Unified soil classification system.—In the Unified system the soils are grouped on the basis of their texture and plasticity as well as on their performance when used as material for engineering structures (*10*). The soil materials are identified as coarse grained, which are gravels (G) and sands (S); fine grained, which are silts (M) and clays (C); and organic and highly organic (Pt). There are no highly organic soils in Howard County.

[8] Italic numbers in parentheses refer to Literature Cited, p. 67.

TABLE 3.—*Engineering*

Soil name	Depth from surface	Classification		
		USDA texture	Unified [1]	AASHO [2]
	Inches			
Acuff (AcA, AcB)	0–8	Loam	SC or CL	A–6 or A–4
	8–40	Sandy clay loam	SC or CL	A–6
	40–60	Sandy clay loam	CL or SC	A–6
Amarillo:				
Fine sandy loam (AfA, AfB, AfC, AsB, AsC)	0–13	Fine sandy loam	SM or SC	A–4, A–2
(For properties of the Cobb soil in mapping units AsB and AsC, refer to the Cobb series)	13–46	Sandy clay loam	SC or CL	A–6
	46–64	Clay loam	CL or SC	A–6
Loamy fine sand (AmB)	0–10	Loamy fine sand	SM	A–2
	10–38	Sandy clay loam	SC	A–6, A–2
	38–48	Fine sandy loam	SM	A–2
Arvana (AvB, AwB) [4]	0–8	Fine sandy loam	SM or SC	A–2, A–4
	8–32	Sandy clay loam	SC or CL	A–6
	32–36	Indurated caliche.		
Berthoud (BeB, BeC)	0–64	Loam	CL or SC	A–6
Brownfield:				
Fine sand (BfB)	0–30	Fine sand	SP–SM or SM	A–2
	30–72	Sandy clay loam	SC	A–6, A–2
	72–82	Fine sandy loam	SM or SC	A–2
Fine sand, thin surface variant (BvB)	0–14	Fine sand	SP–SM or SM	A–2
	14–56	Sandy clay loam	SC	A–2, A–4 or A–6
	56–82	Fine sandy loam	SM, ML or ML–CL	A–2, A–4 or A–6.
Cobb	0–10	Fine sandy loam	SM or ML	A–4
	10–38	Sandy clay loam	SC or CL	A–4 or A–6
	38–60	Weakly cemented sandstone.		
Dalby	0–58	Clay	CH	A–7
Drake (DrC, DrD)	0–60	Loam	CL	A–6
Ector (Ec, Er)	0–7	Loam	SC	A–6, A–2
	7–12	Limestone.		

See footnotes at end of table.

Engineers define a fine-grained soil as one in which more than half of the material will pass through a No. 200 sieve, which has openings 0.074 millimeter in size.

Under the Unified system, clean sands are identified by the symbols SW or SP; sands with fines of silt and clay are identified by the symbols SM or SC; silts and clays that have a low liquid limit are identified by the symbols ML and CL; and silts and clays that have a high liquid limit are identified by the symbols MH and CH.

After an engineer has been trained and has obtained experience, he can make approximate classification of soils, based on visual field inspection and observation. Exact classification, however, must be based on review and application of complete laboratory analysis data. Field classifications are useful in determining when and upon which soils laboratory analyses should be made.

Soil engineering interpretations

Table 3 gives estimates of some soil properties significant in engineering, and of the classification of the soil material in the principal horizons. For each soil layer significant in engineering, table 3 lists the USDA textural classification (*7*) and the Unified and AASHO engineering classifications.

The data in table 3 are based on tests by the Texas State Highway Department and Bureau of Public Roads, on samples taken from soils that have similar classifications to those of soils in Howard County, and on field experience with the same kind of soils. Table 3 excludes the miscellaneous land types in Howard County. No engineering test data were available for the soils in the county.

Because the properties estimated in table 3 are for a typical profile, some variation from the values given should be excepted. A profile representative of each series in the county is fully described in the section "Descriptions of the Soils."

The columns headed "Percentage passing sieve" list percentages of material small enough to pass the openings of No. 4, No. 10, and No. 200 sieves.

properties of soils

Percentage passing sieve [3]—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per inch of soil	*pH*	
100	80–90	40–60	0. 8–2. 5	0. 15	6. 6–7. 5	Low to moderate.
100	80–90	45–60	0. 8–2. 5	. 15	6. 6–8. 3	Low to moderate.
100	80–90	45–65	0. 8–2. 5	. 11	7. 8–8. 3	Low to moderate.
100	70–90	30–50	2. 5–5. 0	. 13	6. 6–7. 5	Low.
100	70–90	45–60	0. 8–2. 5	. 15	6. 6–8. 3	Low to moderate.
100	70–90	45–65	0. 8–2. 5	. 11	7. 8–8. 3	Low to moderate.
100	60–80	15–25	2. 5–5. 0	. 10	6. 6–7. 3	Low.
100	70–90	30–40	0. 8–2. 5	. 15	6. 6–7. 8	Low to moderate.
100	60–80	20–35	2. 5–5. 0	. 13	7. 5–8. 3	Low.
100	70–90	30–50	2. 5–5. 0	. 13	6. 6–7. 5	Low.
100	70–90	40–65	0. 8–2. 5	. 15	7. 0–8. 0	Low to moderate.
100	70–90	40–55	0. 8–2. 5	. 16	7. 8–8. 3	Moderate.
100	70–90	10–20	5–10	. 05	6. 6–7. 3	Low.
100	70–90	30–45	0. 8–2. 5	. 15	6. 6–7. 8	Moderate.
100	70–90	15–30	2. 5–5. 0	. 10	6. 6–8. 3	Low.
100	70–90	10–20	5–10	. 05	6. 6–7. 3	Low.
100	70–90	30–45	0. 8–2. 5	. 15	6. 6–7. 8	Moderate.
100	70–90	30–55	0. 8–2. 5	. 10	6. 6–8. 3	Low to moderate.
100	70–90	40–55	2. 5–5. 0	. 13	6. 6–7. 3	Low.
90–100	70–90	40–65	0. 8–2. 5	. 15	6. 6–8. 0	Low to moderate.
100	90–100	75–95	0–0. 05	. 08	7. 8–8. 3	Very high.
100	90–100	60–75	0. 8–2. 5	. 15	7. 8–8. 3	Low to moderate.
50–70	35–50	25–45	0. 8–2. 5	. 15	7. 8–8. 3	Low.

