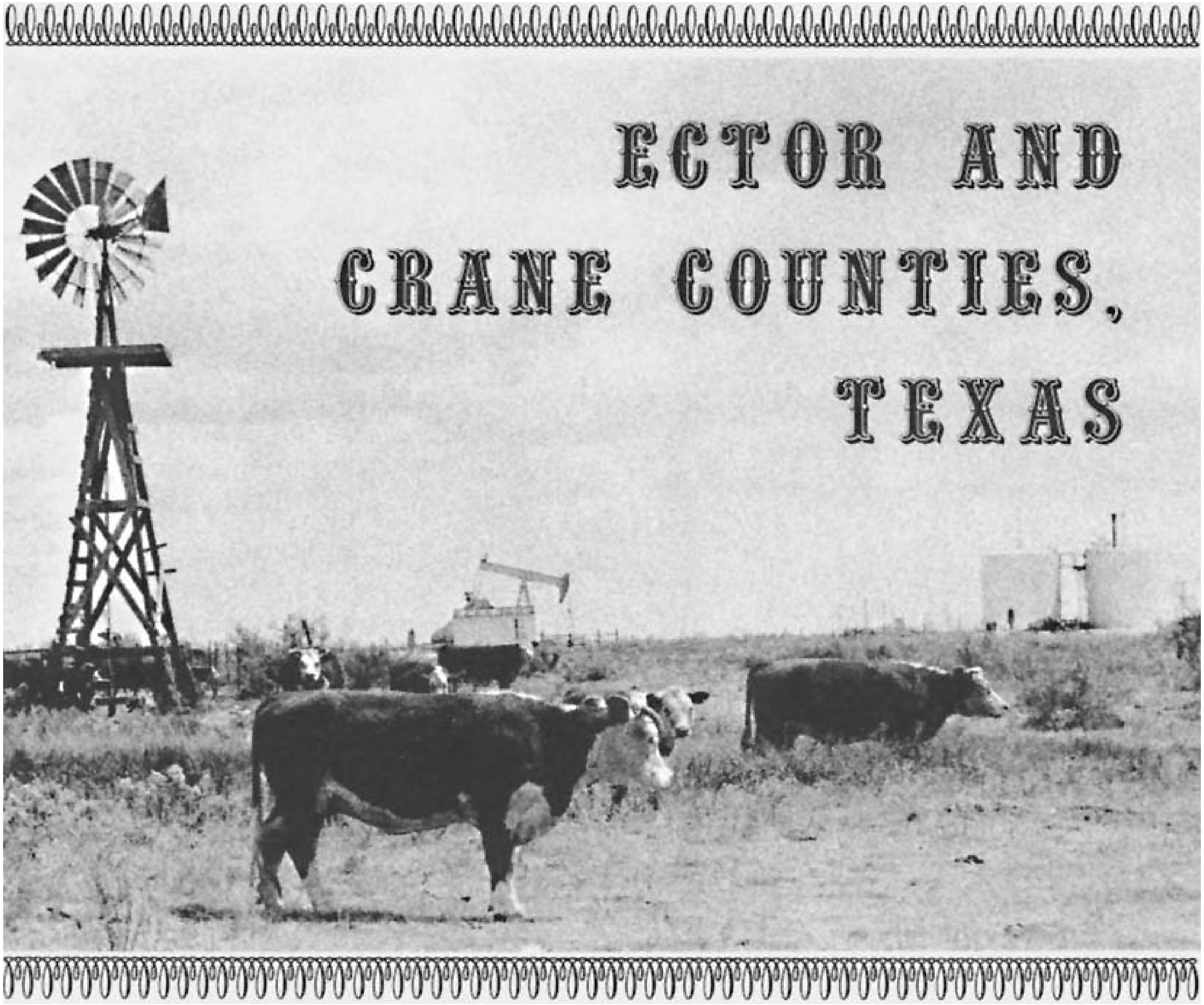
SOIL SURVEY OF

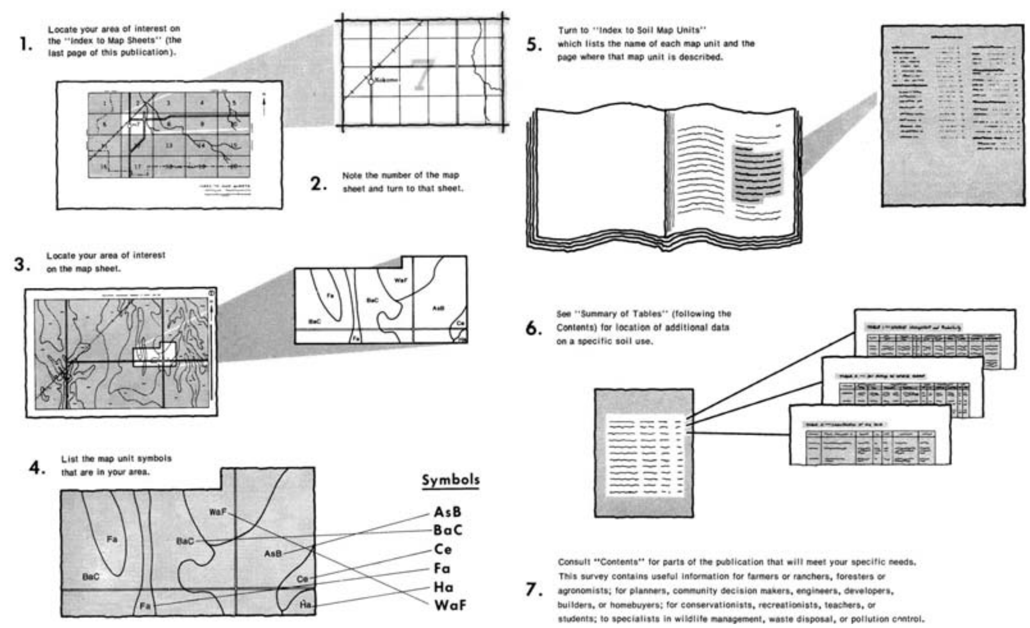


ELECTRONIC VERSION

This soil survey is an electronic version of the original printed copy, dated August 1978. It has been formatted for electronic delivery. Additional and updated information may be available from the Web Soil Survey. In Web Soil Survey, identify an Area of Interest (AOI) and navigate through the AOI Properties panel to learn what soil data is available.

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

HOW TO USE THIS SOIL SURVEY



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

Major fieldwork for this soil survey was completed in the period 1967-74. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1973. This survey was made cooperatively by the Soil Conservation Service and the Texas Agricultural Experiment Station. It is part of the technical assistance furnished to the Sandhills Soil and Water Conservation District.

Cover: Areas of Kimbrough-Stegall association, nearly level, are used mainly as rangeland.

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Issued August 1978

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Summary of Tables

*The tables listed below have been formatted to accommodate file size and accessibility. The original tables along with the manuscript and maps are available on CD and paper copy. A copy can be obtained by contacting the Field office.

Note: The Soil Data Mart may provide more current tables for this survey area.

Foreword

This soil survey contains much information useful in land-planning programs in Ector and Crane Counties. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

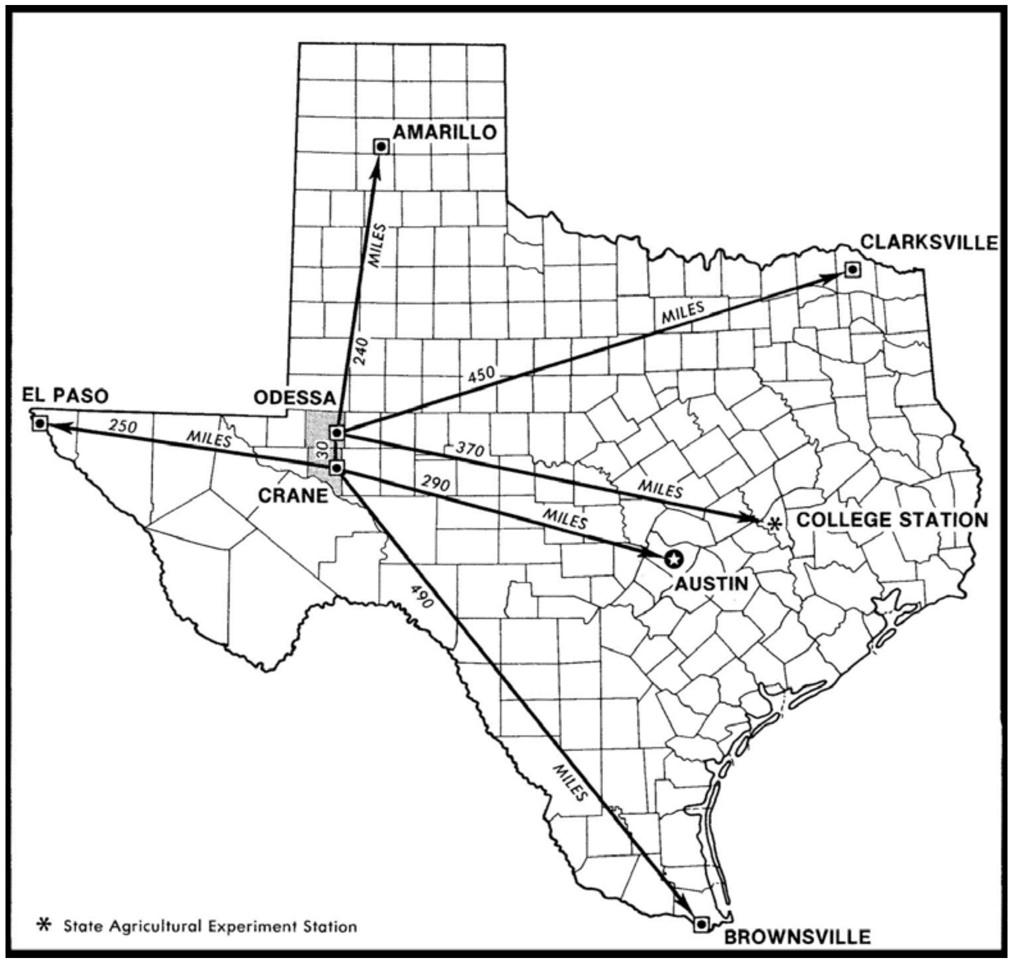
This soil survey has been prepared for many different users. Farmers, ranchers, and agronomists can use it to determine the potential of the soil and the management practices required for food and fiber production. Planners, community officials, engineers, developers, builders, and homebuyers can use it to plan land use, select sites for construction, develop soil resources, or identify any special practices that may be needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the soil survey to help them understand, protect, and enhance the environment.

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

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map; the location of each kind of soil is shown on detailed soil maps. Each kind of soil in the survey area is described, and much information is given about each soil for specific uses. Additional information or assistance in using this publication can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

This soil survey can be useful in the conservation, development, and productive use of soil, water, and other resources.

George C. Marks
State Conservationist
Soil Conservation Service



Location of Ector and Crane Counties in Texas

SOIL SURVEY OF ECTOR AND CRANE COUNTIES, TEXAS

By Lonnie Watson. Soil Conservation Service
Soils surveyed by Lonnie Watson and Nathaniel R. Conner,
Soil Conservation Service

U. S. Department of Agriculture, Soil Conservation Service,
in cooperation with
the Texas Agricultural Experiment Station

Ector and Crane Counties are located in the western part of Texas. They are mainly in the Trans Pecos and High Plains Land Resource Areas. A small area in the southeastern part of Crane County is in the Edwards Plateau Land Resource Area.

The survey area is roughly rectangular in shape, measuring about 58 miles from north to south and about 28 miles from east to west. It covers about 1,705 square miles, or 1,091,190 acres. The land surface is nearly level to rolling. Most of the drainage flows southward through Landreth Draw into the Pecos River.

The county is about 93 percent range, 5 percent Urban land, and 2 percent water areas and miscellaneous areas.

The soils in the survey area formed under grass and are dominantly dark colored, loamy and sandy, and dry. Unprotected areas are subject to soil blowing.

General nature of the counties

This section briefly discusses the settlement and population, climate, agriculture, and natural resources of the survey area.

Settlement and population

Ector County was created in 1887 from Tom Green County and was organized in 1891. It was named for M. D. Ector, a Texas legislator-jurist. Odessa, a town of approximately 78,380 population, is the county seat. The total population of Ector County is approximately 91,805.

Crane County was created in 1887 from Tom Green County and was organized in 1927. It was named for Baylor University's president, W. C. Crane. Crane, a town of approximately 3,427 population, is the county seat. The total population of Crane County is about 4,172.

Climate

By Robert B. Orton, State climatologist, National Weather Service, Austin.

The climate of the survey area is typical of a semiarid region. The vegetation consists mostly of native grasses. There are very few trees in the area; most are mesquite. There is very little farming in the immediate vicinity. The economy is based on ranching and extensive oil fields.

Table 1 gives data on temperature and precipitation for the survey area. Droughts occur with monotonous frequency. Although several years have excessive precipitation resulting in large accumulations of water, the runoff is so rapid that little benefit is derived from the rainfall. If good rains occur in the spring and summer months, grass production is good, even if the remainder of the year is well below normal.

The annual average precipitation is 13.7 inches in Ector County and 12.9 inches in Crane County. Most of the annual precipitation in the area comes as a result of spring and early summer thunderstorms. These are sometimes accompanied by winds in excess of 40 miles per hour, excessive rainfall over limited areas, and hail. Because the countryside is flat, local flooding may occur, but this is of short duration. Tornadoes are occasionally sighted, but they seldom cause damage or injury because the population of the area is sparse and most people are concentrated in cities or towns.

There is very little precipitation in the winter and infrequent snow. Fog and drizzle resulting from the upslope rise of the terrain from the southeast occur frequently during night hours, but they generally clear by noon.

During the late winter and early spring months, dust storms occur very frequently. The flat plains of the area, which have only grass as vegetation, offer little resistance to the strong winds. Dust in many of these storms remains suspended in the air for several days after the storm has passed. The sky is occasionally obscured by dust, but in most storms visibility ranges from 1 to 3 miles.

Daytime temperatures are warm in the summer, but there is a large diurnal range and most nights are comfortable. In summer the normal daily maximum temperature is in the low to mid 90's and the normal minimum temperature is in the upper 60's and low 70's. In winter the temperature ranges from the upper 50's to the low and middle 30's.

The temperature usually drops below 32 degrees F early in November, and the last temperature below 32 degrees usually comes early in April.

Winters are characterized by frequent cold periods followed by rapid warming. In spring there is violent thunderstorm activity, but summers are warm and dry and are characterized by numerous small convective showers. Extremely variable weather occurs during the fall. Frequent cold fronts are followed by chilly weather for 2 or 3 days and then by rapid warming. Cloudiness is at a minimum.

Because the prevailing winds in this area are from the southeast and the terrain rises upslope from the same direction, low cloudiness and drizzle frequently occur in winter and spring. Glaze occurs when the temperature is below freezing, but it usually lasts for only a few hours.

Although summer afternoon temperatures are frequently above 90 degrees F, the low humidity and resultant rapid evaporation have a cooling effect. The climate of the area is generally quite pleasant, and the more disagreeable weather is concentrated in the late winter and spring months.

Agriculture

The main agricultural enterprises in the survey area are cow-calf, sheep, and poultry operations.

Most cow-calf operations produce stocker calves for fall delivery. In addition to the cow-calf operations, there are steers where introduced grasses give additional forage during a part of the year. Feeding of protein supplement is necessary for winter maintenance of cattle. Sheep ranching is a minor enterprise. Sheep are generally raised in combination with cattle. Poultry is produced on a large scale by a small number of poultrymen.

Natural resources

Soil, water, oil, and gas are the most important natural resources in the survey area. The area's wildlife and caliche are also important. Soil is basic to the production of forage for livestock and food and fiber for market or home consumption.

Irrigation is used on many lawns, gardens, and small farms throughout the survey area.

Oil and gas are produced from numerous wells in the survey area. They are a major source of income to some of the landowners and serve as a solid tax base for revenue to operate public facilities.

Wildlife in the survey area provide recreation and income for many landowners.

Caliche is plentiful in the survey area and is mined commercially, being used mainly in road construction locally.

How this survey was made

Soil scientists made this survey to learn what kinds of soil are in the survey area, where they are, and how they can be used. The soil scientists went into the area knowing they likely would locate many soils they already knew something about and perhaps identify some they had never seen before. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; the kinds of rock; and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material, which has been changed very little by leaching or by the action of plant roots.

The soil scientists recorded the characteristics of the profiles they studied, and they compared those profiles with others in counties nearby and in places more distant. Thus, through correlation, they classified and named the soils according to nationwide, uniform procedures.

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

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others are made up of two or more kinds of soil, and a few have little or no soil material at all. Map units are discussed in the sections "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of different kinds of soil in different uses under different levels of management. Also, data are assembled from other sources, such as test results, records, field experience, and information available from state and local specialists. For example, data on crop yields under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it is readily available to different groups of users, among them farmers, managers of rangeland, engineers, planners, developers and builders, homebuyers, and those seeking recreation.

General soil map for broad land use planning

The general soil map at the hack of this publication shows, in color, map units that have a distinct pattern of soils and of relief and drainage. Each map unit is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern. The general textural terms in the legend refer to texture of the surface layer of the major soils.

The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified on the map. Likewise, areas of soils having properties that are distinctly unfavorable for certain land uses can be located.

Because of its small scale, the map does not show the kind of soil at a specific site. Thus, it is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

Map unit descriptions

The map units in Ector and Crane Counties are discussed in the following pages.

1. Conger-Tencee-Upton

Very shallow and shallow, nearly level to hilly, loamy and gravelly soils over indurated caliche.

This map unit is made up of nearly level to hilly soils that have 0 to 30 percent slopes. It makes up about 21 percent of the survey area.

Conger soils make up about 42 percent of the map unit, Tencee soils 27 percent, Upton soils 6 percent, and minor soils make up the rest.

Conger soils are on uplands along drainageways and ridges and around playas. The surface layer is brown, calcareous loam about 5 inches thick. The next layer is light brown, calcareous clay loam about 11 inches thick. Indurated caliche is below a depth of 16 inches.

Tencee soils are on convex ridges. The surface layer is light brown, calcareous very gravelly loam about 15 inches thick. It has 40 percent, by volume, caliche fragments in the upper part and 45 percent in the lower part. About 20 to 25 percent of the surface is covered by caliche fragments that are less than three-fourths of an inch across. Depth to indurated caliche is 15 inches.

Upton soils are on gently undulating uplands. The surface layer is brown, calcareous gravelly loam about 6 inches thick. The next layer is pale brown, calcareous gravelly clay loam about 10 inches thick. Depth to indurated caliche is 16 inches.

The minor soils are the Blakeney, Kimbrough, Lazier, Reagan and Reakor soils. Blakeney, Kimbrough, and Lozier soils are in convex areas on uplands. Reagan and Reakor soils are in slightly depressed to nearly level areas on uplands.

This unit is used mainly for range. It has low potential for growing short and mid grasses. The soil blowing hazard is slight to moderate, and the water erosion hazard is moderate.

This unit has low potential for most urban uses because the soils have a cemented layer. The potential for recreational uses is medium because of the small fragments on the surface and the cemented layer.

2. Ratliff-Holloman-Reakor

Very shallow to deep, nearly level, loamy soils over calcium carbonate or gypsum

This map unit consists of nearly level soils on broad uplands. Slopes range from 0 to 3 percent. This unit makes up about 20 percent of the survey area.

Ratliff soils make up about 30 percent of the unit, Holloman soils 13 percent, Reakor soils 8 percent, and minor soils 49 percent.

Ratliff soils are in nearly level, concave areas. The surface layer consists of brown, calcareous loam about 8 inches thick. The next layer is light brown, calcareous clay loam about 16 inches thick. The underlying layer is pink, calcareous clay loam about 56 inches thick. The calcium carbonate ranges from 30 to 40 percent, by volume, in the lower 56 inches.

Holloman soils are on upland areas adjacent to drains. The surface layer is light brown, calcareous loam about 8 inches thick. The underlying layer is a calcareous, weakly cemented gypsum bed about 32 inches thick. It is very pale brown in the upper 16 inches and pink in the lower 16 inches.

Reakor soils are in nearly level to slightly depressed areas. The surface layer is light brownish gray, calcareous silty clay loam about 7 inches thick. The next layer is light brown, calcareous silty clay loam about 21 inches thick. Below that is 20 inches of light brown, calcareous silty clay loam, 12 inches of light brown, calcareous wilt loam, and 20 inches of light brown, calcareous silty clay. The calcium carbonate content of the soil ranges from 8 to 40 percent, by volume.