TABLE 3.—*Engineering properties*

Soil name	Depth from surface	Classification		
		USDA texture	Unified [1]	AASHO [2]
	Inches			
Gomez (Go)	0–16	Loamy fine sand	SM	A–2
	16–70	Fine sandy loam	SM or ML	A–4
Latom (LaD)	0–8	Fine sandy loam	SM or ML	A–4
	8–20	Sandstone.		
Mansker (MkA, MkB, MkC)	0–16	Loam	CL	A–6
	16–48	Clay loam	CL	A–6
Mobeetie (MoB, MoC)	0–56	Fine sandy loam	SM, SC, or CL	A–4
Olton (OcA, OcB)	0–10	Clay loam	CL	A–6
	10–30	Clay loam	CL	A–6
	30–40	Clay loam	CL	A–6
	40–72	Loam	CL	A–6
Ozona (OzB)	0–8	Clay loam	CL or CH	A–6 or A–7
	8–18	Clay	CH	A–7
	18–24	Clay loam	CL	A–6
Portales:				
Fine sandy loam (PfA, PfB)	0–15	Fine sandy loam	SM–SC or ML	A–4
	15–36	Sandy clay loam	CL	A–6 or A–4
	36–60	Sandy clay loam	CL or SC	A–6 or A–4
Loam (PoA, PoB)	0–12	Loam	SC or ML or CL	A–4 or A–6
	12–32	Sandy clay loam	CL or SC	A–4 or A–6
	32–60	Clay loam	CL	A–6
Potter (Ps)	[5] 0–6	Loam	ML or CL	A–4 or A–6
Randall (Rc)	0–70	Clay	CH	A–7
Reagan (ReA, Rg [6])	0–8	Loam	ML or CL	A–4 or A–6
	8–32	Clay loam	CL	A–6
	32–62	Clay loam	CL	A–6
Reeves (RmB)	0–18	Loam	CL	A–6
	18–34	Gypsiferous loam.		
Roscoe (Ro)	0–60	Clay	CH	A–7
Rowena (RwA, RwB)	0–10	Clay loam	CL	A–6
	10–38	Clay	CH	A–7
	38–62	Clay and clay loam	CL	A–6
Simona (SfB)	0–18	Fine sandy loam	SM, SC, or CL	A–4
	18	Caliche.		
Spade (SlB, SlC) (For properties of Latom soil in mapping units SlB and SlC, refer to the Latom series.)	0–22	Fine sandy loam	SM	A–4
	22	Soft sandstone.		
Springer:				
Fine sandy loam (SpA, SpB)	0–45	Fine sandy loam	SM, SC, or CL	A–4
	45–60	Loam	ML or ML–CL	A–4
Loamy fine sand (Sr, Ss3 [7])	0–12	Loamy fine sand	SM	A–2
	12–48	Fine sandy loam	SM, SC, or CL	A–4
	48–70	Loamy fine sand	SM	A–2
Spur (St)	0–60	Clay loam	CL	A–6
Stamford (SuA, SuB) (For properties of the Dalby soil in mapping units SuA and SuB, refer to the Dalby series.)	0–60	Clay	CH	A–7
Tivoli (Tf)	0–60	Fine sand	SP–SM	A–3

See footnotes at end of table.

of soils—Continued

Percentage passing sieve [3]—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per inch of soil	*pH*	
100	70–90	15–25	2. 5–5. 0	0. 08	7. 8–8. 3	Low.
100	70–90	45–55	2. 5–5. 0	. 11	7. 8–8. 3	Low.
80–100	70–90	40–55	2. 5–5. 0	. 12	7. 8–8. 3	Low.
98–100	90–100	60–75	0. 8–2. 5	. 16	7. 8–8. 3	Low to moderate.
90–100	65–95	50–88	0. 8–2. 5	. 13	7. 8–8. 3	Low to moderate.
90–100	70–90	40–55	0. 8–2. 5	. 13	7. 8–8. 3	Low.
98–100	90–100	70–80	0. 8–1. 5	. 17	6. 6–7. 3	High.
98–100	90–100	70–80	0. 2–0. 8	. 17	6. 6–7. 8	High.
98–100	90–100	60–80	0. 2–0. 8	. 16	7. 8–8. 3	High.
98–100	70–90	60–80	0. 2–0. 8	. 10	7. 8–8. 3	Moderate.
100	90–100	70–80	0. 2–0. 8	. 16	7. 8–8. 3	Slow.
100	90–100	70–80	0. 2–0. 8	. 16	7. 8–8. 3	Slow.
90–100	80–90	70–80	0. 2–0. 8	. 16	7. 8–8. 3	Moderate.
98–100	70–90	40–55	0. 8–2. 5	. 11	7. 8–8. 3	Low.
98–100	90–100	50–65	0. 8–2. 5	. 13	7. 8–8. 3	Moderate to low.
90–100	80–90	45–65	0. 8–2. 5	. 13	7. 8–8. 3	Moderate.
98–100	90–100	45–75	0. 8–2. 5	. 17	7. 8–8. 3	Moderate to low.
98–100	80–90	45–55	0. 8–2. 5	. 17	7. 8–8. 3	Moderate to low.
90–100	70–90	70–80	0. 8–2. 5	. 15	7. 8–8. 3	Moderate.
90–100	50–85	50–75	0. 8–2. 5	. 15	7. 8–8. 3	Low.
98–100	90–100	75–98	0–0. 05	. 17	6. 6–8. 0	Very high.
95–100	80–95	60–75	0. 8–2. 5	. 17	7. 8–8. 3	Low to moderate.
95–100	80–95	70–80	0. 8–2. 5	. 17	7. 8–8. 3	Moderate.
95–100	70–90	50–80	0. 8–2. 5	. 15	7. 8–8. 3	Low to moderate.
95–100	90–100	60–75	0. 8–2. 5	. 16	7. 8–8. 3	Low to moderate.
100	95–100	85–98	0–0. 05	. 17	7. 0–8. 3	Very high.
98–100	90–100	70–90	0. 8–2. 5	. 16	7. 4–8. 3	Moderate.
98–100	90–100	80–95	0. 2–0. 8	. 21	7. 4–8. 3	High to very high.
90–98	85–95	70–90	0. 8–2. 5	. 16	7. 8–8. 3	Moderate.
95–100	70–90	40–55	0. 8–2. 5	. 12	7. 8–8. 3	Low.
90–100	65–85	40–50	0. 8–2. 5	. 12	7. 8–8. 3	Low.
90–100	70–90	40–55	2. 5–5. 0	. 12	6. 6–7. 8	Low.
90–100	85–95	60–75	2. 5–5. 0	. 10	7. 3–8. 3	Low.
90–100	70–90	15–25	0. 5–10. 0	. 08	6. 6–7. 8	Low.
90–100	85–95	40–55	2. 5–5. 0	. 11	6. 6–7. 8	Low.
90–100	70–90	15–25	0. 5–10. 0	. 08	7. 3–8. 3	Low.
100	90–100	70–80	0. 8–2. 5	. 17	7. 8–8. 3	Low to moderate.
100	90–100	75–95	0–0. 05	. 15	7. 8–8. 3	Very high.
100	80–90	5–10	0. 5–10. 0	. 06	6. 6–8. 3	Low.

TABLE 3.—*Engineering properties*

Soil name	Depth from surface	Classification		
		USDA texture	Unified [1]	AASHO [2]
	Inches			
Tobosa (ToA)	0–52	Clay	CH	A–7
	52	Limestone		
Uvalde (UsA, UsB)	0–60	Silty clay loam	CL	A–6
Veal (VeB, VeC)	0–8	Fine sandy loam	SM–SC, CL	A–4
	8–17	Sandy clay loam	SC or CL	A–6
	17–60	Clay loam	CL	A–6
Vernon:				
Soils (VsB, Vx)	0–16	Clay	CH or CL	A–7 or A–6
	[8] 16–48			
Clay loam	0–8	Clay loam	CL	A–6
	8–18	Clay	CH or CL	A–7 or A–6
	[8] 18–24			
Weymouth (WvB) (For properties of Vernon soil in mapping unit unit WvB, refer to Vernon clay loam.)	0–40	Clay	CL or ML–CL	A–6
	[9] 40–50			
Zavala (Za)	0–36	Fine sandy loam	SM, SC, or CL	A–4
	36–62	Sandy clay loam	CL or SC	A–6
Zita (ZfA)	0–8	Fine sandy loam	SM, SC, or CL	A–4
	8–34	Loam	ML or ML–CL	A–4
	34–60	Clay loam	CL	A–6

[1] Based on the Unified Soil Classification System (*10*). Tech. Memo. No. 3–357, 2 v., Waterways Experiment Station, Corps of Engineers. Soils identified as SP–SM, SM–SC, and ML–CL have borderline classification.
[2] Based on Standard Specifications for Highway Materials and Methods of Sampling and Testing (pt. 1; ed. 7): The Classification of Soil and Soil Aggregate Mixtures for Highway Construction Purposes, AASHO Designation: M 145–49.
[3] Data estimated for modal soil using USDA Soil Conservation Service textural chart, and correlated with test data on soil samples from other counties with soils similar to those of Howard County.

Permeability, as shown in table 3, refers to the ability of a soil to transmit water. Estimates were made for each soil as it occurs in place on the basis of results from permeability tests on similar soil material. In table 3 permeability is given as a range of values for each soil type. An exception to this rule is permeability of clay soils, such as Roscoe clay. The clay soils take up water rapidly through cracks when they are dry, but water moves very slowly into them when the cracks seal.

Available water capacity, in inches per inch of soil depth, is an estimate of the capillary water in the soil when it is wet to field capacity. When the soil is at the wilting point of common crops, the amount of water listed in table 3 will wet the soil material to a depth of 1 inch without deeper percolation.

The column headed "Reaction" refers to the degree of acidity or alkalinity, expressed as the pH value of a soil. The pH of a neutral soil is 7.0, of an acid soil is less than 7.0, and of an alkali soil is more than 7.0. Reaction is a useful soil property. It indicates conditions that might cause corrosion or other forms of deterioration in metal and concrete structural materials that are placed in contact with a soil.

Estimates of shrink-swell potential are based on the liquid limit of the soil and indicate the change in volume to be expected in the soils when the moisture content changes. In this county shrink-swell potential is rated by the relative terms *low*, *moderate*, *high*, and *very high*. It is risky to use soils that have high shrink-swell potential as building sites.

Salinity is not rated because there are only a few small, scattered areas of saline soils in this county. Dispersion also is not a problem and is not rated.

Table 4 rates the soils of Howard County as sources of material for engineering uses and gives specific characteristics that affect the suitability of each soil as a site for engineering structures. These features were estimated on the basis of estimates from engineering test data from other counties, the engineering properties in table 3, and observations of field performance of the soils.

Topsoil is fertile soil material, ordinarily high in organic matter. It is used to topdress roadsides, gardens, and lawns. Spur soils are loamy, fertile soils that are good sources of topsoil, but Drake soils are poor sources of topsoil because they have a very high content of lime. Tivoli soils are too sandy to be used for topsoil unless fertilizer is added and the soils are watered frequently.

The suitability of a soil for road fill depends largely on texture and its natural water content. Plastic soils, such as Tobosa clay, are difficult to compact. These soils are *of soils*—Continued

Percentage passing sieve [3]—			Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 4 (4.7 mm.)	No. 10 (2.0 mm.)	No. 200 (0.074 mm.)				
				Inches per inch of soil	*pH*	
100	90–100	75–95	0–0. 05	0. 22	7. 8–8. 3	Very high.
90–100	75–90	70–80	0. 8–2. 5	. 18	7. 8–8. 3	Moderate.
90–100	70–90	45–55	2. 5–5. 0	. 13	7. 8–8. 3	Low.
90–100	70–90	40–55	0. 8–2. 5	. 16	7. 8–8. 3	Low to moderate.
90–100	65–90	65–84	0. 8–2. 5	. 13	7. 8–8. 3	Low to moderate.
100	90–100	80–90	0–0. 05	. 15	7. 8–8. 3	High.
100	90–100	70–80	0. 05–0. 2	. 14	7. 8–8. 3	High.
100	90–100	80–90	0–0. 05	. 15	7. 8–8. 3	High.
100	85–95	50–80	0. 8–2. 5	. 14	7. 8–8. 3	Moderate.
100	80–90	40–55	2. 5–5. 0	. 12	6. 6–7. 8	Low.
100	80–90	45–65	0. 8–2. 5	. 15	6. 6–7. 8	Low.
100	70–90	40–55	1. 5–2. 5	. 13	6. 6–7. 8	Low.
100	80–90	60–75	0. 8–2. 5	. 16	6. 6–8. 3	Low to moderate.
90–100	85–95	70–80	0. 8–2. 5	. 13	7. 8–8. 3	Low to moderate.

[4] Properties are as given except that indurated caliche begins at a depth of 18 inches.
[5] Underlain by variable material containing much caliche.
[6] Gypsum outcrop in this mapping unit not estimated.
[7] Mapping unit Ss3 is severely eroded and has a surface layer of variable thickness.
[8] Varies from clay to shaly clay; properties not estimated.
[9] Unconsolidated loamy red beds; properties not estimated.

rated poor as a source of road-fill material. Amarillo loamy fine sand is rated fair because it contains enough fines to compact well when its subsoil and the topsoil are mixed together. Loamy alluvial land is a good source of gravel, and rough broken land is a possible source of hard caliche and gravelly earth for road fill. Potter soils are rated poor as a source of road fill, though they have good potential for gravel.

Soil features affecting highway location or road subgrade are based on the estimated classification of the soil material. In flat terrain the features apply to materials in the A and B horizons. In areas where slopes are 5 percent or steeper, the features listed mainly apply to soil materials in the C horizon. Stamford clay and Tobosa clay provides poor locations for highways because they are fine-textured soils and have a plastic clay layer that impedes internal drainage. Also these soils have high shrink-swell potential. Tivoli fine sand and other coarse-textured soils make only fair locations for highways because they erode easily and usually lack stability unless the soils are confined.

Spur clay loam and other soils that frequently are flooded do not provide good sites for reservoirs. Reeves soils have gypsiferous material in their substratum, which seeps water and is unsuitable for reservoir areas. Frequent floods, rock near the surface, highly permeable material, and stoniness are features that make it difficult to locate a site for reservoirs and embankments for farm ponds.

About 500 acres of Acuff, Olton, and Amarillo soils are irrigated by sprinklers. Other soils in the county are suitable for irrigation if irrigation water can be found. Spur clay loam is rated unsuitable for irrigation because it is occasionally flooded. Other soils, such as Spade fine sandy loam, have adverse features such as low water-holding capacity and low productivity.

Field terraces and diversion terraces constructed from coarse-textured soils, such as Springer loamy fine sand, are difficult to maintain because of poor stability. On Spur clay loam and other soils that are often flooded, diversion terraces are destroyed or damaged by floodwater.

Grassed waterways are used on soils to carry off water from terrace outlets and other areas. Soils that contain excessive amounts of lime are poorly suited for grassed waterways because the soils tend to be droughty and establishing vegetation is difficult. Drake and Reeves soils are of this kind. Frequent flooding is also a hazard because the floodwaters retard growth or kill plants in the waterways. The Springer and Spade soils have low productivity because their surface layer is loamy sand or fine sandy loam, but productivity can be increased on these soils by adding fertilizer.

TABLE 4.—*Engineering*

Soil and map symbol	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Dikes and levees
Acuff loam (AcA, AcB)	Good	Good	Good grading of soil material.	Moderate permeability; good to poor stability.
Amarillo fine sandy loam (AfA, AfB, AfC).	Good	Good	Moderate permeability; low to moderate shrink-swell potential.	Moderate permeability; good to poor stability.
Amarillo loamy fine sand (AmB)	Fair	Fair	Hazard of soil blowing; low shrink-swell potential.	Moderate permeability; good to poor stability; highly susceptible to soil blowing.
Amarillo and Cobb fine sandy loams (AsB, AsC). (Interpretations are for Cobb soil; see Amarillo fine sandy loam for interpretations of Amarillo soil.)	Good	Fair	Sandstone at a depth of 38 to 60 inches; unstable when wet.	Moderately rapid permeability; unstable in some places when wet.
Arvana fine sandy loam (AvB, AwB)	Good	Fair	Indurated caliche at a depth of 16 to 40 inches.	Moderate permeability; fair stability.
Berthoud loam (BeB, BeC)	Fair	Fair	Hazard of soil blowing	Moderate permeability; fair stability.
Brownfield fine sand (BfB)	Poor	Fair	Hazard of soil blowing	Moderate permeability; good to poor stability; high susceptibility to soil blowing.
Brownfield fine sand, thin surface variant (BvB).	Poor	Fair	Hazard of soil blowing	Moderate permeability; good to poor stability; highly susceptible to soil blowing.
Clayey alluvial land (Ca)	Poor	Fair	High shrink-swell potential.	High shrink-swell potential; slowly permeable.
Cobb fine sandy loam. (For interpretations see Amarillo and Cobb fine sandy loams).				
Drake soils (DrC, DrD)	Poor	Fair	Hazard of soil blowing; poor stability.	Moderate to moderately rapid permeability; poor stability; highly susceptible to soil blowing.
Ector soils (Ec)	Poor	Poor	Stoniness; very shallow over limestone.	Stoniness
Ector-Rock outcrop complex (Er)	Poor	Poor	Stoniness; steep slopes; very shallow over limestone.	Stones and rock outcrops