The minor soils include Upton, Conger, Reeves, Reagan, Ima, and Toyah soils, a soil that is similar to Reeves soils but has a gypsum layer at a depth of more than 40 inches, a soil that is similar to Holloman soils but has a gypsum layer at a depth of 10 to 20 inches, and a soil that is similar to Reakor soils but has a zone of calcium carbonate accumulation at a depth of more than 40 inches. Upton and Conger soils are on uplands along drainageways and ridges and around slight depressions. Reeves soils, the soil that is similar to Reeves soils, and the soil that is similar to Holloman soils are along drainageways. Reagan soils and the soil that is similar to Reakor soils are in slight depressions. Ima soils are on ridges. Toyah soils are in drainageways.

This unit is used mainly for range. It has medium potential for growing short and mid grasses. Some areas are suited to cultivation. The soil blowing hazard and water erosion hazard are moderate.

This unit has medium potential for most urban uses because the soils have very shallow gypsum layers and high corrosivity to uncoated steel. The potential for recreational uses is medium to high.

3. Penwell-Jalmar-Pyote

Deep, undulating to rolling, sandy soils

This unit consists *of* broad *areas of* sandy soils on uplands. Slopes range from 1 to 16 percent. This unit makes up about 19 percent of the survey area.

Penwell soils make up about 47 percent of the unit, Jalmar soils 15 percent, Pyote soils 12 percent, and minor soils the remaining 26 percent.

Penwell soils are on convex ridges. The surface layer is brown, noncalcareous fine sand about 13 inches thick. The underlying layer, to a depth of 80 inches, is noncalcareous fine sand that is light brown in the upper part and pink in the lower part.

Jalmar soils are on convex, undulating ridges. The surface layer consists of noncalcareous fine sand that is brown in the top 13 inches and reddish brown from 13 to 35 inches. The next layer is red, noncalcareous to slightly calcareous sandy clay loam about 37 inches thick. The underlying layer is reddish yellow, calcareous sandy clay loam. This layer is 35 percent, by volume, calcium carbonate.

Pyote soils are in irregular to oval-shaped area. The surface layer is noncalcareous fine sand about 34 inches thick. It is yellowish red in the upper part and reddish yellow in the lower part. The next layer is reddish yellow, noncalcareous fine sandy loam about 36 inches thick. The underlying layer is reddish yellow, noncalcareous loamy fine sand about 10 inches thick.

The minor soils include Kinco and Wickett soils, a soil that is similar to Reeves soils but has a fine sand surface layer, and a soil that is similar to Jalmar soils but has more than 40 inches of fine sand in the upper part of the profile. These minor soils are nearly level to gently undulating and are in irregularly shaped areas.

This unit is used mainly for range. It has medium potential for growing mid grasses. The soils are very highly susceptible to soil blowing when there is no vegetation.

This unit has medium potential for most urban uses. The potential is low for playgrounds and camp and picnic areas.

4. Kimbrough-Stegall

Very shallow to moderately deep, nearly level, loamy soils over indurated caliche

This map unit consists of broad, smooth, nearly level to slightly depressed areas. Slopes range from 0 to 3 percent. The unit makes up about 14 percent of the survey area.

Kimbrough soils make up about 64 percent of the unit, Stegall soils 19 percent, and minor soils 17 percent.

Kimbrough soils are in broad, nearly level areas. They have a brown, calcareous loam surface layer about 7 inches thick that is 10 to 15 percent caliche fragments. The underlying layer is strongly cemented caliche in the upper part and weakly cemented caliche in the lower part.

Stegall soils are in nearly level to slightly depressed areas. They have a brown, mildly alkaline clay loam surface layer about 6 inches thick. The next layer is reddish brown, moderately alkaline clay loam about 25 inches thick. The underlying layer is indurated caliche that is laminated in the upper one-half inch and is weakly to strongly cemented below that.

The minor soils are the Slaughter and Lipan soils. Slaughter soils are on smooth plains and in slight depressions. Lipan soils are in enclosed depressions or intermittent lakes that are somewhat rounded or oval in shape.

This unit is used mainly for range. It has low potential for growing short and mid grasses. Some areas are suitable for cultivation. The soil blowing hazard and water erosion hazard are slight to moderate.

This unit has low potential for most urban uses because the soils are shallow or moderately deep to indurated caliche. The potential for recreational uses is medium because of the indurated caliche layer.

5. Penwell-Dune land

Deep, rolling, sandy soils

This unit consists of broad, hummocky area. Soils have 1 to 16 percent slopes. This unit makes up about 10 percent of the survey area.

Penwell soils make up about 52 percent of the unit, Dune land 34 percent, and minor soils 14 percent.

Penwell soils are in concave, undulating to rolling areas. These soils have a brown, noncalcareous fine sand surface layer about 13 inches thick. The underlying layer, to a depth of 80 inches, is noncalcareous fine sand that is light brown in the upper part and pink in the lower part.

Dune land is on convex, undulating to rolling ridges. It consists of light colored, eolian sands that show little evidence of soil development. The sands have formed active dunes that are constantly shifting due to the wind. They are more unstable on the east and north sides.

The minor soils are the Pyote and Jalmar soils and a soil that is similar to the Reeves soils but has a surface layer of fine sand over gypsum. The Pyote and

Jalmar soils are nearly level to gently undulating. The soil that is similar to Reeves soils is along drainageways.

This unit is used mainly for range. The Penwell soils have medium potential for growing mid and tall grasses. Dune land supports little vegetation except on the outer edges in lows between dunes. The vegetation in these laws consists of shinnery, New Mexico bluestem, switchgrass, Havard panicum, and sand bluestem. Absence of vegetation makes this unit highly susceptible to soil blowing.

This unit has medium potential for urban uses. It is so sandy that the potential for recreational uses is low.

6. Faskin-Douro

Deep and moderately deep, nearly level to gently sloping, loamy soils

This map unit consists of broad areas of nearly level to gently sloping soils that have 0 to 3 percent slopes. This unit makes up about 9 percent of the survey area.

Faskin soils make up about 45 percent of the unit, Douro soils 24 percent, and minor soils 31 percent.

Faskin soils have a reddish brown, noncalcareous, fine sandy loam surface layer about 8 inches thick. The next layer is noncalcareous sandy clay loam about 44 inches thick. It is reddish brown in the upper 28 inches and yellowish red in the lower 16 inches. The underlying layer is reddish yellow calcareous sandy clay loam to a depth of 80 inches. It is 20 to 30 percent, by volume, calcium carbonate.

Douro soils have a reddish brown, noncalcareous, fine sandy loam surface layer about 8 inches thick. The next layer is red, noncalcareous sandy clay loam about 22 inches thick. The underlying layer is strongly cemented caliche in the upper 24 inches and weakly cemented caliche in the lower 12 inches.

The minor soils are Triomas soils and a soil that is similar to Douro soils but has indurated caliche at a depth of 8 to 20 inches. These are nearly level to gently sloping soils on ridges. In some areas, fine sandy loam mounds have accumulated around the base of catclaw and mesquite trees.

This unit is mainly used for range. It has high potential for growing short and mid grasses. This unit is suitable for cultivation. The soils are moderately susceptible to blowing if left unprotected, and the water erosion hazard is moderate.

The Douro soils have a low potential for urban uses, because of the cemented layer between depths of 20 and 40 inches. The Faskin soils have high potential for urban uses, and all limitations are easily overcome. The potential for some recreation uses is high.

7. Wickett-Kinco-Triomas

Moderately deep and deep, nearly level to gently undulating, sandy soils

This unit consists of broad areas of nearly level to gently undulating soils that have 0 to 5 percent slopes. This unit makes up about 6 percent of the survey area.

Wickett soils make up about 52 percent of the unit, Kinco soils 26 percent, Triomas soils 9 percent, and minor soils the remaining 13 percent.

Wickett soils are on convex areas and ridges. These soils have a reddish brown, noncalcareous, loamy fine sand surface layer about 12 inches thick. The next layer is yellowish red, noncalcareous fine sandy loam about 16 inches thick. Depth to indurated, platy caliche is 28 inches.

Kinco soils have a brown, calcareous, loamy fine sand surface layer about 9 inches thick. The next layer is brown, calcareous fine sandy loam about 21 inches thick. The underlying layer is calcareous sandy loam about 42 inches thick. It is reddish yellow in the upper part and pinkish white in the lower part.

Triomas soils have a noncalcareous loamy fine sand surface layer about 18 inches thick. It is brown in the upper part and reddish brown in the lower part. Below that is 28 inches of yellowish red sandy clay loam, 19 inches of red sandy clay loam, and 10 inches of reddish yellow sandy clay. The underlying layer is reddish yellow sandy clay loam that is 2.5 percent, by volume, weakly to strongly cemented bodies of calcium carbonate.

The minor soils are Blakeney, Douro, Jalmar, Ima, Ratliff, and Reeves soils and a soil that is similar to Wickett soils but has indurated caliche below a depth of 40 inches. Blakeney soils are along drainageways and around playas. The nearly level to gently undulating Douro, Jalmar, and Ima soils are on convex ridges. The nearly level Ratliff soils are in concave areas. The nearly level to gently sloping Reeves soils are on uplands upslope from drains. The soil that is similar to Wickett soils is on the same landscape as Wickett soils.

This unit is mainly used for range. It has medium potential for growing short and mid grasses. Some areas are suitable for cultivation. Areas that have no vegetation are highly susceptible to soil blowing.

This unit has high potential for most urban uses. Its potential for recreation uses is medium, because it is so sandy.

8. Patrole-Toyah-Pecos

Deep, nearly level, loamy and clayey, saline soils

This unit consists of long, narrow, nearly level to slightly depressed areas adjacent to the Pecos River. Slopes range from 0 to 1 percent. This unit makes up about 1 percent of the survey area.

Patrole soils make up about 26 percent of the unit, Toyah soils 23 percent, Pecos soils 20 percent and minor soils the remaining 31 percent.

Patrole soils are in nearly level to slightly depressed areas adjacent to major streams. They have a light reddish brown, calcareous, silt loam surface layer about 10 inches thick. The underlying layer is about 50 inches thick. It is light brown, calcareous silty clay loam over reddish brown, calcareous clay. These soils are moderate to high in salinity.

Toyah soils are in slightly depressed areas. These soils have a dark grayish brown, calcareous loam surface layer about 16 inches thick. The underlying layer is about 44 inches thick. It is light brownish gray, calcareous loam over reddish brown, calcareous clay loam. These soils are moderate to high in salinity.

Pecos soils are in nearly level areas that rarely flood. However, a few areas are occasionally flooded by run-in water from side drains. The soils have dark grayish brown, calcareous silty clay in the top 10 inches and very dark grayish brown, calcareous clay to a depth of 16 inches. Films and threads of calcium sulfate and other salts range from few to common. The underlying layer, to a depth of 80 inches, is calcareous clay. It is grayish brown in the upper 16 inches and reddish brown in the lower 48 inches. These layers contain many bodies of calcium sulfate and other salts.

The minor soils are similar to Pecos soils and to Toyah soils but do not have a dark surface layer. They are on convex ridges. These soils generally have less than 1 percent slope but are at a higher elevation than the surrounding soils.

This unit is used mainly for range. It has medium potential for growing mid grasses. The soil blowing hazard is moderate, and the water erosion hazard is slight.

The potential for urban uses is low. Occasionally this map unit is flooded; this limitation is very difficult to overcome. The potential for recreation uses is low because of the occasional flooding.

Land use considerations

The map units in the survey area vary widely in their potential for major land uses, as indicated in table 2. For each land use, general ratings of the potential of each soil unit in relation to the other soil units are indicated. Kinds of soil limitations are also indicated in general terms. The ratings of soil potential reflect the relative cost of practices and the hazard of continuing soil-related problems after the practices are installed. The ratings do not consider location in relation to existing transportation systems or other facilities.

Kinds of land uses considered include cultivated farm crops, specialty crops, range, urban uses, and recreation. The cultivated farm crops grown in the survey area include cotton, grain sorghum, and wheat. Specialty crops include vegetables and nursery crops, which are grown on limited acreage and generally require intensive management. Range refers to land in native grasses. Urban uses include land used as residential, commercial, and industrial sites. Recreation includes nature study areas, and hiking.

In general, the kind of soil, low rainfall, and lack of irrigation water are the important factors that influence land use in the survey area.

About 94 percent of the survey area is used for range. In general, the survey area has medium potential for range. According to table 2, about 9 percent of the survey area has high potential for range, 56 percent has medium potential, and 35 percent has low potential.

There has been an increase in the number of acres used for specialty crops, urban development, and recreation. The Faskin-Douro unit has medium potential for cultivated farm crops and specialty crops. Good management practices are required, however, to prevent the soil from blowing. The sandy soils also require careful management to prevent them from blowing. The Wickett-Kinco-Triomas unit has high potential for urban uses, but soil blowing and low strength are problems. The Faskin-Douro unit has low potential for hiking and nature study.

The general soils information in this section and more detailed information in the following sections can be used as a guide in planning orderly growth and development of the survey area. This information is especially helpful in determining which lands to allocate to each use.

Soil maps for detailed planning

The map units shown on the detailed soil maps at the back of this publication represent the kinds of soil in the survey area. They are described in this section. The descriptions together with the soil maps can be useful in determining the potential of a soil and in managing it for food and fiber production; in planning land use and developing soil resources; and in enhancing, protecting, and preserving the environment. More information for each map unit, or soil, is given in the section "Use and management of the soils."

Preceding the name of each map unit is the symbol that identifies the soil on the detailed soil maps. Each soil description includes general facts about the soil and a brief description of the soil profile. In each description, the principal hazards and limitations are indicated, and the management concerns and practices needed are discussed.

The map units on the detailed soil maps represent an area on the landscape made up mostly of the soil or soils for which the unit is named. Most of the delineations shown on the detailed soil map are phases of soil series.

Soils that have profiles that are almost alike make up a *soil series.* Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series commonly is named for a town or geographic feature near the place where a soil of that series was first observed and mapped. The Penwell series, for example, was named for the town of Penwell in Ector County.

Soils of one series can differ in texture of the surface layer or in the underlying substratum and in slope, erosion, stoniness, salinity, wetness, or other characteristics that affect their use. On the basis of such differences, a soil series is divided into phases. The name of a *soil phase* commonly indicates a feature that affects use or management. For example, Conger loam, 0 to 2 percent slopes, is one of several phases within the Conger series.

Some map units are made up of two or more dominant kinds of soil. Such map units are called soil complexes and soil associations.

A *soil complex* consists of areas of two or more soils that are so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area includes some of each of the two or more dominant soils, and the pattern and proportion are somewhat similar in all areas. Douro-Urban land complex is an example.

A *soil association* is made up of soils that are geographically associated and are shown as one unit on the map because it is not practical to separate them. A soil association has considerable regularity in geographic pattern and in the kinds of soil that are a part of it. The extent of the soils can differ appreciably from one delineation to another; nevertheless, interpretations can be made for use and management of the soils. Patrole-Toyah association is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because there is little value in separating them. The pattern and proportion of the soils are not uniform. An area shown on the map has at least one of the dominant (named) soils or may have all of them. Toyah soils, frequently flooded, is an undifferentiated group in this survey area.

Most map units include small, scattered areas of soils other than those that appear in the name of the map unit. Some of these soils have properties that differ substantially from those of the dominant soil or soils and thus could significantly affect use and management of the map unit. These soils are described in the description of each map unit. Some of the more unusual or strongly contrasting soils that are included are identified by a special symbol on the soil map.

Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Urban land is an example. Some of these areas are too small to be delineated and are identified by a special symbol on the soil map.

The acreage and proportionate extent of each map unit are given in table 3, and additional information on properties, limitations, capabilities, and potentials for many soil uses is given for each kind of soil in other tables in this survey. (See "Summary of tables.") Many of the terms used in describing soils are defined in the Glossary.

Soil descriptions

BfA—Blakeney fine sandy loam, 0 to 2 percent slopes. This shallow, nearly level to gently sloping soil is mainly along drainageways and around playas. Areas are irregular in shape and range from 20 to several hundred acres in size.

The surface layer is brown, calcareous fine sandy loam about 6 inches thick (fig. 1). The next layer is light brown, calcareous fine sandy loam about 10 inches thick. Depth to strongly cemented caliche is about 16 inches.

Surface runoff and internal drainage are medium. Permeability is moderately rapid in the upper 16 inches and moderately slow or slow below 16 inches. The soil blowing hazard and water erosion hazard are moderate. The plant rooting zone is restricted by the shallow depth over rock. Available water capacity is very low.

Included with this soil in mapping are small areas of Conger and Kimbrough soils. Also included is a soil similar to the Blakeney soil that is more than 20 inches deep to an indurated caliche layer. Included soils make up less than 10 percent of any one mapped area.

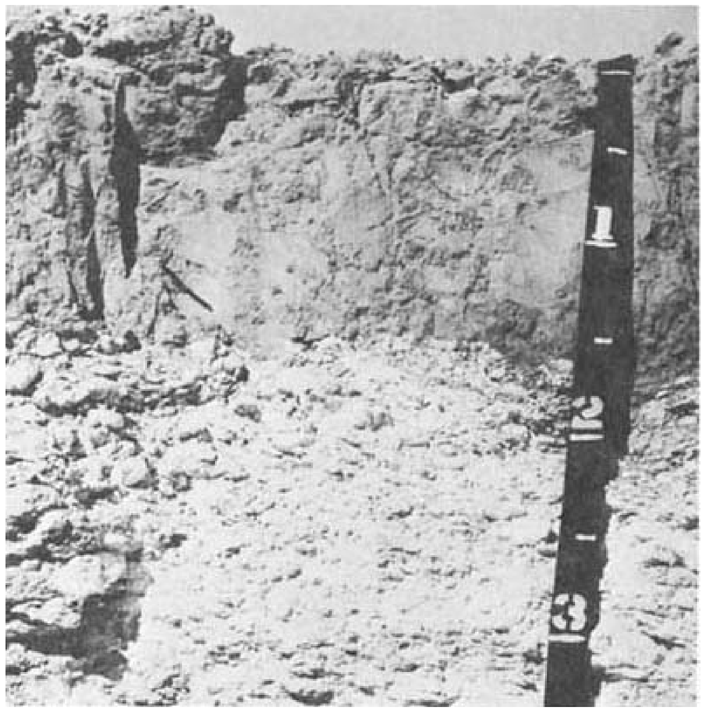


Figure 1.—Profile of Blakeney fine sandy loam, 0 to 2 percent slopes. Indurated caliche is at a depth of about 20 inches.

This Blakeney soil is used mainly for range. It has medium potential for growing a mixture of short and mid grasses. Low rainfall, very low available water capacity, and a shallow rooting depth limit the production of forage.

This soil has low potential for most urban uses. The shallow depth to indurated caliche is the limiting feature. Its potential for recreational uses is medium because the soil is dusty. Capability subclass VIe; Shallow range site.

CnA—Conger loam, 0 to 2 percent slopes. This shallow, nearly level to gently sloping soil is along drainageways and ridges and around playas. These areas are irregular in shape and range from 20 to several hundred acres in size.

The surface layer is brown, calcareous loam about 5 inches thick. The next layer is light brown, calcareous clay loam about 11 inches thick (fig. 2). Indurated caliche is below a depth of 16 inches.

Surface runoff and internal drainage are medium. Permeability is moderate in the upper 16 inches and moderately slow or slow below 16 inches. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is shallow, and the available water capacity is very low.

Included with this soil in mapping are small areas of Blakeney, Kimbrough, Ratliff, Tencee, and Reagan soils. Included soils make up less than 20 percent of any one mapped area.

This Conger soil is used mainly for range. It has low potential for growing a mixture of short and mid grasses. Low rainfall, very low available water capacity, and a shallow rooting zone limit the production of forage.

This soil has low potential for most urban uses. The shallow depth to indurated caliche is the limiting feature. Its potential for recreational uses is medium because the soil is dusty. Capability subclass VIe; Shallow range site.

Figure 2.—Profile of Conger loam, 0 to 2 percent slopes. Indurated caliche is at a depth of about 15 inches.

CRA—Conger-Reagan association, nearly level. This association is on uplands. Slopes are weakly convex to slightly concave and range from 0 to 3 percent. Areas are irregular-shaped and range from 50 to several hundred acres in size. This association consists of about 60 percent Conger soils, 30 percent Reagan soils, and 10 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

Conger soils are on convex ridges. They have a brown, calcareous loam surface layer about 6 inches thick. The next layer is pale brown, calcareous clay loam about 9 inches thick. The underlying layers are strongly cemented in the upper part and weakly cemented in the lower part. The strongly cemented layer is about 20 inches thick, and the weakly cemented layer is about 45 inches thick.