interpretations of soils—Continued

Soil features affecting—Continued				
Farm ponds		Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment			
Moderate permeability; highly calcareous in substratum; seepage hazard.	Good grading of soil material; good stability; can be made impervious by wet compaction.	Deep soil; moderate to high water-holding capacity.	Moderate permeability; hazard of erosion; high water-holding capacity.	No unfavorable features.
Moderate permeability; highly calcareous in substratum; seepage hazard.	Good grading of soil material; moderately permeable.	Moderate permeability; moderate to high water-holding capacity.	Moderate permeability; moderate to high water-holding capacity.	Slopes susceptible to water erosion.
Moderate permeability; highly calcareous in substratum; seepage hazard.	Poorly graded surface soil; well-graded subsoil; fair stability.	High susceptibility to soil blowing; moderate permeability; low water-holding capacity in surface layer; high intake rate.	High susceptibility to soil blowing.	High susceptibility to soil blowing.
High seepage losses; sandstone in subsoil in some places.	Moderately rapid permeability; unstable in some places when wet; sandstone at moderate depth; fair stability.	Moderately rapid permeability; subject to water erosion.	Moderately rapid permeability; unstable when wet in some places; subject to water erosion.	Susceptibility to water erosion.
High seepage losses; indurated caliche in substratum.	Limited borrow material because of indurated caliche; good grading.	Limited water-holding capacity.	Limited borrow material because of indurated caliche.	Susceptibility to water erosion.
Moderate seepage------	No unfavorable features--	Moderate intake rate; high water-holding capacity; sloping.	Susceptibility to gully and sheet erosion; fair stability; moderate permeability; gentle to moderate slopes.	Susceptibility to gully and sheet erosion.
Moderate permeability; calcareous substratum; seepage losses.	Poorly graded surface soil; well-graded subsoil; fair stability.	Moderate permeability; subject to soil blowing; low water-holding capacity.	High susceptibility to soil blowing; well-graded subsoil.	High susceptibility to soil blowing.
Moderate permeability; calcareous substratum; seepage losses.	Poorly graded surface soil; well-graded subsoil; fair stability.	Moderate permeability; susceptibility to soil blowing; low water-holding capacity.	High susceptibility to soil blowing; well-graded subsoil.	High susceptibility to soil blowing.
Variable textured material; stratified; frequent flooding.	High shrink-swell potential; frequent flooding.	Very slow permeability; frequent flooding.	Frequent flooding; very slow permeability high shrink-swell potential.	Frequent flooding.
Moderate to moderately rapid permeability; highly calcareous soil material; moderate seepage.	Seepage hazard; moderate to moderately rapid permeability.	Moderate to moderately rapid permeability; low water-holding capacity; high susceptibility to soil blowing; moderate to steep slopes.	Poor stability; high susceptibility to soil blowing; highly calcareous subsoil.	High susceptibility to soil blowing; highly calcareous subsoil.
Stoniness; very shallow over limestone; seepage hazard.	Stoniness; very shallow over limestone.	Very shallow soils over limestone.	Very shallow soils over limestone.	Soils very shallow over limestone.
Stones and rock outcrops; seepage hazard.	Very shallow soils over limestone; rock outcrops.	Stoniness; steep slopes; very shallow over limestone; nonarable.	Very shallow soils over limestone; stony.	Soils very shallow over limestone; stony.

TABLE 4.—*Engineering*

Soil and map symbol	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Dikes and levees
Gomez loamy fine sand (Go)	Poor	Fair	Hazard of soil blowing	Moderately rapid permeability; poor stability; highly susceptible to soil blowing.
Gypsum outcrop (Gy)	Poor	Poor	Stoniness; highly calcareous; hazard of soil blowing.	Hazard of seepage
Latom fine sandy loam (LaD)	Fair in surface layer.	Poor	Sandstone within 20 inches of surface.	Fair stability; very shallow over sandstone.
Mansker loam (MkA, MkB, MkC)	Fair	Good	No unfavorable features	Moderate permeability; good stability; caliche near surface; moderately susceptible to soil blowing.
Mobeetie fine sandy loam (MoB, MoC)	Fair	Fair	Hazard of soil blowing	Moderately rapid permeability; fair stability.
Olton clay loam (OcA, OcB)	Good	Fair	High shrink-swell potential in subsoil.	Moderate permeability; fair stability.
Ozona clay loam (OzB)	Poor to fair	Fair	Limestone at a depth of 15 to 42 inches in some places.	Limestone at a depth of 15 to 42 inches in some places; good stability.
Portales fine sandy loam (PfA, PfB)	Good	Good	No unfavorable features	Moderate to moderately rapid permeability; poor stability.
Portales loam (PoA, PoB)	Good	Good	No unfavorable features	Moderate permeability; good to poor stability.
Potter soils (Ps)	Poor	Poor	Caliche near surface; erosion hazard on steep slopes.	Moderate to rapid permeability; soft to hard caliche near surface.
Randall clay (Rc)	Poor	Poor	Very high shrink-swell potential; flooding hazard.	Very slow permeability; fair stability; very high shrink-swell potential.
Reagan loam (ReA)	Good	Good	No unfavorable features	Moderate permeability
Reagan-Gypsum outcrop complex (Rg)	Poor to fair	Poor to good	High gypsum content	High gypsum content; poor stability.
Reeves loam (RmB)	Fair	Good	Gypsum in subsoil and substratum.	Gypsum in subsoil and substratum; fair stability in surface layer.

interpretations of soils—Continued

Soil features affecting—Continued				
Farm ponds		Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment			
Moderately rapid permeability; seepage hazard.	Fair grading of soil materials.	Moderately rapid permeability; low water-holding capacity; high susceptibility to soil blowing.	Poor stability; high susceptibility to soil blowing; highly calcareous subsoil.	High susceptibility to soil blowing; highly calcareous subsoil.
Moderate permeability, highly calcareous; seepage hazard.	Seepage hazard	Soil profile stony and highly calcareous; nonarable.	Seepage; highly calcareous; nonarable.	Not suitable for cultivation.
Seepage hazard; very shallow over sandstone.	Sandstone outcropping; fair stability; seepage hazard; very shallow over sandstone.	Sandstone outcropping; nonarable; very shallow over sandstone.	Very shallow soil over sandstone; nonarable.	Very shallow soil over sandstone; nonarable.
Moderate permeability; soft caliche near surface; seepage.	Good grading of soil material; susceptibility to soil blowing.	Shallow soil over soft caliche; low water-holding capacity.	Shallow soil over soft caliche.	Shallow soil over soft caliche; moderately susceptible to soil blowing.
Moderate seepage loss	Moderate permeability; seepage hazard.	Moderately high water-holding capacity; high intake rate; gently sloping to moderately sloping.	Gully and sheet erosion; fair stability; moderate permeability; gently sloping to moderately sloping.	Gully and sheet erosion.
No favorable features	High shrink-swell potential.	Moderate intake rate; moderately high water-holding capacity.	No unfavorable features	No unfavorable features.
Limestone near surface in some places.	Limestone near surface in some places; fair stability in surface layer.	Low water-holding capacity; limestone near surface in some places; thin surface layer.	Limestone near surface in some places.	Limestone near surface in some places.
Moderate to moderately rapid permeability; highly calcareous subsoil; moderate seepage.	Good grading of soil material.	Moderately rapid permeability; moderate water-holding capacity	No unfavorable features	Deep soil; no unfavorable features.
Moderate permeability; calcareous substratum subject to seepage.	Soil material well graded; good stability; can be made impervious by wet compaction.	Moderate permeability; deep soil; high water-holding capacity.	No unfavorable features	Deep soil; no unfavorable features.
Moderate to rapid permeability; very shallow over caliche.	Moderate to rapid permeability; caliche near surface.	Moderate to rapid permeability; caliche near surface.	Very shallow soils over caliche; stony.	Very shallow soils over caliche; stony.
Soil cracks if allowed to dry.	Poor grading of soil material; very high shrink-swell potential; poor stability.	Very slow permeability; hazard of flooding.	Hazard of flooding; susceptible to cracking if dry; very high shrink-swell potential.	Susceptible to cracking if dry; subject to flooding.
Moderate permeability; calcareous substratum; subject to seepage.	Good to fair grading of soil material; good stability.	Moderate permeability; high water-holding capacity.	No unfavorable features	No unfavorable features.
High seepage losses	High gypsum content; poor stability.	High gypsum content; nonarable.	High gypsum content; nonarable; poor stability.	Subject to water erosion; high gypsum content; nonarable.
Gypsum in subsoil and substratum; high seepage losses.	Gypsum in subsoil and substratum.	Moderate to shallow over gypsum; low water-holding capacity.	Gypsum in subsoil and substratum at shallow to moderate depths.	Gypsum in subsoil and substratum at shallow to moderate depths.

TABLE 4.—*Engineering*

Soil and map symbol	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Dikes and levees
Roscoe clay (Ro)	Poor	Poor	Very high shrink-swell potential; subject to flooding.	Very high shrink-swell potential; subject to soil cracking if dry.
Rough stony land (Rs)	Poor	Poor	Steep slopes; stony	Steep slopes; stony
Rowena clay loam (RwA, RwB)	Fair	Poor	High shrink-swell potential.	Slow permeability; high shrink-swell potential in subsoil.
Saline alluvial land (Sa)	Poor	Poor	High water table	High water table; frequent flooding.
Sandy alluvial land (Sd)	Fair	Poor	Erosion hazard	Frequent flooding; fair stability.
Simona fine sandy loam (SfB)	Fair	Fair	Underlain by indurated caliche.	Underlain by indurated caliche.
Spade-Latom sandy loams (SlB, SlC)	Fair	Poor	Sandstone near surface	Fair stability; sandstone near surface.
Springer fine sandy loam (SpA, SpB)	Poor	Poor	Subject to soil blowing	Moderately rapid permeability; fair stability.
Springer loamy fine sand (Sr, Ss3)	Poor	Fair	Subject to soil blowing	Moderately rapid permeability; poor stability.
Spur clay loam (St)	Good	Fair	Hazard of flooding	Moderate permeability
Stamford and Dalby clays (SuA, SuB)	Poor	Poor	Very high shrink-swell potential.	Very slow permeability; high shrink-swell potential; subject to piping.
Tivoli fine sand (Tf)	Poor	Poor	Hazard of soil blowing	Moderately rapid permeability; high susceptibility to soil blowing; hard caliche substratum.
Tobosa clay (ToA)	Poor to fair	Poor	Very high shrink-swell potential.	Good to fair stability
Uvalde silty clay loam (UsA, UsB)	Fair	Fair	Calcareous substratum	Moderate permeability; fair stability; moderate shrink-swell potential.
Veal fine sandy loam (VeB, VeC)	Poor	Fair	Caliche near surface	Moderately rapid permeability; fair stability; soft caliche near surface.

interpretations of soils—Continued

Soil features affecting—Continued				
Farm ponds		Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment			
Soil cracks if allowed to dry.	Very slow permeability; subject to cracking; poor stability; very high shrink-swell potential.	Very slow permeability	Susceptibility to cracking if soil is dry; subject to flooding in some areas.	Hazard of flooding in some places.
Steep slopes; stony	Steep slopes; stony	Steep slopes; stony; nonarable.	Steep slopes; stony; nonarable.	Steep slopes; stony; nonarable.
Seepage losses in substratum in some places.	Slowly permeable material; high shrink-swell potential; fair stability.	Low intake rate; high water-holding capacity.	No unfavorable features	No unfavorable features.
High water table	High water table; frequent flooding.	High water table; frequent flooding; nonarable.	High water table; frequent flooding; nonarable.	High water table; frequent flooding; nonarable.
Frequent flooding; subject to seepage.	Fair stability; unsatisfactory for cores; frequent flooding.	Rapid permeability; frequent flooding; nonarable.	Lack of soil binder; easily eroded; frequent flooding; nonarable.	Susceptibility to wind and water erosion; frequent flooding; nonarable.
Underlain by indurated caliche; seepage losses.	Underlain by indurated caliche.	Shallow over caliche; low water-holding capacity.	Underlain by indurated caliche.	Underlain by indurated caliche.
Moderate to rapid permeability; sandstone near surface; seepage hazard.	Fair grading of soil material in surface layer; fair stability.	Moderately rapid permeability; sandstone near surface; low water-holding capacity.	Moderate depth to sandstone; low water-holding capacity.	Sandstone at moderate depths.
High seepage losses	Fair stability; moderately rapid permeability.	High intake rate; moderate water-holding capacity.	Susceptibility to soil blowing.	Susceptibility to soil blowing.
High seepage losses	Poor stability; moderately rapid permeability; seepage.	Low water-holding capacity; high intake rate.	Poor stability; susceptibility to soil blowing.	Susceptibility to soil blowing.
Moderate permeability; occasional flooding.	Soil material well graded; occasional flooding.	Occasional flooding	Occasional flooding	Occasional flooding.
Very high shrink-swell potential; very slowly permeable when wet.	Very high shrink-swell potential; very susceptible to piping; poor stability.	Very slow intake rate; low to moderate available water capacity.	Very slow permeability; susceptible to cracking and piping; very high shrink-swell potential.	Low to moderate available water capacity.
Moderately rapid permeability.	Soil material poorly graded; poor stability.	Moderately rapid permeability; susceptible to soil blowing; low water-holding capacity; high intake rate.	Poor stability; hazard of soil blowing.	Hazard of soil blowing; very sandy.
Very slow permeability when wet; very high shrink-swell potential.	Very high shrink-swell potential; subject to cracking when dry; poor stability.	Very slow intake rate	Very high shrink-swell potential.	Very high shrink-swell potential; subject to cracking when dry.
Moderate permeability; calcareous substratum.	Soil material well graded; can be made impervious by wet compaction.	Moderate permeability; high water-holding capacity.	Moderate permeability; high water-holding capacity.	High water-holding capacity.
Moderate to rapid permeability; soft caliche near surface.	Soil material well graded; fair stability; soft caliche near surface.	Shallow over soft caliche; low water-holding capacity.	Shallow over soft caliche; low water-holding capacity.	Shallow over soft caliche; low water-holding capacity.