Conger soils have medium surface runoff and internal drainage. Permeability is moderate in the upper 15 inches and moderately slow or slow below 15 inches. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is restricted by the shallow depth over indurated caliche. Available water capacity is very low.

Reagan soils are in slight depressions. They have a brown, calcareous silty clay loam surface layer about 10 inches thick. The next layer is calcareous silty clay loam about 20 inches thick. It is brown in the upper part and light brown in the lower part.

The next layer, about 50 inches thick, is silty clay loam and has an accumulation of calcium carbonate. It is pink in the upper part and reddish yellow in the lower part.

Reagan soils have moderate permeability. Surface runoff is slow, and internal drainage is medium. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is deep and easily penetrated by plant roots. Available water capacity is high.

Included in mapping are small areas of Ratliff, Upton, Slaughter, and Tencee soils. Also included is a soil similar to Reagan soils that does not have an accumulation of calcium carbonate within 40 inches of the surface.

This association is used mainly as range. The Conger soils have low potential for growing plants, and the Reagan soils have medium potential. The climax plant community is a mixture of short and mid grasses. The Conger soils in this association are limited for forage production by their very low available water capacity and shallow rooting zone. Because the Reagan soils have a high available water capacity and a deep rooting zone, they produce more forage than Conger soils if properly grazed and managed for brush control.

The Conger soils have low potential for urban uses, mainly because they are shallow to indurated caliche. The Reagan soils have medium potential for urban uses. Low strength and moderate shrink-swell are the limiting features. Both soils have medium potential for recreational uses because they are dusty. Conger soils in capability subclass VIe, Shallow range site; Reagan soils in capability subclass IVe, Loamy range site.

Do—Douro-Urban land complex. This complex of nearly level to gently sloping Douro soils and Urban land is on uplands. Slopes are convex and range from 0 to 3 percent. The areas are irregular in shape and range from 20 to 500 acres in size. This complex is about 60 percent Urban land, 30 percent Douro soils, and 10 percent other soils. The soils and urban areas are so closely intermingled that mapping them separately at the scale used is not feasible.

The Douro soils of this map unit have a reddish brown, noncalcareous fine sandy loam surface layer about 8 inches thick. The next layer is red, noncalcareous sandy clay loam about 22 inches thick. The underlying layers are about 36 inches thick. They have strongly cemented caliche in the upper part and weakly cemented caliche in the lower part.

Surface runoff is slow, internal drainage is medium, and permeability is moderate in the Douro soils. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is moderately deep, and the available water capacity is low.

Urban land consists of sites for works and structures and disturbed areas. The soil in these areas has been so altered or obscured that classification is not practical. The main works and structures are office buildings, warehouses, schools, churches, dwellings, garages, sidewalks, driveways, streets, and paved parking lots. Also included in this map unit are areas that have been disturbed by cutting, filling, or grading.

Included in mapping are areas of Faskin, Stegall, and Slaughter soils. Also included are areas of a soil similar to Douro soils that has indurated caliche 8 to 20 inches below the surface.

This complex has low potential for most urban uses. Indurated caliche at a depth of 20 to 40 inches is the main limiting feature, but this problem can be overcome if structures are carefully designed and installed. Lawns and trees must be well fertilized and watered. Potential for most recreational uses is high. Not placed in a capability subclass or range site.

DU—Dune land. Dune land consists of mostly barren, active sand dunes that range from 20 to 200 feet in height. Slopes are mostly 8 to 16 percent, but they range to 20 percent in places. The dunes consist of light colored, eolian sands that show little evidence of soil development. Areas are irregular to crescent-shaped and range from 50 to 500 acres in size.

These dunes consist of noncalcareous, very pale brown fine sand that has been reworked by wind (fig. 3). They have a very low available water capacity and are excessively drained. They are constantly shifting, due to the wind, and are most unstable on the east and north sides. Between the dunes are small concave blowout areas where the soil material is similar to that of the lower layers of Penwell and Pyote soils.

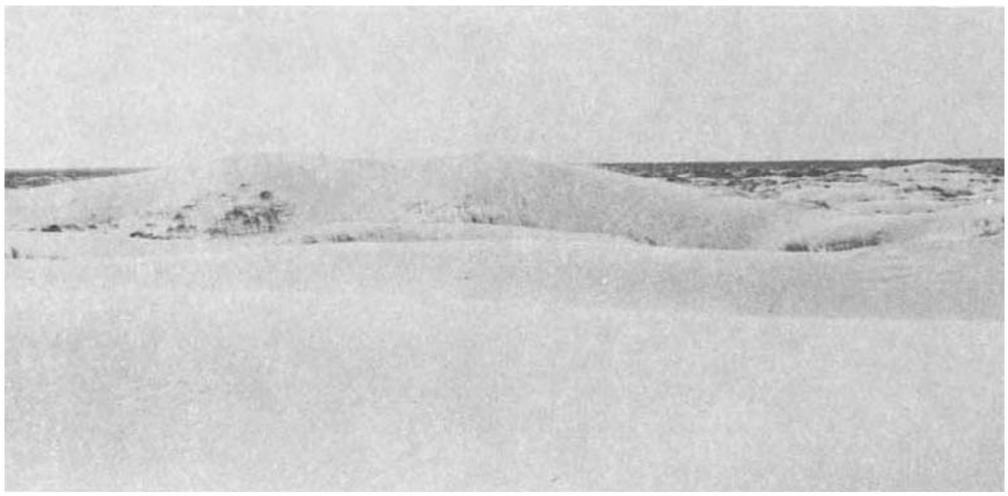


Figure 3.—Active sand dunes and sparse vegetation are characteristic of Dune land.

During years of normal to low rainfall, these dunes have little vegetation except for shinnery and tall grasses on the outer edges and between the dunes. During consecutive years of high rainfall, these dunes support a sparse cover of sand bluestem, switchgrass, New Mexico bluestem, giant reedgrass, Havard panicum, and shinnery.

The soil blowing hazard is severe. Dune land has little value except for wildlife and recreation. Not placed in a capability subclass or range site.

Fa—Faskin-Urban land complex. This complex of nearly level to gently sloping Faskin soils and Urban land is on uplands. Slopes are convex and range from 0 to 3 percent. The areas are irregular in shape and range from 40 to 1,500 acres in size. This complex is about 60 percent Urban land, 30 percent Faskin soils, and 10 percent other soils. The soils and the Urban areas are so closely intermingled that mapping them separately at the scale used is not feasible.

The Faskin soils in this map unit have a reddish brown, noncalcareous, fine sandy loam surface layer about 8 inches thick. The next layer is noncalcareous sandy clay loam about 44 inches thick. It is reddish brown in the upper 28 inches and yellowish red in the lower 16 inches. The underlying layer is reddish yellow sandy clay loam about 28 inches thick. It ranges from 20 to 30 percent, by volume, calcium carbonate.

Surface runoff is slow to medium, internal drainage is medium, and permeability is moderate in the Faskin soils. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is deep, and the available water capacity is medium.

Urban land consists of sites for works and structures and disturbed areas. The soil is an altered or obscured that classification is not practical. The main works and structures are office buildings, warehouses, schools, churches, dwellings, garages, sidewalks, driveways, streets, and paved parking lots. Also included in this map unit are areas that have been disturbed by cutting, filling, or grading.

Included in mapping are areas of Douro and Triomas soils. Also included are some areas of Faskin soils that are weakly to strongly cemented below a depth of 48 inches.

This map unit has high potential for growing trees and shrubs and for most urban uses. It needs adequate water and fertilizer to establish lawns and gardens. Potential for most recreational uses is high. Not placed in a capability subclass or range site.

FDA—Faskin-Douro association, nearly level. This association is on uplands. Slopes range from 0 to 3 percent. Areas are irregular in shape and range from 50 to several hundred acres in size. Local shifting of soil by wind is evident in some places. This association consists of 50 percent Faskin soils, 30 percent Douro soils, and 20 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Faskin soils in this association have a reddish brown, noncalcareous fine sandy loam surface layer about 8 inches thick. The next layer is noncalcareous sandy clay loam about 44 inches thick. It is reddish brown in the upper 28 inches and yellowish red in the lower 16 inches. The underlying layer is reddish yellow calcareous sandy clay loam about 28 inches thick. It ranges from 20 to 30 percent, by volume, calcium carbonate.

In the Faskin soils, surface runoff is slow to medium, internal drainage is medium, and permeability is moderate. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is deep and easily penetrated by plant roots. Available water capacity is medium.

The Douro soils in this association have a reddish brown, noncalcareous fine sandy loam surface layer about 8 inches thick. The next layer is red, noncalcareous sandy clay loam about 22 inches thick. The underlying layer is strongly cemented caliche in the upper 24 inches and weakly cemented caliche in the lower 12 inches (fig. 4).

Figure 4.—Profile of Douro fine sandy loam, in an area of Faskin-Douro association, nearly level. Indurated caliche is at a depth of 36 inches.

In the Douro soils, surface runoff is slow, internal drainage is medium, and permeability is moderate. The soil blowing hared and water erosion hazard are moderate. The rooting zone is moderately deep, and plant roots easily penetrate to the cemented layer. Available water capacity is low.

Included in mapping are small areas of Triomas soils, a soil similar to Faskin soils that has indurated caliche below 60 inches, and a soil similar to Douro soils that has indurated caliche less than 20 inches deep.

This association is used mainly as range. It has high potential for growing a mixture of short and mid grasses. Careful management is needed to minimize soil blowing. Proper stocking, controlled grazing, and brush management are also needed.

The Douro soils have low potential for urban uses. Indurated caliche at a depth of 20 to 40 inches is the main limiting feature. The Faskin soils have high potential for urban uses. Low strength limits their use for local roads and streets but can be overcome by careful design and installation. Both soils have high potential for recreational uses. Capability subclass IVe; Sandy Loam range site.

Ho—Holloman-Urban land complex. This complex of nearly level to gently sloping Holloman soils and Urban land is on uplands. Slopes arc concave and range from 0 to 2 percent. Areas an' long and narrow or irregular in shape and range from 20 to 500 acres in size. This complex consists of about 50 percent Holloman soils, 30 percent Urban land, and 20 percent other soils. The soils and the Urban areas are so closely intermingled that mapping them separately at the scale used is not feasible.

The Holloman soils have a light brown, calcareous loam surface layer about 8 inches thick. The underlying layer is a calcareous, weakly cemented gypsum bed about 32 inches thick. It is very pale brown in the upper 16 inches and pink in the lower 16 inches.

Surface runoff and internal drainage are medium in the Holloman soils. Permeability is moderate in the upper 8 inches and moderately slow below 8 inches. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is very shallow, and the available water capacity is very low.

Urban land consists of areas of works and structures and disturbed areas that have so altered or obscured the soil profile that classification is not practical. The main works and structures are office buildings, warehouses, schools, churches, dwellings, garages, sidewalks, driveways, streets, and paved parking lots. Also included in this map unit art areas that have been disturbed by cutting, filling, or grading.

Included in mapping are areas of Reeves and Ratliff soils and a soil similar to Toyah soils that has gypsum beds within 20 to 40 inches of the surface.

The potential for most urban uses is low. Depth to gypsum, low strength, and corrosivity are the main limiting features. Topsoil should be added, and adequate water and fertilizer should be applied for most lawn and garden uses. Potential for recreation uses is medium because the soils of this complex are dusty. Not placed in a capability subclass or range site.

HRA—Holloman-Reeves association, nearly level. This association is on uplands. Slopes range from 0 to 3 percent. Areas are irregular in shape and range from 20 to several hundred acres in size. This association is 56 percent Holloman soils, 22 percent Reeves soils, and 22 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Holloman soils have a light brown, calcareous loam surface layer about 8 inches thick. The underlying layer is a calcareous, weakly cemented gypsum bed about 32 inches thick (fig. 5). It is very pale brown in the upper 16 inches and pink in the lower 16 inches.

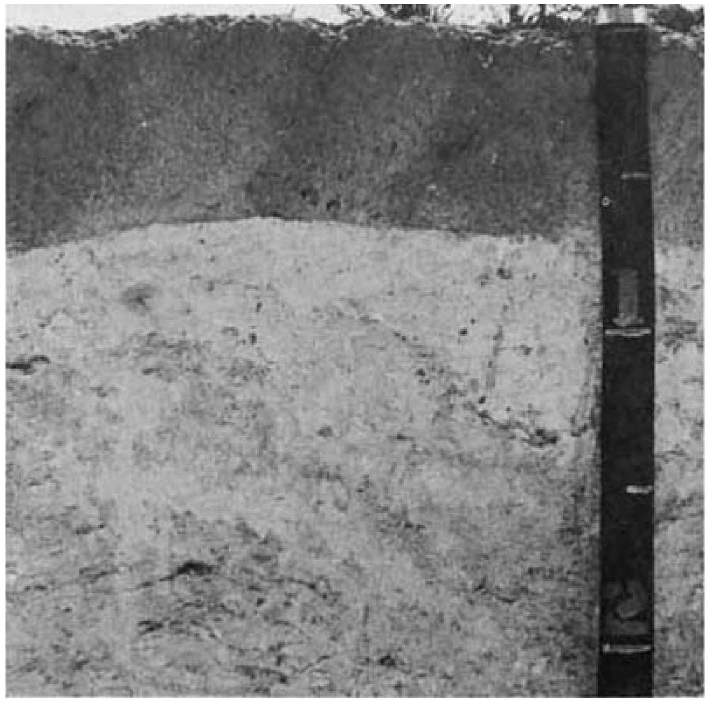


Figure 5.—Profile of Holloman loam, in an area of Holloman Reeves association, nearly level. Weekly cemented gypsum is at a depth of 8 inches.

The Holloman soils have medium surface runoff and internal drainage and moderate permeability. The soil blowing hazard and water erosion hazard are moderate. The plant rooting zone is very shallow, and the available water capacity is very low.

The Reeves soils have a light brown, calcareous loam surface layer about 9 inches thick. The next layer is light brown, calcareous loam about 18 inches thick (fig. 6). The underlying layer is calcareous white loam to a depth of 36 inches and pink sandy loam from 36 to 60 inches. This horizon ranges from 25 to 50 percent, by volume, calcium sulfate and calcium carbonate.

In the Reeves soils, surface runoff and internal drainage are medium, and permeability is moderate. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is moderately deep, and the available water capacity is medium.

Minor soils included in mapping are Kinco, Ima, Reakor, and Reagan soils and a soil similar to Reeves soils that is more than 40 inches deep to gypsum.

This association is used mainly as range (fig. 7). It has low potential for growing a mixture of short and mid grasses. Management should include proper stocking, controlled grazing, and brush management.

The Holloman soils have low potential for most urban uses. Depth to the gypsum layer, low strength, and corrosivity are the limiting features. Reeves soils have a medium potential for urban uses. Shrink-swell, low strength, and corrosivity to uncoated steel are the limiting features. Both soils have medium potential for recreational uses because they are dusty. Holloman soils in capability subclass VIIs, Gyp range site; Reeves soils in capability subclass VIIe; Loamy range site.

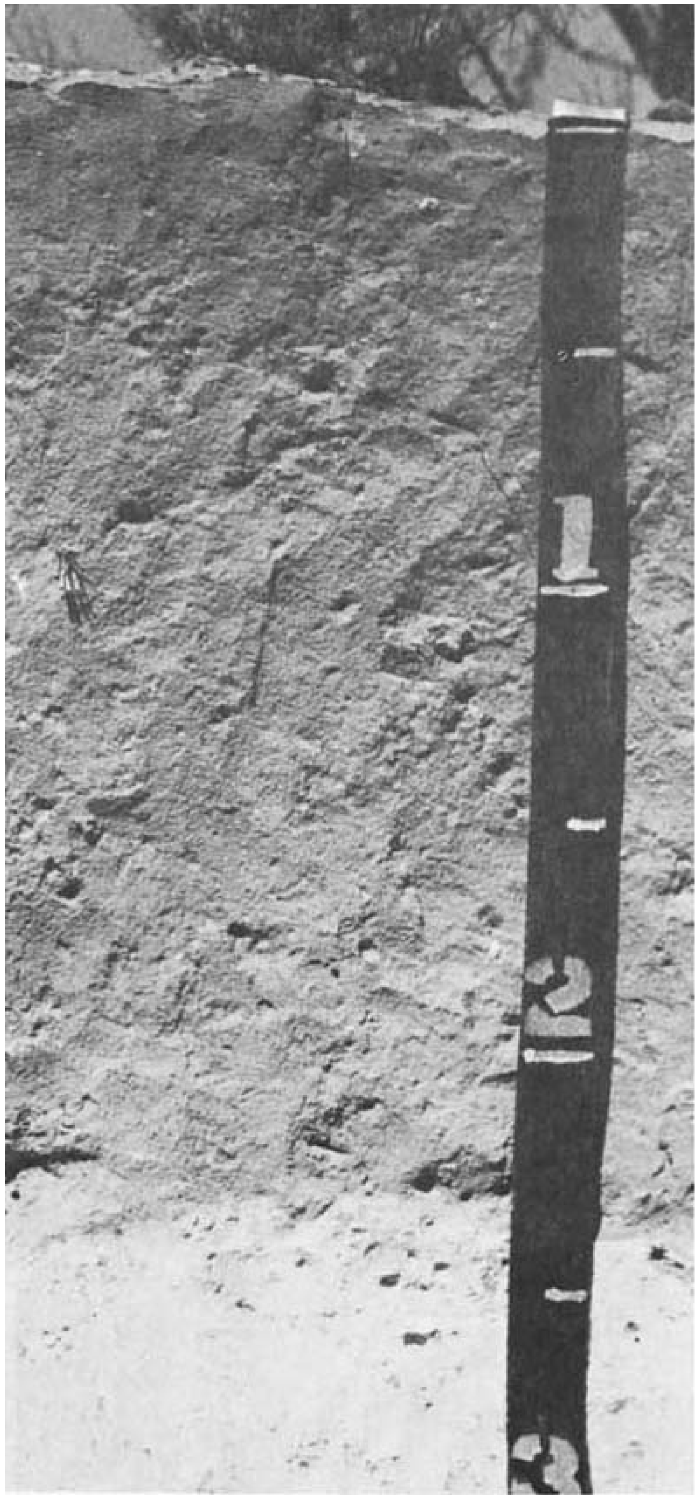


Figure 6.—Profile of Reeves loam, in an area of Holloman-Reeves association, nearly level. Weakly cemented gypsum and calcium carbonate are at a depth of about 28 inches.

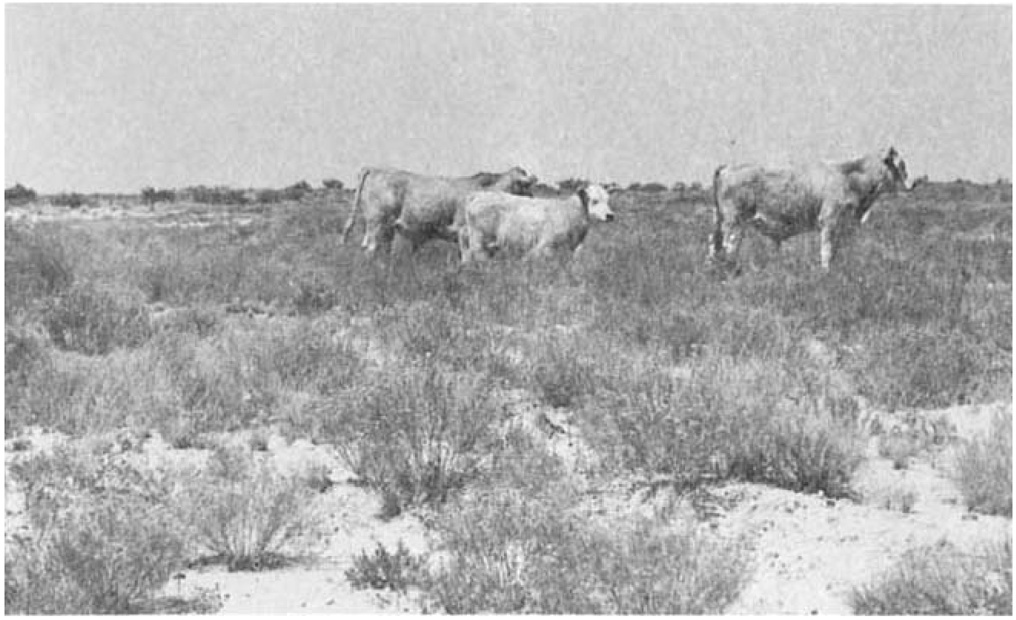


Figure 7.—An area of Holloman-Reeves association, nearly level. Holloman soils are in the Gyp range site, and Reeves soils are in the Loamy range site.