TABLE 4.—*Engineering*

Soil and map symbol	Suitability as source of—		Soil features affecting—	
	Topsoil	Road fill	Highway location	Dikes and levees
Vernon soils (VsB)	Poor	Poor	High shrink-swell potential; subject to erosion.	High shrink-swell potential; slowly permeable; subject to cracking.
Vernon-Badland complex (Vx)	Poor	Poor	High shrink-swell potential; moderately steep.	High shrink-swell potential; slowly permeable; subject to cracking.
Weymouth-Vernon clay loams (WvB) (Interpretations are for Weymouth soil; see Vernon soils for interpretations of Vernon soil.)	Poor	Poor	Moderate shrink-swell potential.	Moderate shrink-swell potential.
Zavala fine sandy loam (Za)	Fair	Fair	Fair	Moderate permeability; fair stability.
Zita fine sandy loam (ZfA)	Fair	Good	Fair	Moderate permeability; fair stability.

Formation and Classification of Soils

This section discusses the effects of the five factors of soil formation on the formation of the soils in Howard County. Also, the current system of soil classification is explained, and the soils in the county are placed in some categories in that system and in the great soil groups of the older system.

Factors of Soil Formation

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

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

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

Parent material

About 62 percent of the acreage of the soils in Howard County developed in outwash from the Rocky Mountains that was deposited in Quaternary and late Tertiary periods. Wind has reworked most of this outwash. The parent materials are largely alkaline or calcareous, unconsolidated, and sandy or silty.

In some areas the lime in the soil has been increased by additions brought up by a high water table. Also, some shallow, enclosed basins have received lime in runoff water from surrounding slopes.

About 7 percent of the acreage of the soils in this county developed from Cretaceous material of Mesozoic age. The parent material is largely consolidated limestone. Most of the limestone has been coated with calcium carbonate.

About 31 percent of the acreage of the soils in the county is underlain by interbedded shale, clay, sandstone, and some conglomerate of the Triassic red beds. Soils that developed from red-bed material have a dense, compact, clayey subsoil through which water moves very slowly.

Climate

Precipitation, temperature, humidity, and wind have been important in the development of the soils of Howard County. The county has scanty precipitation in winter, fairly heavy rain in spring and early in fall, and high winds in spring. Because evaporation is high, rainwater seldom wets the soil below living roots. For this reason, lime has accumulated in a horizon in most soils. Also because of the low rainfall, free lime is throughout the

interpretations of soils—Continued

Soil features affecting—Continued					
Farm ponds		Irrigation	Terraces and diversions	Waterways
Reservoir area	Embankment			
Very slow permeability.	High shrink-swell potential.	Very slow permeability; low intake rate.	Very slow permeability; subject to cracking; high shrink-swell potential.	Very slow permeability; subject to water erosion and cracking.
Very slow permeability.	High shrink-swell potential.	Not suitable for cultivation.	Very slow permeability; high shrink-swell potential; nonarable.	Very slow permeability; subject to water erosion and cracking; nonarable.
Slow permeability	Stable on flat slopes; suitable for cores.	Slow permeability; shallow over loamy red beds.	Moderate shrink-swell potential; subject to water erosion.	Shallow over loamy red beds; subject to water erosion.
High losses from seepage; occasional flooding.	Fair stability; occasional flooding.	Moderately high water-holding capacity.	Moderately high intake rate; subject to soil blowing.	Occasional flooding; high susceptibility to wind and water erosion.
High seepage losses	Good to fair stability	Moderately high water-holding capacity.	Subject to soil blowing	No unfavorable features.

profile in many of the younger soils. Mobeetie fine sandy loam is an example. The variation in temperature has encouraged the weathering of both the underlying rocks and the unconsolidated deposits into parent material from which the soils have formed. The high winds, common in the county, have aided in the breakdown of the parent material by reworking many deposits and by shifting materials from place to place.

Plants and animals

All the soils of Howard County formed under grass. Short and mid grasses were dominant on the moderately fine textured soils, and tall grasses covered the sandy soils. These grasses contributed large amounts of organic matter to the soil. Decaying leaves and stems were distributed on the soil surface. When the roots in the soils decayed, a network of tubes and pores was left that increase the passage of air and water through the soil. The decaying roots provide abundant food for bacteria and fungi, and the air and water encourage their growth.

Earthworms and insects are the most noticeable animal life in the soil. Worm casts and insect burrows add to the movement of air and water in the soil.

Large prairie-dog towns thrived in the area around Luther. The burrowing of these animals did much to offset the leaching of free lime from the soil. Soil structure was destroyed and more lime was brought to the surface. Consequently, the subsoil has weaker structure, and in many places the Cca horizon is less visible.

Man's influence on the soil has been as great as that of any living organism. Man has allowed wind and water erosion to take place and this erosion has reduced the silt, clay, and organic matter in the soil. The ability of the soil to take in water and air has been reduced in areas where the soil is compacted. Irrigation has changed the moisture supply in some areas. Overgrazing has changed the composition of the vegetation on the range.

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Relief

Relief influences soil development through its effect on drainage and runoff. The degree of profile development depends mainly on the average amount of the moisture in the soil, if other factors of soil formation are equal. The soils on steep slopes absorb less moisture and normally have a less well-developed profile than soils on flats and in depressions. Continuous erosion on the steep slopes retards the effects of most of the soil-forming processes.

Relief also influences the kind and amount of vegetation on a soil. Slopes facing north receive less direct sunlight than those facing south and, therefore, less moisture is lost through evaporation. As a result, soils on north-facing slopes have a more dense vegetative cover. The prevailing westerly winds have deposited soil material on slopes facing east and have removed soil material from those facing west. As a result, in many areas the deeper soils are on the east-facing slopes.

Most of the dark-colored soils in the county occur in slightly depressional or concave positions, or on broad, nearly level plains. The additional moisture that accumulates in such places aids in the growth of more plants and increases the biological activity. Consequently, more organic matter is added to the soil. An example of a soil of this kind is Portales loam.

Time

The characteristics of a soil are determined mainly by the length of time that the soil-forming factors have acted on the soil. Some soil material that has been in place for only a short time has not been influenced enough by climate and living organisms for the development of well-defined horizons. Examples of young soils of this kind are the duny Drake soils and soils on bottom lands.

The soils on steep slopes are immature because geologic erosion has removed soil material almost as fast as it has formed. Soils that have been in place for a long time and have approached equilibrium with their environment are mature, or old, soils. These soils show marked differences in their horizons. They are well drained and nearly level to gently sloping.

Classification of Soils

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

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

Two systems of classifying soils have been used in the United States in recent years. The older system was adopted in 1938 (*2*) and revised later (*9*). The system currently used was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of the system should search for the latest literature available (*6*, *8*).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together.

New soil series must be established and concepts of some established series, especially older ones that have been used little in recent years, must be revised in the course of the soil survey program. A proposed new series has tentative status until review of the series concept at state, regional, and national levels results in a judgment that the new series should be established. Most of the soil series described in this publication have been established earlier. When the survey was sent to the printer, two of the soil series, the Acuff and Rowena, had tentative status.

In table 5, the soil series of Howard County are placed in some categories of the current system and in the great soil group of the older system. Most of the classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized in the current system. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate the soil orders are those that tend to give broad climatic groupings of soils. Two exceptions, Entisols and Histosols, occur in many different climates.

Table 5 shows that the six soil orders in Howard County are Alfisols, Aridisols, Entisols, Inceptisols, Mollisols, and Vertisols. Alfisols are soils that have a clay-enriched B horizon high in base saturation. In Howard County this order includes most of the soils formerly called Reddish Brown and Reddish Chestnut soils.

Aridisols are soils that ordinarily are dry during some periods of the year if they are not irrigated. They show little leaching of carbonates from the solum. Aridisols include some of the soils that were formerly Calcisols.

Entisols are young soils that do not have genetic horizons or that have only the beginnings of such horizons. In this county Entisols include the soils formerly classified as Lithosols.

Inceptisols are generally found on young but not recent land surfaces. In this county Inceptisols include some of the soils formerly called Lithosols and Regosols.

Mollisols have a dark-colored surface layer and have high content of organic matter. These soils are soft in consistence. In Howard County this order includes some of the soils that were formerly called Reddish Chestnut and Alluvial soils and Calcisols.

Vertisols are soils in which natural churning or inversion of soil material takes place, mainly through the swelling and shrinking of clays. Soils in this order were formerly called Grumosols.

SUBORDER: Each order is subdivided into suborders, primarily on the basis of those characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. Soil properties used to separate suborders mainly reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP: Suborders are separated into great groups on basis of uniformity in kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, potassium), and the like. The great group is not shown separately in table 5, because it is the last word in the name of the subgroup.

SUBGROUP: Great groups are subdivided into subgroups, one representing the central (typic) segment of the group and the others, called intergrades, that have properties of one great group and also one or more properties of another great group, subgroup, or order. Subgroups may also be made in those instances where soil properties intergrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group.

FAMILY: Families are separated within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, thickness of horizons, and consistence.

TABLE 5.—*Soil series classified according to the current system and the 1938 system*

Soil series	Current system [1]			1938 system
	Family	Subgroup	Order	Great soil group
Acuff	Fine-loamy, mixed, thermic	Typic Argiustolls	Mollisols	Reddish Chestnut soils.
Amarillo	Fine-loamy, mixed, thermic	Typic Haplustalfs	Alfisols	Reddish Chestnut soils.
Arvana	Fine-loamy, mixed, thermic	Petrocalcic Paleustalfs	Alfisols	Reddish Chestnut soils.
Berthoud [2]	Fine-loamy, mixed, mesic	Typic Ustochrepts	Inceptisols	Regosols.
Brownfield	Loamy, mixed, thermic	Arenic Paleustalfs	Alfisols	Reddish Brown soils.
Cobb	Fine-loamy, mixed, thermic	Typic Haplustalfs	Alfisols	Reddish Chestnut soils.
Dalby	Fine, mixed, thermic	Typic Torrerts	Vertisols	Grumusols.
Drake	Fine-carbonatic, thermic	Ustic Torriorthents	Entisols	Regosols.
Ector	Loamy-skeletal, carbonatic, thermic	Lithic Haplustolls	Mollisols	Lithosols.
Gomez	Coarse-loamy, mixed, thermic	Ustollic Calciorthids	Aridisols	Calcisols.
Latom	Loamy, mixed, calcareous, thermic	Lithic Torriorthents	Entisols	Lithosols.
Mansker	Fine-carbonatic, thermic	Typic Calciustolls	Mollisols	Calcisols.
Mobeetie	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols	Regosols.
Olton	Fine, mixed, thermic	Typic Argiustolls	Mollisols	Reddish Chestnut soils.
Ozona [3]	Fine-mixed, thermic	Petrocalcic Calciustolls	Mollisols	Reddish Brown soils.
Portales	Fine-carbonatic, thermic	Haplic Calciustolls	Mollisols	Calcisols.
Potter	Fine-carbonatic, thermic, shallow	Typic Calciorthids	Aridisols	Lithosols.
Randall	Fine, montmorillonitic, thermic	Udic Pellusterts	Vertisols	Grumusols.
Reagan	Fine-carbonatic, thermic	Ustollic Calciorthids	Aridisols	Calcisols.
Reeves	Fine, gypsic, thermic	Typic Calciorthids	Aridisols	Calcisols.
Roscoe	Fine, montmorillonitic, thermic	Chromic Pellusterts	Vertisols	Grumusols.
Rowena	Fine, mixed, thermic	Vertic Calciustolls	Mollisols	([4]).
Simona [5]	Loamy, carbonatic, thermic, shallow	Typic Paleorthids	Aridisols	Calcisols.
Spade	Coarse-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols	Regosols.
Springer	Coarse-loamy, mixed, thermic	Typic Haplustalfs	Alfisols	Reddish Brown soils.
Spur	Fine-loamy, mixed, thermic	Fluventic Haplustolls	Mollisols	Alluvial soils.
Stamford	Fine, montmorillonitic, thermic	Typic Chromusterts	Vertisols	Grumusols.
Tivoli	Siliceous, thermic	Typic Ustipsamments	Entisols	Regosols.
Tobosa	Fine, montmorillonitic, thermic	Typic Chromusterts	Vertisols	Grumusols.
Uvalde [6]	Fine, mixed, hyperthermic	Haplic Calciustolls	Mollisols	Calcisols.
Veal	Fine-carbonatic, thermic	Ustollic Calciorthids	Aridisols	Calcisols.
Vernon	Fine, mixed, thermic	Typic Ustochrepts	Inceptisols	Lithosols.
Weymouth	Fine-loamy, mixed, thermic	Typic Ustochrepts	Inceptisols	Calcisols.
Zavala [6]	Coarse-loamy, mixed, nonacid, hyperthermic	Typic Ustifluvents	Entisols	Alluvial soils.
Zita	Fine-loamy, mixed, thermic	Typic Haplustolls	Mollisols	Reddish Chestnut soils.

[1] Placement of some soil series in the current system of classification, particularly in families, may change as more precise information becomes available.
[2] Berthoud soils are now restricted to cooler regions than those of Howard County.
[3] Classification reflects placement of the Ozona soils as mapped in Howard County. This classification was questioned shortly before the survey was printed.
[4] This series was recently named and has not been classified according to the 1938 system.
[5] Because of modifications in the Comprehensive classification system before the survey was sent to press, these soils in Howard County do not fit the above classification.
[6] The named series are now restricted to warmer regions than those of Howard County.

General Nature of the County

Some of the general characteristics of the county are discussed in this section. They are agriculture, geology, climate, natural resources, and physiography.

Agriculture

Settlers were first attracted to the area that is now Howard County by the abundance of good grazing land. They established ranches near sources of water, and raising cattle became the main occupation. Later the land was opened to homesteaders, and they cleared large areas of range and planted cotton and other crops.

The county was formed from Bexar Territory in 1876 and was organized in 1882. Population increased and was 41,202 in 1962. Of this population, 31,230 persons lived in Big Spring, the county seat.

Three types of farming are practiced in Howard County. Cattle ranching is practiced on an extensive scale throughout the county and is the main type of farming in the eastern and southern parts. In the more developed northern part of the county, cotton and grain sorghum are grown on medium-sized to large, fully mechanized farms. On these farms raising livestock is a minor enterprise. The third type of farming combines the production of livestock and forage sorghum with the production of cotton and grain sorghum. This type of farming is practiced to some extent in the more developed areas, but it is more common in less developed areas next to the large cattle ranches.

According to the Census of Agriculture, in 1964 there were 496 farms or ranches in the county. The average-sized farm was 1,096 acres. Cotton decreased in acreage from 68,886 acres in 1959 to 60,857 acres in 1964, though it is still the most important crop. Grain sorghum, the second important crop, is usually rotated with cotton or grown under stripcropping along with cotton. Some forage sorghum is also grown, as well as oats, wheat, and sweet sudangrass.

The Census of Agriculture for 1964 gives the following statistics for the county: 18,318 head of cattle and calves; 10,974 head of sheep and lambs; 83,705 pounds of wool shorn; 18,776 bales of cotton sold; and 3,930,113 pounds of grain sorghum sold.

Geology

The soils of Howard County began developing in the Mesozoic and Cenozoic eras. The Mesozoic era covered the Cretaceous and Triassic periods, and the Cenozoic era covered the Tertiary and Quaternary periods (*4*). In the Tertiary period were the Pliocene, Miocene, Oligocene, and Eocene epochs. The Recent and Pleistocene epochs were in the Quaternary period.