JPC—Jalmar-Penwell association, undulating. This association is on uplands. Slopes range from 1 to 8 percent. Areas are irregular in shape and range from 300 to 3,000 acres in size. Local shifting of soil by wind is evident in some places. This association consists of 55 percent Jalmar soils, 23 percent Penwell soils, and 22 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Jalmar soils have a noncalcareous fine sand surface layer that is brown in the top 13 inches and reddish brown from 13 to 35 inches. The next layer is red, noncalcareous to slightly calcareous sandy clay loam about 37 inches thick. The underlying layer is reddish yellow, calcareous sandy clay loam. It contains 35 percent, by volume, calcium carbonate.

Surface runoff is very slow, and internal drainage is medium in Jalmar soils. Permeability is moderate. The soil blowing hazard is severe, and water erosion hazard is slight. The rooting zone is deep and easily penetrated by plant roots. Available water capacity is low.

The Penwell soils have a light brown, noncalcareous fine sand surface layer about 13 inches thick. The underlying layers are reddish yellow, noncalcareous fine sand about 65 inches thick.

Surface runoff is slow in Penwell soils. Internal drainage and permeability are rapid. The soil blowing hazard is severe, and the water erosion hazard is slight. The rooting zone is deep and easily penetrated by plant roots. Available water capacity is very low.

Included in mapping are small areas of Dune land and Pyote soils. Also included around the base of shinnery and mesquite shrubs are Jalmar soils that have a thicker surface layer.

This association is used mainly as range. It has medium potential for growing a mixture of tall and mid grasses. Careful management is needed to minimize soil blowing. Proper stocking, controlled grazing, and brush management are needed.

The potential for urban uses is high. Adequate fertilizer and water must be added to the sandy surface layer to establish lawns and gardens. Potential for recreational uses is low because the soils are too sandy. Jalmar soils in capability subclass VIe, Sandy range site; Penwell soils in capability subclass VIIe, Sandhills range site.

Kb—Kimbrough-Urban land complex. This complex of nearly level to gently sloping Kimbrough soils and Urban land is on knobs and ridges. Slopes are convex and range from 0 to 3 percent. Areas are round to irregular in shape and range from 10 to 100 acres in size. This complex is about 60 percent Kimbrough soils, 30 percent Urban land, and 10 percent other soils. The soils and Urban areas are so closely intermingled that mapping them separately at the scale used is not feasible.

The Kimbrough soils have a dark brown, calcareous loam surface layer about 7 inches thick. The underlying layer is about 57 inches thick. It has strongly cemented caliche in the upper part and weakly cemented caliche in the lower part.

Surface runoff of Kimbrough soils is slow to medium, internal drainage is medium, and permeability is moderate. The soil blowing hazard is moderate, and water erosion hazard is slight. The rooting zone is very shallow to shallow. Available water capacity is very low.

Urban land consists of areas of works and structures and disturbed areas in which the soil is so altered or obscured that classification is not practical. The main works and structures are office buildings, warehouses, schools, churches, dwellings, garages, sidewalks, driveways, streets, and paved parking lots. Also included are areas that have been disturbed by cutting, filling, or grading.

Other soils included in mapping are Stegall, Conger, and Slaughter soils and a soil similar to Douro soils that has a strongly cemented layer of caliche less than 20 inches below the surface.

Potential of this complex for most urban uses is low. Corrosivity to uncoated steel and very shallow to shallow depth to indurated caliche are the main limiting features. Topsoil should be added to establish lawns and gardens. Potential for most recreation uses is high. Depth to indurated caliche limits the use of this complex for playgrounds. Not placed in a capability subclass or range site.

KSA—Kimbrough-Stegall association, nearly level. This association is on uplands. Slopes range from 0 to 3 percent. Areas are round to irregular in shape and range from 200 to several thousand acres in size. This association is 70 percent Kimbrough soils, 23 percent Stegall soils, and 7 percent other soils. The soils are so similar in use and management that mapping them separately is not justified.

The Kimbrough soils have a brown loam surface layer about 7 inches thick that has 10 to 15 percent caliche fragments. The underlying layer is strongly cemented caliche in the upper part and weakly cemented caliche in the lower part.

Surface runoff is slow to medium on the Kimbrough soils. Internal drainage is medium, and permeability is moderate. The soil blowing hazard is moderate, and water erosion hazard is slight. The plant rooting zone is very shallow to shallow. Available water capacity is very low.

Stegall soils are in rounded, nearly level, slight depressions. They have a brown, mildly alkaline, clay loam surface layer about 6 inches thick. The next layer is reddish brown, moderately alkaline clay loam about 25 inches thick. The underlying layer is indurated caliche that has a laminar upper part that is about 1/2 inch thick. Below the laminar layer is weakly to strongly cemented caliche.

In the Stegall soils, surface runoff is slow, internal drainage is medium, and permeability is moderately slow. The soil blowing hazard is slight, and water erosion hazard is moderate. The rooting zone is moderately deep and easily penetrated by plant roots. Available water capacity is low.

Included in mapping are areas of Conger, Slaughter, and Lipan soils and a soil similar to Stegall soils that lacks indurated caliche. Included soils make up less than 15 percent of any one mapped area.

This association is used mainly as range. The Kimbrough soils have low potential for growing short and mid grasses. Their very shallow to shallow depth to caliche and very low available water capacity are the main limiting features. Because Stegall soils are deeper and have a higher available water capacity than Kimbrough soils, they can produce more forage.

This association has low potential for most urban uses. The depth to indurated caliche, which is the main limiting feature for this use, can be overcome by careful design and installation. Potential for most recreational uses is high. Depth to caliche limits some playground uses of the soils. Kimbrough soils in capability subclass VIs, Very Shallow range site; Stegall soils in capability subclass IIIe, Clay Loam range site.

KUA—Kimbrough association, nearly level. This association is on uplands. Slopes are weakly convex to slightly concave and range from 0 to 3 percent. The areas range from 40 to 400 acres in size and are irregular in shape. This association is about 85 percent Kimbrough soils and 15 percent other soils. These soils are so similar in use and management that mapping them separately is not justified. The Kimbrough soils have a surface layer of loam or gravelly loam.

Typically, the Kimbrough soils have a brown, calcareous loam surface layer about 7 inches thick. The underlying layer is strongly cemented caliche in the upper part and weakly cemented caliche in the lower part.

Surface runoff is slow to medium, internal drainage is medium, and permeability is moderate. The soil blowing hazard is moderate, and the water erosion hazard is slight. The rooting zone is very shallow to shallow. Available water capacity is very low.

Included in mapping are small areas of Slaughter, Conger, and Lipan soils and a soil similar to Blakeney soils that has a layer of clay accumulation over indurated caliche.

This association is used mainly for range. It has low potential for a mixture of short and mid grasses.

This association has low potential for most urban uses, Depth to indurated caliche and corrosivity to uncoated steel are the main limitations. Potential for most recreational uses is high. Some playground uses are limited by the very shallow to shallow depth. Capability subclass VIs; Very Shallow range site.

KWB—Kinco-Ima association, gently undulating. This association is on uplands. Slopes range from 1 to 5 percent. Areas are irregular to oval in shape and range from 50 to several hundred acres in size. Local shifting of soils by wind is evident in some places. This association is about 65 percent Kinco soils, 25 percent Ima soils, and 10 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Kinco soils have a brown, calcareous loamy fine sand surface layer about 9 inches thick. The next layer is brown, calcareous fine sandy loam about 21 inches thick. The underlying layer is calcareous sandy loam about 42 inches thick. It is reddish yellow in the upper part and pinkish white in the lower part.

Surface runoff on the Kinco soils is slow, internal drainage is medium, and permeability is moderately rapid. The soil blowing hazard is severe, and the water erosion hazard is slight. The rooting zone is deep. Available water capacity is medium.

The Ima soils have a brown, noncalcareous, loamy fine sand surface layer about 10 inches thick. The next layer is calcareous fine sandy loam about 35 inches thick. It is light reddish brown in the upper part and light brown in the lower part. Below that is pink, calcareous sandy clay loam about 27 inches thick.

Surface runoff on the Ima soils is slow, internal drainage is medium, and permeability is moderately rapid. The soil blowing hazard is severe, and the water erosion hazard is slight. The rooting zone is deep. Available water capacity is medium.

Included in mapping are small areas of a soil similar to Reeves soils that has a loamy fine sand surface layer and a gypsum lower layer. Included soils are less than 15 percent of any one mapped area.

This association is used mainly for range. It has low potential for growing a mixture of short and mid grasses. Management concerns include proper stocking, controlled grazing, and brush management.

This association has high potential for urban uses. Fertilizer and water must be added to establish lawns and gardens because the surface is sandy. Potential for most recreational uses is medium because of the sandy surface. Loamy Sand range site; Kinco soils in capability subclass VIe, Ima soils in capability subclass IVe.

Lc—Lipan clay, depressional. This is a nearly level soil in slightly concave playas. These playas are enclosed depressions or intermittent lakes that are somewhat rounded or oval in shape and range from 10 to 60 acres in size. Slopes range from 0 to 1 percent.

The surface layer is gray, calcareous clay about 25 inches thick. The layer beneath is gray, calcareous clay about 30 inches thick. Depth to lime accumulation is about 55 inches.

Surface runoff is very slow to ponded; water enters the cracked soil rapidly, but after the cracks are closed, water movement into the soil is very slow. In wet years water stands on the surface until it evaporates in the spring or fall. The soil blowing hazard is moderate, and the water erosion hazard is slight. The rooting zone is deep. Available water capacity is high.

Included with this soil in mapping are small areas of a soil that is similar but has indurated caliche at a depth of 34 to (30 inches. This included soil has gilgai microrelief. They micro-lows are mainly 6 to 20 feet wide and 6 to 12 inches lower than the micro-highs. Included soils make up less than 10 percent of any one mapped area.

This Lipan soil is used mainly as range. It has a high potential for growing short and mid grasses, but occasional flooding can affect forage production.

Potential for most urban uses is low. Flooding, very high shrink-swell, low strength, and corrosivity to uncoated steel are the limitations. Potential for most recreational uses is low because of flooding and the clayey surface texture. Capability subclass IVw; Lakebed range site.

LRG—Lozier-Rock outcrop association, steep. This association is on uplands. Slopes are convex and range from 20 to 30 percent. The areas are irregular in shape and range from 20 to several hundred acres in size. About 70 percent of the surface is covered with limestone, caliche, and sandstone fragments. This association consists of about 50 percent Lozier soils, 25 percent Rock outcrop, and 25 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Lozier soils have a light brownish gray, calcareous, gravelly loam surface layer, about R inches thick, that is about. 50 percent, by volume, limestone fragments coated with caliche (fig. 8). Most of these fragments are less than 3 inches across, but some are up to 6 or 8 inches across. The underlying layer is fractured platy limestone.

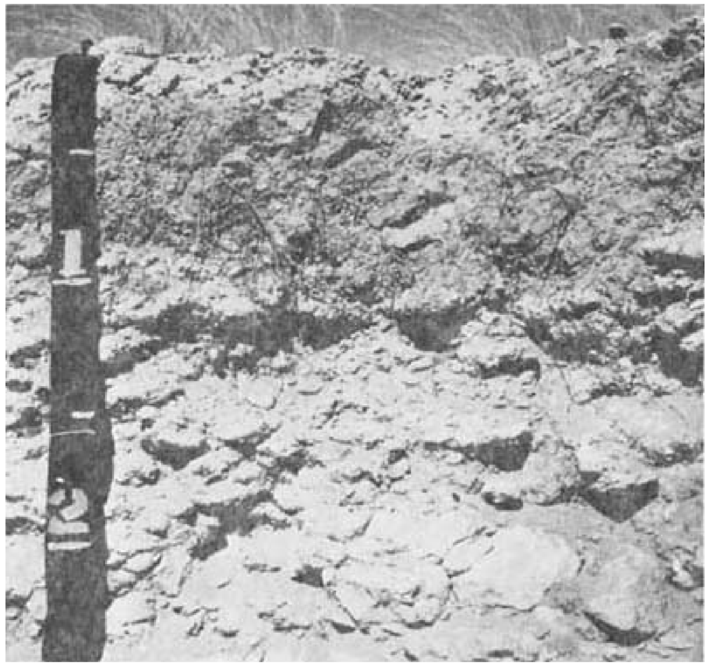


Figure 8.—Profile of Lozier gravelly loam in an area of Lozier-Rock outcrop association, steep. The fractured platy limestone coated with caliche is at a depth of about 10 inches.

Surface runoff on the Lazier soils is rapid, internal drainage is medium, and permeability is moderate. The soil blowing hazard is slight, and the water erosion hazard is moderate. The rooting zone is very shallow to shallow. Available water capacity is very low.

Included in mapping are small areas of Conger, Upton, and Tencee soils and a soil that is similar to Lozier soils but is underlain by sandstone.

This association is used mainly as range. It has low potential for growing a mixture of short and mid grasses. Surface fragments and very shallow to shallow rooting depth are the main limiting features (fig. 9). Management concerns include proper stocking, controlled grazing, and brush management.

Potential for most urban uses is low. Depth to rock, large surface stones, and corrosivity to uncoated steel are the main limiting features. Potential for most recreational uses is low because of stoniness. Capability subclass VIIs; Limestone Hills range site.

PA—Patrole-Toyah association. This is a nearly level association in slight depressions adjacent to major streams. Most areas are rarely flooded. A few areas occasionally are flooded by run-in water from small drains. Slope ranges from 0 to 1 percent. The areas are irregular in shape and range from 50 to 500 acres in size.

This association consists of 43 percent Patrole soils, 33 percent Toyah soils, and 24 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

Patrole soils are in long, narrow, slightly convex areas. They have a light reddish brown, calcareous silt loam surface layer about 10 inches thick. The underlying layer is about 50 inches thick. It is light brown, calcareous silty clay loam over reddish brown, calcareous clay.

Figure 9.—An area of Lozier-Rock outcrop association, steep, in Limestone Hills range site. A stony surface and low potential for range plants are characteristic of this site.

Patrole soils are moderate to high in salinity. Surface runoff is slow. Internal drainage is medium, and permeability is moderately slow. The soil blowing hazard is moderate, and the water erosion hazard is slight. The rooting zone is deep and easily penetrated by plant roots. Available water capacity is low.

Toyah soils are in slight depressions. They have a dark grayish brown, calcareous loam surface layer about 16 inches thick. The underlying layer is about 44 inches thick. It is light brownish gray, calcareous loam over reddish brown, calcareous clay loam.

Toyah soils are moderate to high in salinity. Surface runoff is medium, internal drainage is medium, and permeability is moderate. The soil blowing hazard is moderate, and the water erosion hazard is slight. The rooting zone is deep; plant roots can easily penetrate the soil. The available water capacity is high.

Included in mapping are small areas of Pecos soils and a soil that is similar to Toyah soils but does not have a dark surface layer. This association is used mainly for range. Both Patrole and Toyah soils have medium potential for growing a mixture of mid grasses. Management concerns include proper stocking, controlled grazing, and brush management.

Potential for most urban uses is low. Low strength, high shrink-swell, high corrosivity to uncoated steel, and flooding are the limiting features. Potential for most recreational uses is low. Flooding and a dusty surface are the limiting features. Salty Bottom land range site; Patrole soils in capability subclass VIIs, Toyah soils in capability subclass VIw.

PC—Pecos association. This is a nearly level association on flood plains. Slope ranges from 0 to 1 percent. Areas are irregular in shape and range from 50 to 500 acres in size. Most areas are rarely flooded because rainfall is low, but a few areas are occasionally flooded by run-in water from side drains. This association consists of about 70 percent Pecos soils and 30 percent other soils. These soils are so similar in use and management that mapping them separately is not justified. The Pecos soils have a surface layer of silty clay or clay.

The Pecos soils have a surface layer, about 16 inches thick, that typically is dark grayish brown, calcareous silty clay in the top 10 inches and very dark grayish brown, calcareous clay in the lower part. Films and threads of calcium sulfate and other salts range from few to common. The underlying layer, to a depth of 80 inches, is calcareous clay. It is grayish brown in the upper 16 inches and reddish brown in the lower 48 inches. These layers have many bodies of calcium sulfate and other salts.

Surface runoff and internal drainage are slow. Permeability is very slow. The soil blowing hazard is moderate, and the water erosion hazard is slight. The rooting zone is deep. The available water capacity is low.

Included in mapping are Patrole, Toyah, Holloman, and Reeves soils; a soil that is similar to Toyah soils but has a light-colored surface layer; and a soil that is similar to Pecos soils but has a red clayey surface layer.

This association is used mainly for range. It has medium potential for growing mid grasses (fig. 10). Management should include proper stocking rates, controlled grazing, and brush management.

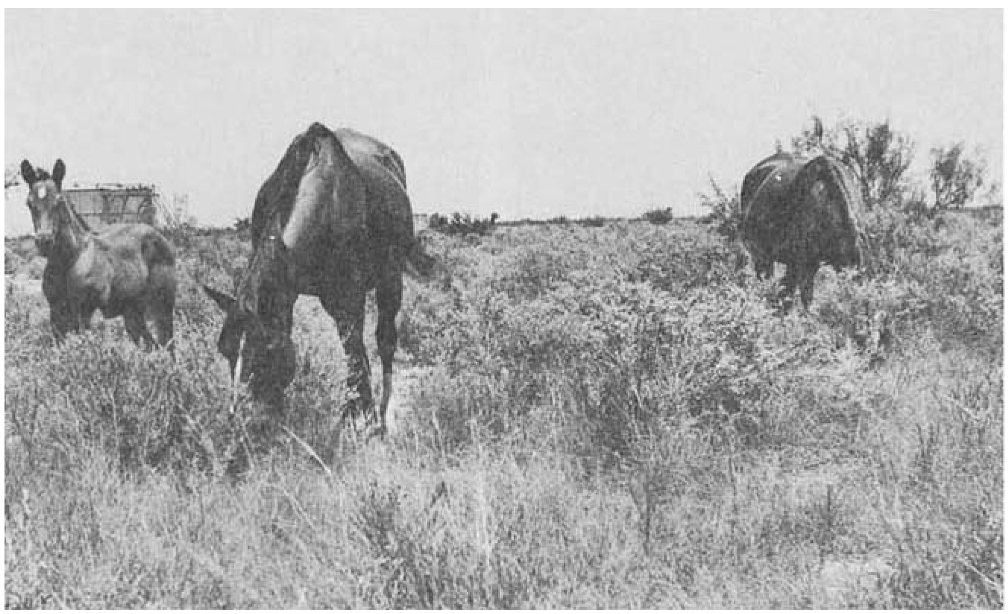


Figure 10.—An area of Pecos association in the Salty Bottomland range site, which has medium potential for native range plants.

Potential for most urban uses is low. Occasional flooding, high shrink-swell, and corrosivity to uncoated steel are the main limiting features. Potential for most recreational uses is low because of flooding. Capability subclass VIIs; Salty Bottomland range site.

PDD—Penwell-Dune land association, rolling. This association is on uplands. Most areas have a duned topography, but some are smooth. Slopes range from 5 to 16 percent. These areas are broad, irregular to moon-shaped, and range from 100 to several thousand acres in size. Local shifting of soil by wind is evident in some places. This association is about 70 percent Penwell soils, 25 percent Dune land, and 5 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Penwell soils have a brown, noncalcareous, fine sand surface layer about 13 inches thick. The underlying layer, to a depth of 80 inches, is noncalcareous fine sand that is light brown in the upper part and pink in the lower part.

Surface runoff is slow on the Penwell soils. Internal drainage and permeability are rapid. The soil blowing hazard is severe, and the water erosion hazard is moderate. The soils are deep and easily penetrated by plant roots. Available water capacity is very low.

Dune land consists of light colored, eolian sands that show little evidence of soil development. The dunes are active; they are constantly shifted by the wind and are especially unstable on the east and north sides. During years of low to normal rainfall these dunes have little vegetation except for shinnery and tall grasses on the outer edges and between the dunes. During consecutive years of above-average rainfall these dunes support sparse tall grasses and annuals.

Included in mapping are small areas of Jalmar and Pyote soils and a soil that is similar to Reeves soils but has a fine sand surface layer over gypsum. Included soils make up less than 10 percent of any mapped area.

This association is used mainly as range. It has medium potential for growing a mixture of tall and mid grasses (fig. 11). Careful management is needed to minimize soil blowing. Management concerns include proper stocking, controlled grazing, and brush management.

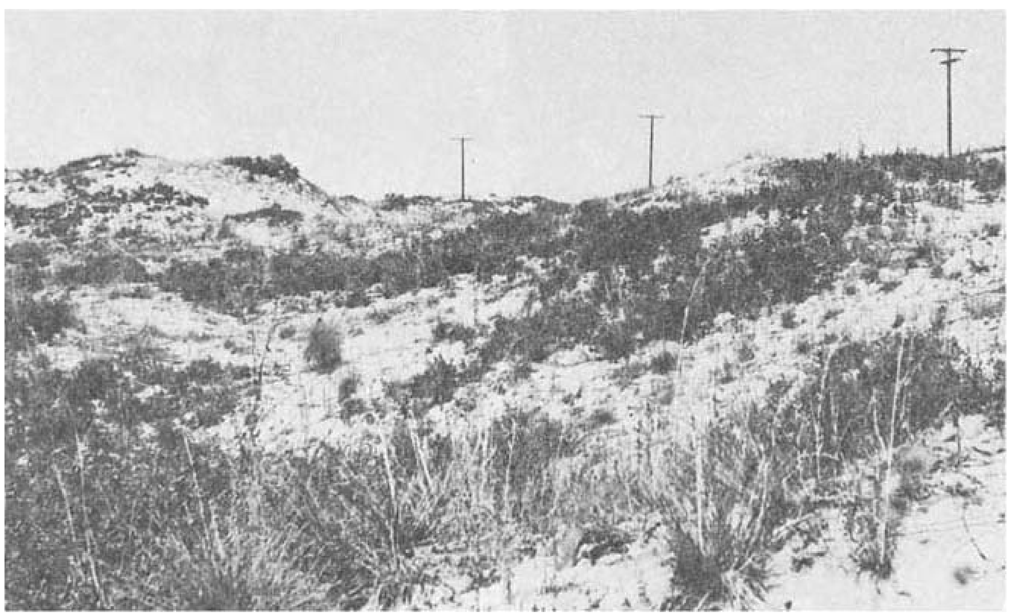


Figure 11.—An area of Penwell-Dune land association, rolling, in the Sandhills range site. Penwell soils support some vegetation, Dune land for the most part, is bare.

Potential for most urban uses is medium. Seepage, a sandy surface layer, and soil blowing are the main limiting features. Potential for most recreational uses is low because the surface is too sandy. Capability subclass VIIe; Sandhills range site.

PPC—Penwell-Pyote association. undulating. This association is on uplands. Slopes range from 1 to 8 percent. Areas are irregular in shape and range from 300 to 3,000 acres or more in size. Local shifting of soil by wind is evident in some areas. This association is about 47 percent Penwell soils, 27 percent Pyote soils, and 26 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Penwell soils have a light brown, noncalcareous fine sand surface layer about 12 inches thick. The underlying layer is reddish yellow, noncalcareous fine sand about 68 inches thick.

Surface runoff is slow on Penwell soils. Internal drainage and permeability are rapid. The soil blowing hazard is severe, and water erosion hazard is moderate. The soils are deep and are easily penetrated by plant roots. Available water capacity is very low.

The Pyote soils have a noncalcareous fine sand surface layer about 34 inches thick that is yellowish red in the upper part and reddish yellow in the lower part. The next layer is reddish yellow, noncalcareous fine sandy loam about 36 inches thick. The underlying layer is reddish yellow, noncalcareous loamy fine sand about 10 inches thick.

Surface runoff on the Pyote soils is very slow; internal drainage is rapid, and permeability is moderately rapid. The soil blowing hazard is severe, and the water erosion hazard is slight. These soils are deep and easily penetrated by plant roots. Available water capacity is low.

Included in mapping are small areas of Jalmar, Wickett, Kinco, and Reeves soils and a soil that is similar to Pyote soils but has a thicker surface layer. These included soils make up less than 30 percent of any one mapped area.

This association is used mainly as range. It has medium potential for growing a mixture of mid and tall grasses. Careful management is needed to minimize soil blowing. Management should include proper stocking, controlled grazing, and brush management.

Penwell soils have medium potential for most urban uses. Seepage and the sandy surface layer are the limiting features. These soils have low potential for recreational uses because they are too sandy. Pyote soils have high potential for most urban uses. The sandy surface layer is a limiting feature. The potential for recreational uses is medium because of the sand. Penwell soils in capability subclass VIIe, Sandhills range site; Pyote soils in capability subclass VIe, Sandy range site.

Ra—Ratliff-Urban land complex. This complex of nearly level to gently sloping Ratliff soils and Urban land is on uplands. Slopes range from 0 to 3 percent. The areas are oval to irregular in shape and range from 20 to 600 acres in size. They are made up of about 50 percent Ratliff soils, 40 percent Urban land, and 10 percent other soils. The soils and the Urban land are so closely intermingled that mapping them separately at the scale used is not feasible.

The Ratliff soils have a brown, calcareous loans surface layer about 8 inches thick. The next layer is light brown, calcareous clay loam about 16 inches thick. The underlying layers are pink, calcareous clay loam, about 56 inches thick, and have an accumulation of 30 to 40 percent, by volume, of secondary carbonates.

Surface runoff is medium, internal drainage is medium, and permeability is moderate in Ratliff soils. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is deep. The available water rapacity is medium.

Urban land consists of areas used for office buildings, warehouses, schools, churches, residential houses, driveways, streets, sidewalks, parks, commercial buildings, and parking lots. Because of the stability of the soil and the nearly level surface, most areas have not been altered greatly during construction.

Included in mapping are areas of Reeves, Reagan, and Faskin soils. Also included are areas of Ratliff soils that are underlain by strongly cemented caliche 20 to 40 inches below the surface. These inclusions make up less than 15 percent of any one mapped area.

This complex has high potential for most urban uses. Additions of adequate water and fertilizer are needed to establish lawns and gardens. Potential for most recreational uses is high. Not placed in a capability subclass or range site.

RFA—Ratliff association, nearly level. This association is on uplands. Slopes are concave and range from 0 to 3 percent. Areas are irregular to oval in shape and range from 20 to several hundred acres in size. This association is made up of about 90 percent Ratliff soils and 10 percent other soils. The soils are so similar in use and management that mapping them separately is not justified. The Ratliff soils have a surface layer of loam or fine sandy loam.

Typically, Ratliff soils have a surface layer of brown, calcareous loam about 8 inches thick. The next layer is light brown, calcareous clay loam about 16 inches thick. The underlying layer is pink, calcareous clay loam about 56 inches thick. It ranges from 30 to 40 percent, by volume, calcium carbonate.

Surface runoff and internal drainage are medium, and permeability is moderate. The soil blowing hazard and water erosion hazard are moderate. Ratliff soils are deep and easily penetrated by plant roots. Available water capacity is medium.

Included in mapping are small areas of Kinco, Conger. Reeves, Reagan, and Lipan soils. These soils make up less than 15 percent of any one mapped area.

This association is used mainly as range. It has high potential for growing a mixture of short and mid grasses. Management includes proper stocking, controlled grazing, and brush management.

The potential for urban uses is high. The association has moderate corrosivity to uncoated steel and low strength for local roads and streets, but these limitations can be overcome with careful design and installation. Potential for most recreational uses is high. Capability subclass IVe; Sandy Loam range site.

RgA—Reagan silty clay loam, 0 to 1 percent slopes. This nearly level soil is on smooth plains. Areas are irregular to oval in shape and range from 20 to 2,000 acres in size.

Typically, the surface layer is calcareous silty clay loam about 11 inches thick. It is light brown in the upper part and brown in the lower part. The next layer is light brown, calcareous silty clay loam about 23 inches thick. The underlying layer is calcareous silty clay loam about 46 inches thick. It is pink in the upper part and reddish yellow in the lower part and contains about 30 to 40 percent, by volume, calcium carbonate.

Surface runoff is slow, internal drainage is medium, and permeability is moderate. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is deep, and the soil is easily penetrated by plant roots. Available water capacity is high.

Included with this soil in mapping are small areas of Conger and Lipan soils and a soil that is similar to Reagan soils but has an accumulation of calcium carbonate below 40 inches. Inclusions make up less than 20 percent of any one mapped area.

This Reagan soil is used mainly for range. It has medium potential for growing a mixture of short and mid grasses. Management concerns include proper stocking, controlled grazing, and brush management.

This soil has medium potential for most urban uses. High shrink-swell upon wetting and drying and low strength under load are the main limiting features. Potential for most recreational uses is medium because the soil is dusty. Capability subclass IVc; Loamy range site.

RRA—Reakor association, nearly level. This association is on slightly depressed uplands. Slopes range from 0 to 3 percent. Areas are irregular to oval in shape and range from 50 to 3,000 acres or more in size. The association consists of about 56 percent Reakor soils and 44 percent other soils. These soils are so similar in use and management that mapping them separately is not justified. The Reakor soils have a surface layer of silty clay loam or clay loam.

Typically, the Reakor soils have a surface layer of light brownish gray, calcareous silty clay loam about 7 inches thick. The next layer is light brown, calcareous silty clay loam about 21 inches thick. Below that is 20 inches of light brown, calcareous silty clay loam; 12 inches of light brown, calcareous silt loam; and 20 inches of light brown, calcareous silty clay. Calcium carbonate ranges from 8 to 40 percent, by volume.

Surface runoff is slow, internal drainage is medium, and permeability is moderate. The soil blowing hazard and water erosion hazard are moderate. Reakor soils are deep and easily penetrated by plant roots. Available water capacity is high.

Included in mapping are areas of Upton and Ima soils, a soil that is similar to Reakor soils but has an accumulation of calcium carbonate at a depth below 40 inches, and a soil that is similar to Ima soils but has no accumulation of secondary carbonate within 60 inches of the surface.

This association is used mainly as range. It has low potential for growing a mixture of short and mid grasses. Management should include proper stocking, controlled grazing, and brush management.

The potential for urban uses is medium. High corrosivity to uncoated steel and high shrink-swell are the limiting features. Potential for recreational uses is medium because the soils are dusty. Capability subclass VIIe; Loamy range site.

Se—Stegall-Urban land complex. This complex of nearly level Stegall soils and Urban land is on slightly depressed uplands. Slopes are concave and range from 0 to 1 percent. Areas are oval to irregular in shape and range from 20 to 100 acres in size. This map unit is 60 percent Urban land, 30 percent Stegall soils, and 10 percent other soils. The Urban land areas and the soils are so closely intermingled that mapping them separately at the scale used is not feasible.

The Stegall soils have a brown, noncalcareous clay loam surface layer about 6 inches thick. Next is 12 inches of reddish brown, noncalcareous clay loam, then 12 inches of reddish brown, noncalcareous clay. The underlying layer is indurated caliche to a depth of 58 inches.

Surface runoff is slow on Stegall soils, internal drainage is medium, and permeability is moderately slow. The soil blowing hazard is slight, and the water erosion hazard is moderate. The rooting zone is moderately deep. The available water capacity is low.

Urban land is used mainly for office buildings, warehouses, schools, churches, dwellings, garages, sidewalks, driveways, streets, and paved parking lots. It also includes areas that have been disturbed by cutting, filling, or grading. In disturbed areas the soil profile has been so altered or obscured that classification is not practical.

Other soils included in this complex are Slaughter, Lipan, and Kimbrough soils and a soil that is similar to Stegall soils but does not have indurated caliche within 40 inches of the surface.

Potential for most urban uses is low. The main limiting features of this complex are low strength, moderate corrosivity to uncoated steel, and indurated caliche less than 40 inches deep. Potential for recreational uses is medium because the surface texture is too clayey, and water moves through the soil too slowly. Not placed in a capability subclass or range site.

SSA—Stegall-Slaughter association, nearly level. This association is on uplands. Slopes are slightly concave and range from 0 to 1 percent. Areas are round to irregular in shape and range from 30 to 400 acres in size. This association is 56 percent Stegall soils, 30 percent Slaughter soils, and 14 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

The Stegall soils have a surface layer of brown, noncalcareous clay loam about 6 inches thick. Below that is 12 inches of reddish brown, noncalcareous clay loam, then 12 inches of reddish brown, noncalcareous clay. Depth to the indurated caliche layer is 30 inches (fig. 12).

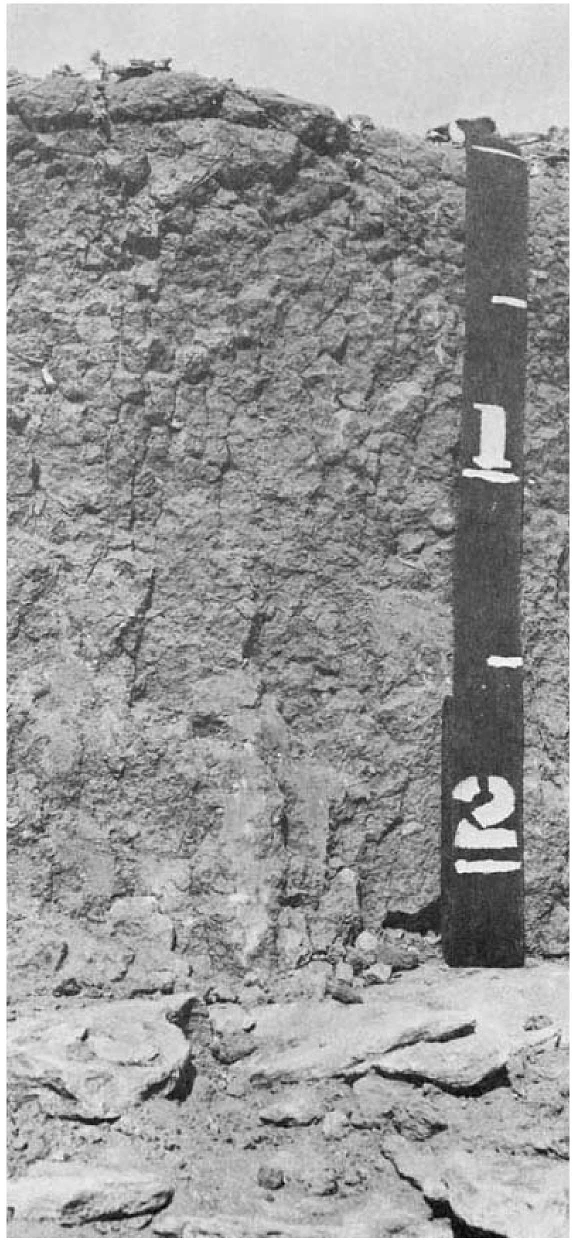


Figure 12.—Profile of Stegall clay loam, in an area of Stegall-Slaughter association, nearly level. Platy caliche is at a depth of about 26 inches.

Surface runoff is slow on the Stegall soils, internal drainage is medium, and permeability is moderately slow. The soil blowing hazard is slight, and the water erosion hazard is moderate. The root zone is moderately deep, and the soils are easily penetrated by plant roots. Available water capacity is low.

The Slaughter soils typically have a brown, noncalcareous clay loam surface layer about 5 inches thick. The next layer is reddish brown, noncalcareous clay about 11 inches thick. Depth to the indurated caliche layer is about 16 inches.

Surface runoff is slow on the Slaughter soils, internal drainage is medium, and permeability is moderately slow. The soil blowing hazard is slight, and the water erosion hazard is moderate. The plant root zone is shallow. Available water capacity is very low.

Included in mapping are small areas of Kimbrough and Conger soils and a soil that is similar to Stegall soils but lacks indurated caliche. These inclusions make up less than 20 percent of any one mapped area.

This association is used mainly as range. It has medium potential for growing a mixture of short and mid grasses. Management concerns include proper stocking, controlled grazing, and brush management.

This association has low potential for most urban uses because of its shallow or moderately deep cemented layer. Potential for most recreational uses is medium. Clay Loam range site; Stegall soils in capability subclass IIIe; Slaughter soils in capability subclass IVs.

TEC—Tencee association, undulating. This association is on uplands. Slopes are convex and range from 1 to 8 percent. Areas are irregular in shape and range from 50 to several hundred acres in size. The association is 80 percent Tencee soils and 20 percent other soils. These soils are so similar in use and management that mapping them separately is not justified. The Tencee soils have a surface layer of very gravelly loam or very gravelly sandy loam.

Typically, the surface layer of Tencee soils is light brown very gravelly loam about 15 inches thick. It is 40 percent, by volume, caliche fragments in the upper part and 45 percent in the lower part (fig. 13). About 20 to 25 percent of the surface is covered with caliche fragments that are less than three-fourths of an inch across. Depth to indurated caliche is 15 inches.

Surface runoff is rapid, internal drainage is medium, and permeability is slow. The soil blowing hazard is slight, and the water erosion hazard is moderate. The plant rooting zone is very shallow to shallow over indurated caliche. Available water capacity is very low.

Included in mapping are small areas of Reakor, Kinco, Ima, and Upton soils. Included soils make up less than 25 percent of any one mapped area.

This association is used mainly as range. It has low potential for growing a mixture of short grasses. Management concerns include proper stocking, controlled grazing, and brush management.

Potential for most urban uses is low. The very shallow to shallow depth to indurated caliche is the main limiting feature. Potential for most recreational uses is medium. Small stones and slope are the main limiting features. Capability subclass VIIe; Gravelly range site.

TNG—Tencee-Hock outcrop association, hilly. This association is on uplands. Slopes are convex and range from 10 to 30 percent. Areas are long and narrow and follow the contour of the rock outcrop. They range from 30 to several hundred acres in size. This association is 80 percent Tencee soils, 15 percent Rock outcrop, and 5 percent other soils. The soils are so similar in use and management that mapping them separately is not justified.

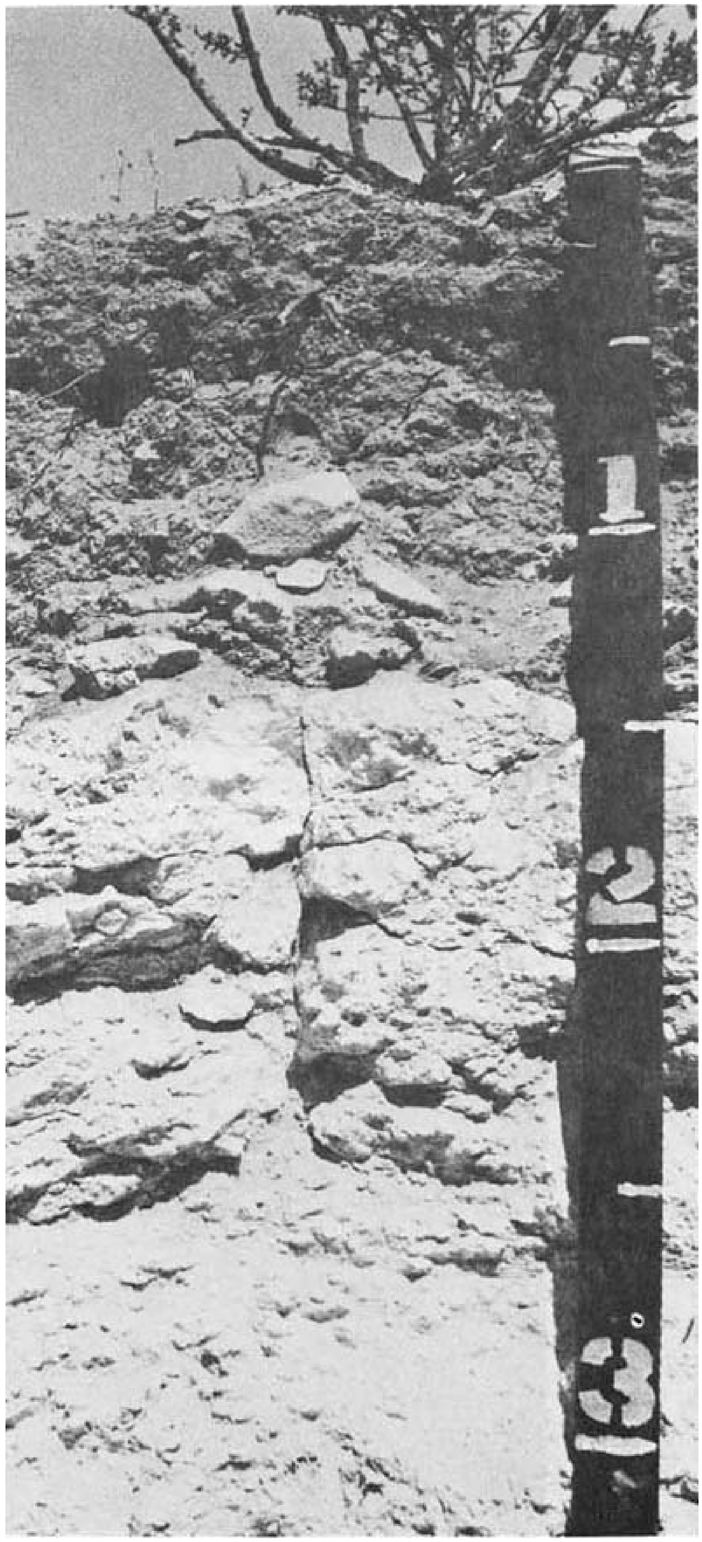


Figure 13.—Profile of Tencee gravelly loam, in an area of Tencee association, undulating. Indurated caliche is at a depth of about 18 inches.