Soils that began developing during the Triassic period make up about 23 percent of the acreage in the county. These soils are in the Rolling Plains area, and they are in the Stamford, Vernon, and other series.

About 5 percent of the acreage consists of soils that began forming in the Cretaceous period (*3*). These soils developed on the Edwards Plateau and are in the Ector, Ozona, Uvalde, and other series.

About 72 percent of the acreage is on the Ilano Estacado or High Plains. Most of the soils in this area began developing in the Recent or Pleistocene epoch of the Quaternary period. A small acreage in this area began forming in the Pliocene epoch of the Tertiary period. In the Cretaceous epoch, this area was covered by seas, but only remnants of these seas remain. The major soils in the area are in the Amarillo, Brownfield, and Portales series.

Climate [9]

Because of its distance from the Gulf of Mexico, Howard County receives rather sparse rainfall. The average annual rainfall is less than 19 inches. The precipitation for the county, by month, is given in table 6.

Most of the rain falls in thundershowers during the period of May through October, when the prevailing southeasterly winds carry moisture from the gulf as far inland as the western part of Texas. During the colder months of the year, November through April, frequent cold fronts cut off the moisture from the gulf and rainfall (or snowfall) is quite limited. Because the amount of rain that falls during thunderstorms is extremely variable, there are large differences in the amount of rainfall from year to year and from place to place within the county.

Winter is characterized by frequent cold fronts accompanied by strong, gusty, northerly winds. Precipitation, if it occurs at all, is usually in the form of light rain or drizzle, freezing rain, or snow flurries. Most of the cold fronts, however, are dry as they pass through the area. Little benefit comes from the snowfall, because it is usually accompanied by strong winds that pile up the light snow in drifts. January, the coldest month, has an average of 18 days with a minimum temperature of 32° F. or below.

The weather in Howard County is most variable late in winter and early in spring. A period of 1 or 2 weeks of warm weather late in February or early in March may be followed by a severe cold spell late in March. Surface winds are most frequent during this period. Soil blowing occurs when the velocity of the wind is 30 miles per hour or more. Occasionally the wind velocity reaches 60 to 80 miles per hour, and duststorms are severe.

Thunderstorms begin in April and reach their peak in July. The thunderstorms are usually accompanied by winds of more than 40 miles per hour. Rain is excessive in small areas, and sometimes there is hail. Flooding is likely in local areas, but it does not last long. Tornadoes occasionally accompany the most violent thunderstorms late in spring and early in summer.

Daytime temperatures are quite high during summer. The average daily maximum is 94° in both July and August, and on an average of 27 days during each month, the maximum temperature is 90° or more. In daytime the range in temperature is wide, but nights are comfortable.

The prevailing winds are from the southeast during the warmer months of the year and are from the southwest during the colder months. Relative humidity is low compared to that in the central and eastern parts of Texas. The highest humidity, between 69 and 73 percent, occurs near sunrise from May through September. Humidity drops to 30 or 40 percent in the afternoon. In March when winds are westerly, the relative humidity is often less than 20 percent.

Evaporation from a U.S. Weather Bureau Class "A" pan averages about 105 inches per year. About 66 percent of the evaporation is in the period of May through October. Mean annual lake evaporation is approximately 72 inches per year.

The average number of days between the last 32° temperature in spring and the first in fall is 219.

The average number of days between the last 28° temperature in spring and the first in fall is 240.

The average date of the last 32° temperature in spring is April 3. Average date of the first 32° temperature in fall is November 8.

TABLE 6.—*Precipitation at Big Spring, Texas*

[Elevation 2,400 feet]

Month	Precipitation [1]			
	Average rainfall	Total in driest year (1917)	Total in wettest year (1932)	Average snowfall
	Inches	*Inches*	*Inches*	*Inches*
January	0.58	0.28	1.12	0.9
February	.69	0	3.81	.5
March	.83	.03	.17	.4
April	1.63	.97	2.24	(2)
May	2.83	.61	5.17	0
June	2.10	.98	4.63	0
July	2.06	.73	.23	0
August	1.95	.17	4.68	0
September	1.96	.79	8.70	0
October	2.03	0	.50	0
November	.95	.12	(2)	.2
December	.77	0	3.00	.5
Year	18.38	4.68	34.25	2.5

[1] Average precipitation based on a 60-year record through 1960.
[2] Trace.

[9] By ROBERT B. ORTON, State climatologist, U.S. Weather Bureau.

The chance that a 32° freeze will occur in spring after April 14 is 1 in 5, and after April 20 is 1 in 20. The chance that a 32° freeze will occur in fall before October 28 is 1 in 5, and before October 20 is 1 in 20. In 2 years out of 10 rainfall will be less than 12 inches. Also in 2 years out of 10 rainfall will exceed 25 inches.

Natural Resources

The most important natural resources in Howard County are its soils, ground water, oil, and wildlife. On the soils of the county, grasses are grown for grazing livestock and cotton, grain sorghum, and other crops are planted.

From the Ogallala formation comes most of the ground water. Wells drilled or dug into this formation supply enough water for domestic use, but water for irrigation is limited. The ground water occurs at depths ranging from 6 to 150 feet.

Oil was first discovered in the county early in the 1920's. In 1958, the average crude oil production was more than 38,000 barrels per day. Other natural resources are natural gas, tile clay, caliche, gypsum, and sand and gravel.

Wildlife in the county includes blue quail, dove, and few prairie chickens and turkeys. Migratory ducks and sandhill cranes are plentiful in the fall and winter. Some of the ranchers have restocked the range with antelope and deer.

Physiography

Howard County lies on the eastern margin of the High Plains, the western margin of the Rolling Plains, and the northern margin of the Edwards Plateau. In most places, the landscape is nearly level to gently sloping and undulating, but in the Edwards Plateau, it is gently sloping to steep.

Two drainageways, Sulphur Springs Creek and Mustang Creek, merge west of Big Spring to form Beals Creek, which crosses the county from the southwest to the southeast. Numerous creeks and draws occur below the escarpments of the High Plains and Edwards Plateau. All of these creeks and draws flow into the Colorado River, which is a few miles east of Howard County.

Playas, or wet-weather lakes, are common on the High Plains in the county. These playas provide drainage for most of the High Plains area.

Numerous salt lakes occur in the west-central part of the county. Some of these lakes have outlets, but others do not. Some of these lakes are dry during the drier parts of the year, but others have water all the time.

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Glossary

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

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

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

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

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

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent; will not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material, and tends to stretch somewhat and pull apart, rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard and brittle; little affected by moistening.

Eolian soil material. Soil parent material accumulated through wind action; commonly refers to sandy material in dunes.

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

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes.

O horizon. The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon. The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and it is therefore marked by the accumulation of humus. The horizons may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon. The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has (1) distinctive characteristics caused by accumulation of clay, sesquioxides, humus, or some combination of these; (2) prismatic or blocky structure; (3) redder or stronger colors than the A horizon; or (4) some combination of these. The combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon. The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter, C.

R layer. Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Microrelief. Minor surface configurations of the land.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 identifies a color with a hue of 10YR, a value of 6, and a chroma of 4.

Parent material. The disintegrated and partly weathered rock from which soil has formed; horizon C in the soil profile.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Permeability. The quality of a soil horizon that enables water or air to move through it. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

Playas. Flat, generally dry, undrained basins that contain water for periods following heavy rains.

Relief. The elevations or inequalities of a land surface, considered collectively.

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

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

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on parent material, as conditioned by relief, over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangement of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are (1) *single grain* (each grain by itself, as in dune sand) or (2) *massive* (the particles adhering together without any regular cleavage, as in many claypans and hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the profile below plow depth.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

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."

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

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