The Tencee soils in this association typically have a pale brown, calcareous very gravelly loam surface layer about 13 inches thick. The surface layer is 50 percent, by volume, angular and subrounded caliche fragments mostly less than three-fourths inch across. The underlying layers are strongly cemented caliche in the upper part and weakly cemented caliche in the lower part.

Surface runoff is rapid, internal drainage is medium, and permeability is slow. The soil blowing hazard is slight, and the water erosion hazard is moderate. The plant rooting zone is very shallow to shallow over indurated caliche. Available water capacity is very low.

In areas of Rock outcrop, bedrock is exposed on 90 percent of the surface. Bedrock consists of sandstone, conglomerate, and limestone.

Included in mapping are small areas of Conger, Kimbrough, and Blakeney soils. Included soils make up less than 10 percent of any one mapped area.

This association is used mainly as range. It has low potential for growing a mixture of short grasses. Management concerns include proper stocking, controlled grazing, and brush management.

The potential for urban use is low. Very shallow to shallow depth to indurated caliche and slope are the main limiting features. Potential for most recreational uses is low because of slope. Capability subclass VIIe; Gravelly range site.

To—Toyah soils, frequently flooded. These are nearly level soils in concave areas along drainageways. The areas are long and narrow in shape and range from 100 to 400 acres in size. Slopes range from 0 to 1 percent.

Toyah soils have variable surface textures, ranging from loam to clay loam. These soils are not uniform and do not occur in a regular pattern.

Typically, the surface layer is dark grayish brown, calcareous clay loam about 12 inches thick. The underlying layer is brown, calcareous clay loam about 38 inches thick. The secondary carbonates range from common fine films and threads to many soft bodies.

Surface runoff and internal drainage are medium, and permeability is moderate. The soil blowing hazard is moderate, and the water erosion hazard is slight. These soils are deep and easily penetrated by plant roots. Available water capacity is high.

Included in mapping are small areas of Ratliff, Reagan, Holloman, and Reeves soils. Included soils make up less than 25 percent of any one mapped area.

Toyah soils are used mainly for range. They have high potential for growing a mixture of mid and tall grasses. Management includes proper stocking and controlled grazing.

The potential for urban uses is low. Flooding, high corrosivity to uncoated steel, and moderate shrink-swell on wetting and drying are the main limiting features. Potential for most recreational uses is low because of flooding and dustiness. Capability subclass Vw; Draw range site.

TrB—Triomas loamy fine sand, 0 to 3 percent slopes. This is a nearly level to gently sloping soil on uplands. The slopes are convex. Areas are irregular in shape and range from 50 to several hundred acres in size. Local shifting of soil by wind is evident in some places.

Typically, the surface layer is noncalcareous loamy fine sand about 18 inches thick. It is brown in the upper part and reddish brown in the lower part. Below that is 28 inches of yellowish red noncalcareous sandy clay loam, 19 inches of red, noncalcareous sandy clay loam, and 10 inches of reddish yellow, noncalcareous sandy clay loam. The underlying layer is reddish yellow, calcareous sandy clay loam that is 25 percent, by volume, weakly to strongly cemented bodies of calcium carbonates.

Surface runoff is slow to very slow, internal drainage is medium, and permeability is moderate. The soil blowing hazard is severe, and the water erosion hazard is slight. The soil is deep and easily penetrated by plant roots. Available water capacity is medium.

Included in mapping are small areas of Faskin, Jalmar, Douro, and Wickett soils. Also included are areas of a soil that is similar to Triomas soils but has an accumulation of fine sand mounds around the base of catclaw and mesquite shrubs.

This soil is used mainly for range. It has medium potential for growing a mixture of tall grasses. This soil is highly susceptible to soil blowing unless properly managed. Management should include proper stocking, controlled grazing, and brush management.

This soil has high potential for most urban uses. Low strength is the main limitation in constructing local roads and streets. Potential for most recreational uses is medium because the soil is sandy. Capability subclass VIe; Loamy Sand range site.

URB—Upton-Reagan association, gently undulating. This association is on uplands. Slopes range from 1 to 5 percent. Areas are irregular in shape and range from 30 to several hundred acres in size. The association is about 70 percent Upton soils, 20 percent Reagan soils, and 10 percent other soils. These soils are so similar in use and management that mapping them separately is not justified.

Upton soils are on convex knolls. Typically, the surface layer is brown, calcareous gravelly loam about 6 inches thick. The next layer is pale brown, calcareous gravelly clay loam about 10 inches thick. Depth to indurated caliche is 16 inches (fig. 14).

Surface runoff and internal drainage are medium, and permeability is moderate in the Upton soils. The soil blowing hazard is slight, and the water erosion hazard is moderate. The plant rooting zone is very shallow to shallow over indurated caliche. Available water capacity is very low.

Reagan soils are in concave areas. They have a calcareous silty clay loam surface layer, about 10 inches thick, that is light brown in the upper part and brown in the lower part. The next layer is light brown, calcareous silty clay loam about 20 inches thick. Below that is a layer that has an accumulation of calcium carbonate. It is silty clay loam about 50 inches thick that is pink in the upper part and reddish yellow in the lower part.

Surface runoff is slow, internal drainage is medium, and permeability is moderate in the Reagan soils. The soil blowing hazard and water erosion hazard are moderate. The rooting zone is deep, and the soils are easily penetrated by plant roots. Available water capacity is high.

Included in mapping are areas of Conger, Blakeney, Tencee, and Lipan soils and a soil that is similar to Reagan soils but has an accumulation of calcium carbonate at a depth below 40 inches. Included soils make up less than 15 percent of any one mapped area.

This association is used mainly as range. Upton soils have low potential for growing a mixture of short and mid grasses. The very shallow to shallow depth to indurated caliche is their main limiting feature. The Reagan soils are deeper and have a higher water holding capacity and, therefore, a medium potential for range production.

The Upton soils have low potential for most urban uses. High corrosivity to uncoated steel and very shallow to shallow depth to indurated caliche are the main limiting features. Reagan soils have medium potential for most urban uses. Low strength and moderate shrink-swell are their main limiting features. Potential for recreational uses is medium because the soils are dusty, and Upton soils have small stones. Upton soils in capability subclass VIIs, Gravelly range site; Reagan soils in capability subclass IVe, Loamy range site.

WAB—Wickett association, gently undulating. This association is on uplands. Slopes are convex and range from 1 to 5 percent. Areas are irregular in shape and range from 30 to several hundred acres in size. Local shifting of soils by wind is evident in some places. The association is about 60 percent Wickett soils and 40 percent other soils. These soils are so similar in use and management that mapping them separately is not justified. The Wickett soils have a surface layer of loamy fine sand and fine sandy loam.

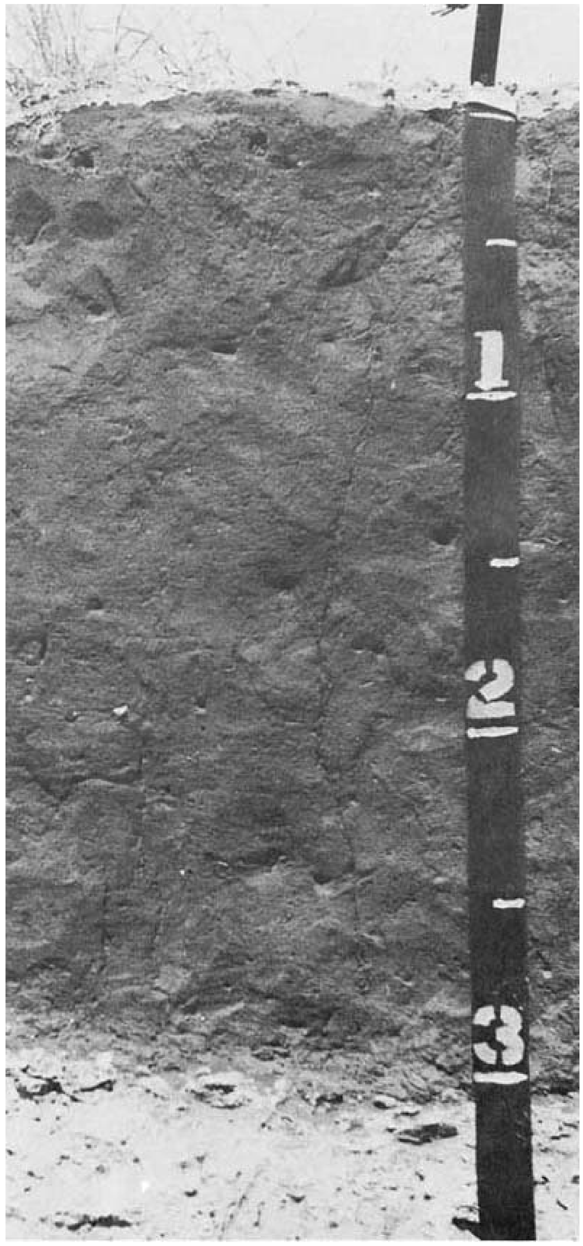


Figure 14.—Profile of Upton gravelly loam, in an area of Upton-Reagan association, gently undulating. Indurated caliche is at a depth of about 20 inches.

Typically, the surface layer is reddish brown, noncalcareous loamy fine sand about 12 inches thick. The next layer is yellowish red, noncalcareous fine sandy loam about 16 inches thick. Depth to indurated platy caliche is 28 inches (fig. 15).

Surface runoff is very slow, internal drainage is medium, and permeability is moderately rapid. Soil blowing hazard is severe, and water erosion hazard is slight. The soils are moderately deep and easily penetrated by plant roots. Available water capacity is very low.

Soils included in mapping are Triomas, Jalmar, Kinco, and Pyote soils and two soils that are similar to Wickett soils. One of the soils similar to Wickett soils has a sandy clay loam layer below the surface layer, and the other soil has indurated caliche at a depth below 40 inches. Also included are sandy mounds accumulated around the base of mesquite shrubs.

This association is used mainly as range. It has medium potential for growing a mixture of mid and tall grasses. Management concerns include proper stocking, controlled grazing, and brush management.

This association has medium potential for most urban uses. Indurated caliche 20 to 40 inches deep is the main limiting feature. Potential for most recreational uses is medium because the soils are sandy. Capability subclass VIe, Loamy Sand range site.

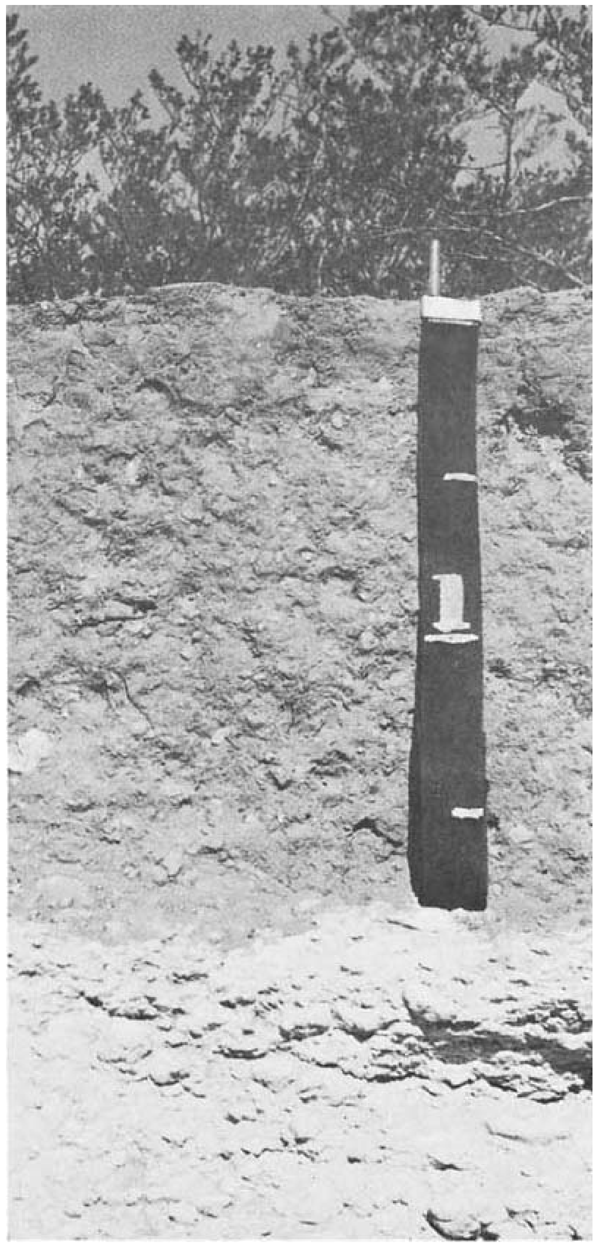


Figure 15.—Profile of Wickett Loamy fine sand, in an area of Wickett association, gently undulating. Indurated caliche is at a depth of about 36 inches.

Use and management of the soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and about unique aspects of behavior of the soils. These notes include data on erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic tank disposal systems, and other factors affecting the productivity, potential, and limitations of the soils under various uses and management. In this way, field experience and measured data on soil properties and performance are used as a basis for predicting soil behavior.

Information in this section is useful in planning use and management of soils for rangeland, as sites for buildings, highways and other transportation systems, sanitary facilities, and parks and other recreation facilities; and for wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and other structures, caused by unfavorable soil properties, can be avoided. A site where soil properties are favorable can be selected, or practices that will overcome the soil limitations can be planned.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area and on the environment. Productivity and the environment are closely related to the nature of the soil. Plans should maintain or create a land-use pattern in harmony with the natural soil.

Contractors can find information that is useful in locating sources of sand and gravel, roadfill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists also can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

Capability classes and subclasses

Capability classes and subclasses show, in a general way, the suitability of soils for most kinds of field crops. The soils are classed according to their limitations when they are used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland or for engineering purposes.

In the capability system, as used in this survey area, the soils are grouped at two levels: capability class and subclass. These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

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

Class I soils have few limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants, or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

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

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

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

Capability subclasses are soil groups within one class; they are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main 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 contains only the subclasses indicated by *w, s, or c* because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use to pasture, rangeland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is indicated in table 4. All soils in the survey area except those named at a level higher than the series are included. Data in this table can be used to determine the farming potential of the area.

The capability subclass is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Range

Joe B. Norris, range conservationist, and Wyatt D. Lipscomb, district conservationist, Soil Conservation Service, assisted in writing this section.

Range is land on which the natural potential plant community of the soil is composed of grasses, forbs, and shrubs valuable for grazing. About 1,014,807 acres of native rangeland in Ector and Crane Counties are grazed by cattle, sheep, and a few deer.

Little cropland in the survey area is used for supplemental feed crops—the amount of livestock grazing depends on the production of native grass. In recent years brush management, followed by reseeding with native or introduced grasses, has been used to increase grass production on many sites.

The average size ranch in Crane County is 15,300 acres. The average size ranch in Ector County is 6,200 acres.

Most ranches are of the cow-calf type that produce stocker calves for fall delivery. In addition to the cow-calf operation, steers are placed where introduced grasses produce additional forage during a part of the year. Feeding of protein supplement is necessary to maintain cows through the winter.

Deer and other wildlife are increasing, but they use little of the forage produced.

A wide variety of range conditions occur over the survey area as a result of varying elevation and climatic conditions.

Most of the range is sandy. Deep sands in the western part of the area produce tall and mid grasses and are capable of using all of the moisture received. Sandy clay loams in the northern and eastern parts of the area produce short and mid grasses. The heavier clayey soils produce short grasses. A general history of periodic drought and heavy use has, on some sites, reduced the climax vegetation to invading plants.

Invading brush is a problem on many sites. Brush management is essential to range improvement in theses areas. Most sites will improve if given proper treatment, including frequent growing-season rests. This will allow the desirable species to reestablish in the plant community.

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

Table 5 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 5.

A *range site* is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. Soils that produce a similar kind, amount, and proportion of range plants are grouped into range sites. For those areas where the relationship between soils and vegetation has been established, range sites can be interpreted directly from the soil map. Properties that determine the capacity of the soil to supply moisture and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table are also important.

Total production refers to the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year the amount and distribution of precipitation and the temperatures are such that growing conditions are substantially better than average; in a normal year these conditions are about average for the area; in an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife.

Characteristic vegetation—grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil is listed by common name. Under *Composition*, the expected proportion of each species is presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegetation, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Engineering

Douglas Bartosh, engineer. Soil Conservation Service, assisted with this section.

This section provides information about the use of soils for building sites, sanitary facilities, construction material, and water management. Among those who can benefit from this information are engineers, landowners, community planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. If pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

On the basis of information assembled about soil properties, ranges of values can be estimated for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to (1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section an useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth 5 or 6 feet. Also, because of the scale of the detailed map in this soil surrey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 6 shows, for each kind of soil, the degree and kind of limitations for building site development; table 7, for sanitary facilities; and table 9, for water management. Table 8 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

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

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 6. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, open ditches, and cemeteries. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and *small commercial buildings* referred to in table 6 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, soil wetness, and depth to a seasonally high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and streets referred to in table 6 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, and shrink-swell potential, are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 7 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* and *poor,* which mean about the same as *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and shallowness to bedrock interfere with installation. Excessive slope can cause lateral seepage and surfacing of the effluent. Also, soil erosion and soil slippage are hazards if absorption fields are installed on sloping soils.

In some soils, loose sand and gravel or fractured bedrock is less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and ground water in the area may be contaminated.

On many of the soils that have moderate or severe limitations for use as septic tank absorption fields, a system to lower the seasonal water table can be installed or the size of the absorption field can be increased so that performance is satisfactory.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level floor and cut slopes or embankments of compacted soil material. Aerobic lagoons generally are designed to hold sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard if the seasonal high water table is above the level of the lagoon floor. If the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soil material affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste by placing refuse in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil material. Landfill areas are subject to heavy vehicular traffic. Risk of polluting ground water and trafficability affect the suitability of a soil for this use. The best soils have a loamy or silty texture, have moderate to slow permeability, are deep to a seasonal water table, and are not subject to flooding. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability, which might allow noxious liquids to contaminate ground water. Soil wetness can be a limitation because operating heavy equipment on a wet soil is difficult. Seepage into the refuse increases the risk of pollution of ground water.

Ease of excavation affects the suitability of a soil for the trench type of landfill. A suitable soil is deep to bedrock and free of large stones and boulders. If the seasonal water table is high, water will seep into trenches.

Unless otherwise stated, the limitations in table 7 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should be suitable for growing plants. Of all the horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

If it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the site should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 8 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction material. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for low embankments, which generally are less than 6 feet high and less exacting in design than high embankments. The ratings reflect the ease of excavating and working the material and the expected performance of the material where it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about some of the soil properties that influence such performance is given in the descriptions of the soil series.

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 12 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor.*

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 8 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and silt-stone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 12.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can restrict plant growth. They are naturally fertile or respond well to fertilizer. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy soils or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils or very firm clayey soils; soils that have suitable layers less than 8 inches thick; soils that have large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 9 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Soil and site limitations are expressed as slight, moderate, and severe. *Slight* means that the soil properties and site features are generally favorable for the specified use and that any limitation is minor and easily overcome. *Moderate* means that some soil properties or site features are unfavorable for the specified use but can be overcome or modified by special planning and design. *Severe* means that the soil properties and site features are so unfavorable and so difficult to correct or overcome that major soil reclamation, special design, or intensive maintenance is required.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low seepage potential, which is determined by permeability and the depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and has favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of the soil for use in embankments, dikes, and levees.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, available water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to intercept runoff. They allow water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock, hardpan, or other unfavorable material; large stones; permeability; ease of establishing vegetation; and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff to outlets at a nonerosive velocity. Features that affect the use of soils for waterways are slope, permeability, erodibility, wetness, and suitability for permanent vegetation.

Recreation

The soils of the survey area are rated in table 10 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

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

The information in table 10 can be supplemented by information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 7, and interpretations for dwellings without basements and for local roads and streets, given in table 6.

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

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

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

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

Wildlife habitat

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the construction of water impoundments. The kind and abundance of wildlife that populate an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, is inadequate, or is inaccessible, wildlife either are scarce or do not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by helping the natural establishment of desirable plants.

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

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of habitat are very severe and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

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

Grain and seed crops are seed-producing annuals used by wildlife. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are sorghum, wheat, oats, and sunflowers.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are black grama, lovegrass, sideoats grama, and alfalfa.

Wild herhaeeous plants are native or naturally established grasses and forbs, including weeds, that provide food and cover for wildlife. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are little bluestem, sideoats grama, and black grama.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture. Examples of shrubs are mesquite, catclaw acacia, white brush, creosote bush, shinnery oak, and fourwing saltbush.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of cropland, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include scaled quail, dove, meadowlark, field sparrow, cottontail rabbit, jackrabbit, and coyote.

Rangeland habitat consists of areas of wild herbaceous plants and shrubs. Wildlife attracted to rangeland include coyote, white-tailed deer, javelina, jackrabbit, cottontail rabbit, meadowlark, dove, and scaled quail.

Town and country planning

In Ector County, rapid population growth and increased mobility have placed more people in situations where soil conditions directly affect them. This is especially true in rural-urban fringe areas to which people have moved in order to enjoy some of the amenities of country living.

Residential subdivision development and the accompanying extension of public utilities create a need for soil information somewhat different from the information needed for purposes of agriculture. Many people need soil information for individual residential tracts that are well beyond areas served by public utilities.

Land appraisers, realtors, city planners, builders, and individuals need soil interpretations that can help them evaluate sites for homes or buildings and areas that should be reserved for other uses. For interpretations of the soil properties important for town and country planning and for engineering, see the sections "Engineering" and "Soil properties." Information in the engineering sections does not eliminate the need for more detailed onsite studies if soils are used for intensive purposes. Some lots will have inclusions of contrasting soils that are too small to show separately at the scale of maps used.

The soils in and around the metropolitan area are mainly Faskin, Douro, Ratliff, Holloman, Kimbrough, and Stegall soils. A brief discussion of these soils and the role they play in selection of sites for sewage disposal systems, underground utility lines, and urban development follows.

Urban development

In selecting a site for construction of urban works and structures, the soil should be carefully investigated. All problems relating to the soil should be known before construction.

One of the first considerations is depth to indurated caliche and gypsum. The Kimbrough, Douro, and Stegall soils have indurated caliche at a depth that ranges from 4 to 40 inches, and Holloman soils have gypsum at a depth that ranges from 4 to 20 inches. These soils can be used for urban works and structures without difficulty because the underlying materials are rippable. It is advisable to make a detailed inspection of the soil at the exact site that is to be used.

Sewage disposal systems

Many houses are being constructed beyond existing municipal sewerlines. These areas must have onsite sewage disposal systems. The effectiveness of these systems depends largely on the sewage lagoon area and the septic tank absorption field.

The soils in the metropolitan area have severe limitations for sewage lagoons and septic tank absorption fields, except for Faskin and Ratliff soils. The other soils in the metropolitan area have underlying layers of indurated caliche or gypsum.

In table 7 the soils are rated for sanitary facilities. By using the soil map to identify the soils and then referring to the ratings in table 7, it is possible to get a general idea of how well septic systems will function in a selected area. It is advisable to make a detailed inspection of the soils at the exact site that is to be used as a filter field.

Underground utility lines

All metals corrode to some degree if buried in the soil, and some metals corrode more rapidly in some soils than in others. The corrosion hazard depends on the physical, chemical, electrical, and biological characteristics of the soil. Occasionally, corrosion is intensified by connecting two dissimilar metals or by extending pipelines through different kinds of soils.

All of the soils in the metropolitan area of Odessa have low to moderate corrosivity limitations, except Holloman soils, which have high corrosivity limitations. Kimbrough, Douro, and Stegall soils have indurated caliche at a depth that ranges from 4 to 40 inches, and Holloman soils have gypsum at a depth that ranges from 4 to 20 inches. These soils can be used for underground utility lines without difficulty because the underlying material is rippable.

For information concerning other soils in the survey area on corrosivity and depth to indurated caliche (cemented pan), see table 14. It is advisable to make a detailed inspection of the soil at the exact site that is to be used.

Soil properties

Douglas Bartosh, engineer, Soil Conservation Service, assisted with this section.

Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

In making soil borings during field mapping, soil scientists can identify several important soil properties. They note the seasonal soil moisture condition or the presence of free water and its depth. For each horizon in the profile, they note the thickness and color of the soil material; the texture, or amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or the natural pattern of cracks and pores in the undisturbed soil; and the consistence of the soil material in place under the existing soil moisture conditions. They record the depth of plant roots, determine the pH or reaction of the soil, and identify any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to determine all major properties of key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many soil series not tested are available from nearby survey areas.

The available field and laboratory data are summarized in tables. The tables give the estimated range of engineering properties, the engineering classifications, and the physical and chemical properties of each major horizon of each soil in the survey area. They also present data about pertinent soil and water features, engineering test data, and data obtained from physical and chemical laboratory analyses of soils.

Engineering properties

Table 12 gives estimates of engineering properties and classifications for the major horizons of each soil in the survey area.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Table 12 gives information for each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 12 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System *(2)* and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) *(1)*,

The *Unified,* system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic-matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example, CL-ML.

The *AASHTO* system classifies soils according to those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified in one of seven basic groups ranging from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines. At the other extreme, in group A-7, are fine-grained soils. Highly organic soils are classified in group A-8 on the basis of visual inspection.

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The estimated classification, without group index numbers, is given in table 12. Also in table 12 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four sieves (U.S. standard) is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and in plasticity index is estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

Physical and chemical properties

Table 13 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in planning and designing drainage systems, in evaluating the potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as a range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops, ornamental plants, or other plants to be grown; in evaluating soil amendments for fertility and stabilization; and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of individual fields can differ greatly from the value given in table 13. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others the swelling was estimated on the basis of the kind and amount of clay in the soil and on measurements of similar soils. The size of the load and the magnitude of the change in soil moisture content also influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A high shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment *(4).* The soil erodibility factor (K) is a measure of the susceptibility of the soil to erosion by water. Soils having the highest K values are the most erodible. K values range from 0.10 to 0.64. To *estimate* annual soil loss per acre, the K value of a soil is modified by factors representing plant cover, grade and length of slope, management practices, and climate. The soil-loss tolerance factor (T) is the maximum rate of soil erosion, whether from rainfall or soil blowing, that can occur without reducing crop production or environmental quality. The rate is expressed in tons of soil loss per acre per year.

Wind erodibility groups are made up of soils that have similar properties that affect their resistance to soil blowing if cultivated. The groups are used to predict the susceptibility of soil to blowing and the amount of soil lost as a result of blowing. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are extremely erodible, so vegetation is difficult to establish. They are generally not suitable for crops.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible, but crops can be grown if intensive measures to control soil blowing are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible, but crops can be grown if intensive measures to control soil blowing are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible, but crops can be grown if measures to control soil blowing are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible, but crops can be grown if measures to control soil blowing are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible, and crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible, and crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to soil blowing soil and water features

Soil and water features

Table 14 contains information helpful in planning land uses and engineering projects that are likely to be affected by soil and water features.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are placed in one of four groups on the basis of the intake of water after the soils have been wetted and have received precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist chiefly of deep, well drained to excessively drained sands or gravels. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils that have a layer that impedes the downward movement of water or soils that have moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clay soils that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water from overflowing streams and with runoff from adjacent slopes. Water standing for short periods after rains or after snow melts is not considered flooding. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, mind, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding; and on information that relates the position of each soil on the landscape to historic floods.

The generalized description of flood hazards is of value in land-use planning and provides a valid basis for land-use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 to 6 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Cemented pans are hard subsurface layers, within a depth of 5 or 6 feet, that are strongly compacted (indurated). Such pans cause difficulty in excavation. The hardness of pans is similar to that of bedrock. A rippable pan can be excavated, but a hard pan generally requires blasting.

Risk of corrosion pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, partical-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Formation of the soils

This section discusses the effects of the five factors of soil formation on the soils in Ector and Crane Counties.

Factors of soil formation

Soil is produced by the action of soil-forming processes on 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 materials; (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 can be formed and, in extreme cases, 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 horizon differentiation. Usually a long time is required for the development of distinct horizons.

The factors of soil genesis are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

Parent material refers to the unconsolidated material from which the soil develops. The soils in this survey area formed in eolian and alluvial deposits of the Quaternary and late Tertiary periods. These deposits have been reworked by soil building forces. Some of the soils in Ector County formed in sandy and silty sediments that are unconsolidated, calcareous, and alkaline. The Faskin and Douro soils formed in these sediments. Some soils, for example, the Stegall and Slaughter soils, formed over a geological stratum called the Ogalalla Formation. The parent material was deposited over the mantle of indurated caliche and subjected to soil forming processes.

The removal of the silt and clay particles from the parent material by wind led to the development of Kinco and Ima soils.

Climate

The climate of the survey area is semiarid, typical of the Southern High Plains, and it is characterized by low rainfall and high evaporation. Soils such as Kinco and Ratliff soils have a horizon of calcium carbonate that accumulated as a result of water leaching; however, these soils have free lime throughout their profile because not enough water passes through them to leach out all of the free lime.

The mild winters and hot summers contribute to the continuous decomposition of residue from plants and animals by micro-organisms, which, in turn, accounts for the high organic matter content of some soils. Kimbrough soils and Stegall soils are an example.

High winds contribute to the development of soils in the survey area by depositing materials that were subjected to soil building forces. Jalmar soils are an example.

Plant and animal life

Plants, animals, insects, bacteria, and fungi are important in the formation of soils. Living organisms affect gains or losses in organic matter and plant nutrients. Structure and porosity are also affected by living organisms.

Vegetation has an effect on soil formation. Most of the soils in the survey area are low in organic matter because of the limited amount of vegetation. Because organic matter is formed from decaying leaves and stems, soils, such as Faskin and Douro soils, that have limited vegetation are low in organic matter.

Animals such as earthworms and termites increase soil porosity by burrowing channels throughout the soil profile. This increases water and air movement in the soil. The growth of plant roots also increases movement of water and air in the soil.

Relief

Relief, or slope, affects soil formation through its influence on runoff and drainage. The northeastern part of Ector County is dissected by numerous small drainageways that flow in a southerly direction. These drainageways dissect nearly level to gently sloping plains that are spotted with numerous small depressions that have no drainage outlets.

The High Plains escarpment is in the southern and southwestern parts of Ector County. Below the escarpment in the southwestern part of the county are Wickett and Penwell soils that have little or no runoff because of their high rate of water intake. Tencee soils, in the southern part of Crane County and below the escarpment, are gently sloping and are shallow over caliche; soil material is removed from the slopes by water erosion. Reagan and Reakor soils are in nearly level areas and are deeper than Tencee soils.

Time

Time is an intricate and important part of soil formation. The length of time that the parent material has been in place is reflected in the degree of development of the soil profile.

Soils that have little development are young soils. Penwell soils are an example. Soils that have well defined soil horizons and structure are older soils. Faskin and Douro soils are examples. Soils that have distinct structure and heavy texture in the subsoil have been developing for an even greater length of time. Stegall and Slaughter soils are examples.

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(5)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 15, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

ORDER. Ten soil orders are recognized as classes in the system. The properties used to differentiate among orders are those that reflect the kind and degree of dominant soil-forming processes that have taken place. Each order is identified by a word ending in *sol*. An example is Aridisol.

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Orthid *(Orth,* meaning true, plus *id*, from Aridisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of expression of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and a prefix that suggests something about the properties of the soil. An example is Calciorthids *(Cale,* meaning lime, plus *orthid,* the suborder of Aridisols.

SUBGROUP. Each great group may be divided into three subgroups: the central (typic) concept of the great groups, which is not necessarily the most extensive subgroup; the intergrades, or transitional forms to other orders, suborders, or great groups; and the extragrades, which have some properties that are representative of the great groups but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceeding the name of the great group. The adjective *Typic* identifies the subgroup that is thought to typify the great group. An example is Typic Calciorthids.

FAMILY. Families are established within a subgroup on the basis of similar physical and chemical properties that affect management. Among the properties considered in horizons of major biological activity below plow depth are particle-size distribution, mineral content, temperature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine silty, mixed, thermic, Typic Calciorthids.

SERIES. The series consists of soils that formed in a particular kind of material and have horizons that, except for texture of the surface soil or of the underlying substratum, are similar in differentiating characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineral and chemical composition.

Soil series and morphology

In this section, each soil series recognized in the survey area is described in detail. The descriptions are arranged in alphabetic order by series name.

Characteristics of the soil and the material in which it formed are discussed for each series. Then a pedon, a small three-dimensional area of soil that is typical of the soil series in the survey area, is described. The detailed descriptions of each soil horizon follow standards in the Soil Survey Manual *(3)*. Unless otherwise noted, colors described are for dry soil.

Following the pedon description is the range of important characteristics of the soil series in this survey area. Phases, or map units, of each soil series are described in the section "Soil maps for detailed planning."

Blakeney series

The Blakeney series consists of shallow, loamy soils on uplands. These soils formed in loamy caliche materials that are indurated in the upper part. Slope ranges from 0 to 2 percent.

Typical pedon of Blakeney fine sandy loam, 0 to 2 percent slopes; from the intersection of Interstate Highway 20 and Farm Road 1601 in Penwell, 2.2 miles west on Interstate 20, 0.7 mile north across railroad on oilfield road, and 100 feet east, in range:

A1—0 to 6 inches; brown (7.5YR 5/4) fine sandy loam, brown (7.5YR 4/4) moist; weak medium subangular blocky structure; slightly hard, friable, nonsticky; common very fine roots; common fine pores; few strongly cemented caliche fragments 5 to 10 mm across; calcareous; moderately alkaline; gradual smooth boundary.

A2—6 to 16 inches; light brown (7.5YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable, nonsticky; common very fine roots; common fine pores; about 3 percent caliche fragments up to 1 inch across; few caliche fragments up to 3 inches across in lower part of horizon; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—16 to 30 inches; white caliche, strongly cemented rounded caliche plates 2 to 5 inches across; abrupt wavy boundary.

Cca—30 to 60 inches; pinkish white weakly cemented caliche; massive; about 50 percent, by volume, calcium carbonate.

The solum ranges from 12 to 20 inches in thickness. It is moderately alkaline throughout.

The A horizon ranges from 5 to 8 inches in thickness. It is brown, pale brown, pinkish gray, light brownish gray, or grayish brown.

The B2 horizon is brown, pale brown, light brown, or pinkish gray. It is loam or fine sandy loam with clay content of 10 to 18 percent.

The Ccam horizon ranges from 10 to 30 inches in thickness. It is indurated to strongly cemented caliche. Caliche plates are 1 to 3 inches thick.

The Cca horizon is white, pink, or pinkish white. It is loam or clay loam earth that is weakly to strongly cemented.

Conger series

The Conger series consists of shallow, loamy soils on uplands. These soils formed in calcareous, loamy material, the upper part of which is indurated caliche. Slope ranges from 0 to 3 percent.

Typical pedon of Conger loam, 0 to 2 percent slopes; from the intersection of U.S. Highway 385 and U.S. Highway 80 in Odessa, 4.5 miles west on U.S. Highway 80, 1.0 mile south on county road, 0.2 mile west, 3.0 miles south, 0.4 mile east on motor road, and 50 feet south, in range:

A1—0 to 5 inches; brown (7.5YR 5/2) loam, brown (7.5YR 4/2) moist; moderate medium subangular blocky structure; slightly hard, friable, slightly sticky; common very fine roots; few fine pores; about 3 percent, by volume, weakly cemented caliche less than 10 mm across; calcareous; moderately alkaline; clear smooth boundary.

B2—5 to 16 inches; light brown (7.5YR 6/3) clay loam, brown (7.5YR 5/3) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky; common very fine roots; few fine pores; 5 to 10 percent, by volume, weakly cemented caliche fragments less than 10 mm across; calcareous; moderately alkaline; abrupt wavy boundary.

Ccam—16 to 32 inches; white caliche plates with a laminar upper surface layer 1/2 inch thick; abrupt wavy boundary.

Cca—32 to 60 inches; white weakly cemented caliche; massive; about 50 percent, by volume, calcium carbonate.

The solum ranges from 12 to 20 inches in thickness. It is moderately alkaline throughout.

The A horizon ranges from 4 to 6 inches in thickness. It is brown or grayish brown.

The B2 horizon is pale brown, light brown, or brown. It is loam or clay loam.

The Ccam horizon ranges from 12 to 24 inches in thickness. It is indurated to strongly cemented caliche.

The Cca horizon is white, pink, or pinkish white. It is loam or clay loam earth that is weakly to strongly cemented.

Douro series

The Douro series consists of moderately deep, loamy soils on uplands. These soils formed over rocklike caliche. Slope ranges from 0 to 3 percent.

Typical pedon of Douro fine sandy loam, in an area of Faskin-Douro association, nearly level; from the intersection of U.S. Highway 80 and U.S. Highway 385 in Odessa, 4.0 miles east on U.S. Highway 80, 0.6 mile south on Loop 338, 0.5 mile west, 0.3 mile north on oilfield road, and 125 feet west, in range:

A1—0 to 8 inches; reddish brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak coarse prismatic and weak medium subangular blocky structure; slightly hard, friable, nonsticky; common very fine roots; common very fine pores; neutral; gradual smooth boundary.

B21t—14 to 22 inches; red (2.5YR 3/6) sandy clay loam, dark red (2.5YR 3/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky; common very fine roots; common very fine pores; thin patchy clay films on prism and ped faces; neutral; gradual smooth boundary.

B22t—22 to 30 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky; few very fine pores; thin patchy clay films on prism and ped faces; noncalcareous; mildly alkaline; abrupt wavy boundary.

C1cam—30 to 54 inches; indurated plates of caliche with a laminar upper surface layer 3/4 inch thick; gradual wavy boundary.

C2ca—54 to 66 inches; weakly cemented caliche; massive; about 50 percent, by volume, calcium carbonate.

The solum is 20 to 40 inches thick over strongly cemented caliche. The caliche has a laminar upper surface.

The A horizon is reddish brown or brown. It is noncalcareous.

The B2t horizon is red, reddish brown, or yellowish red. It is sandy clay loam. It is noncalcareous and moderately alkaline. In some locations it is calcareous in the lower part.

Depth to the Ccam horizon ranges from 20 to 40 inches. The caliche plates range from 2 to 8 inches across and from 3 to 8 inches in thickness, The laminar upper surface of the caliche ranges from 1/2 inch to 3 inches in thickness.

The Cca horizon is weakly cemented caliche that is 20 to 50 percent, by volume, calcium carbonate.

Faskin series

The Faskin series consists of deep, loamy soils on uplands. These soils formed in loamy calcareous outwash and eolian materials. Slope ranges from 0 to 3 percent.

Typical pedon of Faskin fine sandy loam, in an area of Faskin-Douro association, nearly level; from the intersection of U.S. Highway 385 and U.S. Highway 80 in Odessa, 13.4 miles north on U.S. Highway 385, 7.5 miles east on Texas Highway 158, and 200 feet north, in range:

A1—0 to 8 inches; reddish brown (5YR 4/4) fine sandy loam, dark reddish brown (5YR 3/4) moist; weak subangular blocky structure parting to weak fine granular; hard, friable, nonsticky; common very fine roots; common very fine pores; neutral; clear smooth boundary.

B21t—8 to 24 inches; reddish brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; very hard, friable, slightly sticky; common fine roots; patchy clay films on ped and prism faces; sand grains coated with clay films; neutral; clear smooth boundary.

B22t—24 to 36 inches; reddish brown (5YR 5/4) sandy clay loam, reddish brown (5YR 4/4) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; very hard, friable, slightly sticky; few very fine roots; nearly continuous clay films on prism faces; noncalcareous; mildly alkaline; clear smooth boundary.

B23t—36 to 52 inches; yellowish red (5YR 5/6) sandy clay loam, reddish brown (5YR 4/4) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; very hard, friable, slightly sticky; common very fine pores; nearly continuous clay films on prism faces and patchy clay films on ped faces; noncalcareous; mildly alkaline; gradual wavy boundary.

B24tca—52 to 74 inches; reddish yellow (5YR 6/6) sandy clay loam, reddish yellow 15Y R 6/6) moist; weak coarse prismatic structure parting to weak fine subangular blocky; hard, friable, slightly sticky; patchy clay films on peds; 30 percent, by volume, soft bodies of calcium carbonate, mainly coatings on peel faces; calcareous; moderately alkaline; gradual wavy boundary.

B25tca—74 to 80 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky; few discontinuous clay films on peds; 20 percent, by volume, soft calcium carbonate, mainly coating on ped faces; calcareous; moderately alkaline.

The solum is more than 60 inches thick. Depth to the calcic layer ranges from 40 to 60 inches.

The A horizon is reddish brown or brown.

The Bt horizon is reddish brown, yellowish red, or reddish yellow. It is sandy clay loam or clay loam. Reaction is mildly alkaline or moderately alkaline.

The Btca horizon is reddish yellow or yellowish red. It is clay loam or sandy clay loam. Calcium carbonate content ranges from 15 to 40 percent, by volume.

Some pedons have indurated caliche at a depth below 60 inches.

Holloman series

The Holloman series consists of very shallow to shallow, loamy soils on uplands. These soils formed in calcareous, loamy gypsum material. Slope ranges from 0 to 3 percent.

Typical pedon of Holloman loam, in an area of Holloman-Reeves association, nearly level; from the intersection of Texas Highway 329 and U.S. Highway 385 in Crane, 15.9 miles west on Texas Highway 329, 1.3 miles north on Farm Road 1053, 1.1 miles west, 0.3 mile south on oilfield road, and 30 feet east, in range:

A1—0 to 8 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) moist; weak medium platy structure in upper 1 inch and weak fine granular structure in the lower part; slightly hard, friable, slightly sticky; common roots; many pores; calcareous; moderately alkaline; abrupt smooth boundary.

C1cs—8 to 24 inches; very pale brown (10YR 8/3) weakly cemented massive gypsum beds; calcareous; moderately alkaline; diffuse boundary.

C2cs—24 to 40 inches; pink (7.5YR 8/4) weakly cemented gypsum beds; calcareous; moderately alkaline.

The solum is 3 to 20 inches thick over weakly cemented gypsum.

The A horizon is light brown, brown, or light brownish gray. It is calcareous and moderately alkaline.

The Ccs horizon is very pale brown or pink. It is weakly cemented gypsum beds that are calcareous and moderately alkaline.

Ima series

The Ima series consists of deep, sandy soils on uplands. These soils formed in highly calcareous unconsolidated loamy sediments. Slope ranges from 1 to 5 percent.

Typical pedon of Ima loamy fine sand, in an area of Kinco-Ima association, gently undulating; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 8.8 miles south on U.S. Highway 385, 3.2 miles west, 1.3 miles southwest on oilfield road, and 60 feet south, in range:

A1—0 to 10 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine granular structure; slightly hard, friable, nonsticky; common fine roots; few pores and worm casts; noncalcareous; moderately alkaline; clear smooth boundary.

B21—10 to 34 inches; light reddish brown (5YR 6/4) fine sandy loam, reddish brown (5YR 5/4) moist; weak coarse prismatic structure parting to weak fine granular; slightly hard, friable, slightly sticky; few fine and very fine roots; few pores and worm casts; few films and threads of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B22—34 to 46 inches; light brown (7.6YR 6/4) fine sandy loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky; few very fine roots; few films and threads of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

C1ca—45 to 56 inches; pink (7.5YR 8/4) sandy clay loam, pink (7.5YR 7/4) moist; massive; hard, friable, slightly sticky; about 50 percent, by volume, calcium carbonate; weakly cemented calcium carbonate in the upper 2 to 3 inches; calcareous; moderately alkaline; gradual wavy boundary.

C2ca—56 to 72 inches; pink (5YR 8/4) sandy clay loam, pink (5YR 7/4) moist; massive; hard, friable, slightly sticky; about 40 percent, by volume, calcium carbonate; weakly to strongly cemented bodies of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to 56 inches in thickness. The lower part of the solum has an accumulation of calcium carbonate that ranges from 10 to 80 percent, by volume.

The A horizon is brown. It is noncalcareous and moderately alkaline.

The B horizon is light reddish brown, reddish brown, light brown, or brown. It is fine sandy loam or sandy loam. It is calcareous and moderately alkaline. Calcium carbonate varies from a few films and threads to about 5 percent, by volume.

The Cca horizon is pink. It is calcareous and moderately alkaline. Calcium carbonate ranges from 10 to 80 percent, by volume, below a depth of 40 inches.

Jalmar series

The Jalmar series consists of deep, sandy soils on uplands. These soils formed in eolian loamy sediments. Slope ranges from 1 to 8 percent.

Typical pedon of Jalmar fine sand, in an area of Jalmar-Penwell association, undulating; from the intersection of U.S. Highway 80 and U.S. Highway 385 in Odessa, 18.3 miles west on U.S. Highway 80, 2.3 miles north, 3.0 miles northwest, 1.0 mile west, 0.3 mile north, 0.3 mile west on oilfield road, and 40 feet south, in range:

A11—0 to 13 inches; brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) moist; single grained; loose, nonsticky; common very fine and fine roots; neutral; gradual smooth boundary.

A12—13 to 35 inches; reddish brown (5YR 5/4) fine sand, reddish brown (5YR 4/4) moist; single grained; loose, nonsticky; common very fine roots; neutral; clear smooth boundary.

B21t—35 to 55 inches; red (2.5YR 4/6) sandy clay loam, dark red (2.5YR 3/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky; few fine roots; clay films on ped faces; nearly continuous clay films on prism faces; neutral; gradual wavy boundary.

B22t—55 to 72 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky; clay films on prism and ped faces; few films and threads of calcium carbonate; slightly calcareous; mildly alkaline; gradual wavy boundary.

B23tca—72 to 80 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard, friable, slightly sticky; patchy clay films on ped faces; about 35 percent, by volume, soft masses of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 60 to more than 80 inches in thickness.

The A horizon is reddish brown or brown. It is noncalcareous and mildly alkaline or neutral.

The Bt horizon is red, light reddish brown, reddish brown, yellowish red, or reddish yellow. It is noncalcareous and mildly alkaline or neutral.

The Btca horizon is reddish yellow or yellowish red. It is calcareous and moderately alkaline. It is 2 to 36 percent, by volume, calcium carbonate.

Kimbrough series

The Kimbrough series consists of very shallow to shallow, loamy soils on uplands. These soils formed over thick beds of indurated platy caliche material. Slope ranges from 0 to 3 percent.

Typical pedon of Kimbrough loam in an area of Kimbrough association, nearly level; from the intersection of U.S. Highway 385 and U.S. Highway 80 in Odessa, 1.6 miles south on U.S. Highway 385, 1.2 miles southeast on ranch road, and 10 feet south, in range:

A1—0 to 7 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak medium subangular blocky structure; hard, friable, slightly sticky; common very fine roots; common very fine pores; few fragments of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—7 to 29 inches; indurated plates of caliche with a smooth upper surface and nodular development beneath; laminar in the upper 1/4 inch.

C2ca—29 to 60 inches; strongly cemented and slightly platy caliche; about 60 percent or more, by volume, calcium carbonate.

The solum is 4 to 12 inches thick over caliche. The upper 1/8 to 1 inch of the surface layer is laminar. Below the laminar layer the caliche is strongly cemented.

The A horizon is brown, dark brown, or dark grayish brown. It is neutral through moderately alkaline. It is loam or gravelly loam.

The C1cam horizon consists of indurated plates of caliche with a smooth upper surface and nodular development beneath. It is laminar in the upper 1/4 inch.

The Cca horizon is strongly cemented and slightly platy caliche.

Kinco series

The Kinco series consists of moderately deep, sandy soils on uplands. These soils formed in highly calcareous unconsolidated sandy sediments. Slope ranges from 1 to 5 percent.

Typical pedon of Kinco loamy fine sand, in an area of Kinco-Ima association, gently undulating; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 8.8 miles south on U.S. Highway 385, 32 miles west, 1.5 miles southwest on oilfield road, and 90 feet south, in range:

A1—0 to 9 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine granular structure; slightly hard, friable; few fine and very fine roots; few pores and worm casts; calcareous; moderately alkaline; clear smooth boundary.

B2—9 to 30 inches; brown (7.6YR 5/4) fine sandy loam, dark brown (7.5YR 4/4) moist; weak coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky; few fine roots; few pores and worm casts; few films and threads of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

C1ca—30 to 46 inches; reddish yellow (5YR 6/6) sandy loam, yellowish red (5YR 5/6) moist; massive; hard, friable, slightly sticky; about 50 percent, by volume, calcium carbonate; few weakly to strongly cemented bodies of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C2ca—45 to 58 inches; pinkish white (7.5YR 8/2) sandy loam, pinkish gray (7.5YR 7/2) moist; massive; hard, friable, slightly sticky; about 35 percent, by volume, calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

C3ca—58 to 72 inches; pinkish white (7.5YR 8/2) sandy loam, pinkish gray (7.5YR 7/2) moist; massive; hard, friable, slightly sticky; about 25 percent, by volume, calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 24 to 36 inches in thickness. The lower part of the solum has an accumulation of calcium carbonate that ranges from 20 to 50 percent, by volume. All horizons are calcareous and moderately alkaline.

The A horizon is brown or pale brown.

The B horizon is loam or fine sandy loam. Calcium carbonate ranges from few films and threads to about 6 percent, by volume.

The Cca horizon is pinkish white or reddish yellow. Calcium carbonate ranges from 20 to 30 percent, by volume.

Lipan series

The Lipan series consists of deep, clayey soils on the bottoms of enclosed depressions or intermittent lakes (playas). These soils formed in calcareous clayey sediments. They crack when dry and have gilgai microrelief. Slope ranges from 0 to 1 percent.

Typical pedon of Lipan clay, depressional, at the center of a microdepression; from the intersection of US. Highway 80 and U.S. Highway 385 in Odessa, 8.4 miles north on U.S. Highway 385, 0.9 mile east on Loop 338, 0.6 mile northeast, 1.8 miles east on oilfield road, and 0.1 mile south, in range:

A11—0 to 5 inches; gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak fine subangular blocky structure; very hard, very firm, very sticky and plastic; many fine roots; calcareous; moderately alkaline; abrupt smooth boundary.

A12—5 to 25 inches; gray (10YR 6/1) clay, gray (10YR 5/1) moist; moderate medium blocky structure; very hard, very firm, very sticky and plastic; few fine roots; shiny pressure faces on peds; calcareous; moderately alkaline; gradual smooth boundary.

AC1—25 to 36 inches; gray (10YR 6/1) clay, gray (10YR 5/1) moist; moderate medium blocky structure; parallelepipeds or wedge-shaped peds; slickensides extend downward from a depth of 25 inches; very hard, very firm, very sticky and plastic; few very fine roots; shiny pressure faces on peds; about 2 to 4 percent, by volume, calcium carbonate; calcareous; moderately alkaline; gradual smooth boundary.

AC2—36 to 55 inches; light brownish gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; weak fine blocky structure; parallelepipeds or wedge-shaped peds; slickensides that intersect; very hard, very firm, very sticky and plastic; shiny pressure faces on peds; about 8 to 10 percent, by volume, small bodies of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

Cca—55 to 80 inches; pale brown (10YR 6/3) clay, brown (10YR 5/3) moist; massive; very hard, very firm, very sticky and plastic; about 30 percent, by volume, calcium carbonate ranging from weakly to strongly cemented bodies; calcareous; moderately alkaline.

In undisturbed areas, gilgai microrelief consists of microknolls that are 3 to 8 inches higher than the microdepressions. Distance between the center of the microknolls and the center of the microdepressions is 3 to 16 feet. When the soil is dry, cracks 1 to 2 inches wide extend from the surface into the AC horizon.

The solum ranges from 48 to 66 inches in thickness. It is moderately alkaline throughout. Intersecting slickensides begin at a depth of 20 to 30 inches.

The A horizon ranges from 15 to 30 inches in thickness. It is gray or dark gray.

The AC horizon is gray, grayish brown, or light brownish gray. It is clay or silty clay; the clay content ranges from 40 to 60 percent.

The Cca horizon is pale brown, light brownish gray, gray, or brown. Calcium carbonate makes up 2 to 35 percent, by volume, of the Cca horizon.

Lozier series

The Lozier series consists of very shallow to shallow, loamy soils on uplands. These soils formed over limestone. Slope ranges from 20 to 30 percent.

Typical pedon of Lozier gravelly loam, in an area of Lozier-Rock outcrop association, steep; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 14.2 miles south on U.S. Highway 385, 0.2 mile west on oilfield road, and 816 feet south, in range:

A1—0 to 8 inches; light brownish gray (10YR 6/2) gravelly loam, brown (10YR 5/3) moist; weak platy structure in the upper 2 inches and weak fine subangular blocky structure below that; slightly hard, friable; many very fine roots; about 50 percent, by volume, angular and subrounded limestone fragments coated with caliche, mostly 3 inches or less across; calcareous; moderately alkaline; abrupt wavy boundary.

R&Cca 8 to 20 inches; fractured platy limestone coated with caliche; cracks and fractures filled with calcium carbonate; abrupt irregular boundary.

R—20 to 72 inches; fractured platy limestone.

The solum is 4 to 16 inches thick over fractured platy limestone coated with caliche. The soil has more than 35 percent coarse fragments.

The A horizon is light brown or light brownish gray. It is calcareous and moderately alkaline.

The R&Cca horizon is pink and has fractured limestone coated with caliche.

The R horizon is fractured platy limestone.

Patrole series

The Patrole series consists of deep, loamy soils on flood plains. These soils formed in saline clayey alluvial material. Slope ranges from 0 to 1 percent.

Typical pedon of Patrole silt loam, in an area of Patrole-Toyah association; from the intersection of Farm Road 1053 and Texas Highway 329 about 15.9 miles west of Crane, 5.8 miles south on Farm Road 1053 to bridge over the Pecos River, from north end of bridge 0.2 mile north on Farm Road 1053, 0.3 mile east, and 150 feet south, in range:

A1—0 to 10 inches; light reddish brown (5YR 6/3) silt loam, reddish brown (5YR 5/3) moist; weak platy structure parting to weak fine granular; slightly hard, friable, slightly sticky; many very fine roots; few pores and worm casts; many thin strata of very fine sandy loam bedding planes evident; many films, threads, and soft bodies of calcium sulfate and other salts; 1/8 inch of the surface crust is yellowish red (5YR 5/6); saline; calcareous; moderately alkaline; gradual wavy boundary.

C1—10 to 28 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; massive; hard, friable, sticky; few very fine roots; few thin strata of clay; bedding planes evident; common films, threads, and soft masses of calcium sulfate and other salts; saline; calcareous; moderately alkaline; clear wavy boundary.

C2—28 to 60 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; massive; extremely hard, extremely firm very sticky and plastic; few thin strata of silty clay loam; few bedding planes; many films, threads, and elongated soft bodies of calcium sulfate and other salts; few thin strata of grayish brown (2.5Y 5/2); saline; calcareous; moderately alkaline.

The thickness of the fine silty horizon over the clayey horizon ranges from 20 to 36 inches. This soil is stratified with silt in the upper part and clay in the lower part. It is calcareous and moderately alkaline throughout. It contains gypsum and other salts. Electrical conductivity ranges from 10 to 20 millimhos per centimeter.

The A horizon is brown, pale brown, light brown, or light reddish brown.

The C horizon is light reddish brown, reddish brown, light brown, or brown. It is loam, silt loam, or silty clay loam in the upper part and silty clay loam, silty clay, or clay in the lower part.

Some pedons have lenses and strata of more loamy materials below 40 inches.

Pecos series

The Pecos series consists of deep, clayey soils on flood plains. These soils formed in calcareous and saline clayey alluvium. Slope ranges from 0 to 1 percent.

Typical pedon of Pecos silty clay, in an area of Pecos association; from the north end of the bridge over the Pecos River on Farm Road 11 in the extreme southwest corner of Crane County, 0.4 mile northwest on Farm Road 11, 1.8 miles north on oilfield road, and 45 feet west, in range:

A11—0 to 10 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; common fine and very fine roots; common very fine tubes and pores; few threads of calcium sulfate and other salts; electrical conductivity about 17 mmho/cm; many cracks 1/4 to 1/2 inch wide; calcareous; moderately alkaline; clear smooth boundary.

A12—10 to 16 inches; very dark grayish brown (10YR 3/2) clay, very dark brown (10YR 2/2) moist; moderate medium subangular blocky structure; very hard, very firm, very sticky and very plastic; common fine and very fine roots; common films and threads of calcium sulfate and other salts; electrical conductivity about 20 mmho/cm; many cracks 1/4 to 1/2 inch wide; calcareous; moderately alkaline; abrupt wavy boundary.

C1—16 to 32 inches; grayish brown (10YR 5/2) clay, dark grayish brown (10YR 4/2) moist; common fine and medium distinct olive brown

(2.5YR 4/4) mottles; massive; very hard, very firm, very sticky and very plastic; few very fine roots; many threads and bodies of calcium sulfate and other salts; electrical conductivity about 20.0 mmho/cm; calcareous; moderately alkaline; clear smooth boundary.

C2—32 to 40 inches; reddish brown (5YR 5/3) clay, reddish brown (5YR 4/3) moist; massive; very hard, very firm, very sticky and very plastic; many bodies of calcium sulfate and other salts; calcareous; moderately alkaline; clear smooth boundary.

C3—40 to 80 inches; reddish brown (5YR 5/3) clay, reddish brown (5YR 4/3) moist; few fine yellowish brown mottles; massive; very hard, very firm, very sticky and very plastic; many bodies of calcium sulfate and other salts; calcareous; moderately alkaline.

The thickness of the soil to a horizon of contrasting texture ranges from 50 to more than 100 inches. The electrical conductivity ranges from 16 to 20 millimhos per centimeter. Cracks in the upper 20 inches range from 1/4 to 1/2 inch wide. The soil is calcareous and moderately alkaline.

The A horizon is dark grayish brown, very dark grayish brown, grayish brown, or brown. It is silty clay or clay.

The C horizon is grayish brown, reddish brown, reddish gray, very pale brown, brown, dark brown, dark grayish brown, light brownish gray, or very dark grayish brown. It contains many bodies of calcium sulfate and other salts.

Penwell series

The Penwell series consists of deep, sandy soils on uplands. These soils formed in eolian sand. Slope ranges from 1 to 16 percent.

Typical pedon of Penwell fine sand, in an area of Penwell-Dune land association, rolling; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 5.8 miles west on Texas Highway 329, 9.1 miles north on Farm Road 1601, 4.6 miles west on Farm Road 1233, and 100 feet north, in range:

A1—0 to 13 inches; brown (7.5YR 5/4) fine sand, dark brown (7.5YR 4/4) moist; single grained; loose, nonsticky; common fine and very fine roots; neutral; gradual smooth boundary.

C1—13 to 48 inches; light brown (7.5YR 614) fine sand, brown (7.5YR 5/4) moist; single grained; loose, nonsticky; few very fine roots; neutral; gradual smooth boundary.

C2—48 to 80 inches; pink (7.5YR 7/4) fine sand, strong brown (7.5YR 5/6) moist; single grained; loose, nonsticky; neutral.

The A and C horizons are more than 80 inches thick. They are noncalcareous and mildly alkaline or neutral.

The A horizon is brown, yellowish brown, light brown, or light yellowish brown.

The C horizon is light brown, pink, very pale brown, pale brown, or reddish yellow. It is fine sand or loamy fine sand.

Pyote series

The Pyote series consists of deep, sandy soils on uplands. These soils formed in sandy and loamy unconsolidated sediments of eolian or outwash origin. Slope ranges from 1 to 8 percent.

Typical pedon of Pyote fine sand in an area of Penwell-Pyote association, undulating; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 6.0 miles west on Texas Highway 329, 9.0 miles north on Farm Road 1601, 1.3 miles west on Farm Road 1233, and 200 feet south, in range:

A11—0 to 14 inches; yellowish red (5YR 5/6) fine sand, yellowish red (5YR 4/6) moist; single grained; loose, nonsticky; many fine roots; noncalcareous; mildly alkaline; gradual smooth boundary.

A12—14 to 34 inches; reddish yellow (5YR 6/6) fine sand, yellowish red (5YR 5/6) moist; single grained; loose, nonsticky; few fine roots; noncalcareous; mildly alkaline; clear smooth boundary.

B21t—34 to 52 inches; reddish yellow (5YR 8/6) fine sandy loam, yellowish red (5YR 5/6) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky; patchy clay films on prism faces; noncalcareous; mildly alkaline; gradual smooth boundary.

B22t—52 to 70 inches; reddish yellow (5YR 6/8) fine sandy loam, yellowish red (5YR 5/8) moist; weak coarse prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky; patchy clay films on prism faces; noncalcareous; mildly alkaline; gradual smooth boundary.

C—70 to 80 inches; reddish yellow (5YR 7/6) loamy fine sand, reddish yellow (5YR 6/6) moist; single grained; loose, nonsticky; noncalcareous; mildly alkaline.

The solum ranges from 40 to 80 inches in thickness.

The A horizon ranges from 20 to 40 inches in thickness. It is yellowish red, reddish yellow, reddish brown, light reddish brown, light brown, or brown. It is neutral or mildly alkaline.

The Bt horizon is reddish yellow, reddish brown, light reddish brown, or yellowish red. It is fine sandy loam; the clay content in the control section is 8 to 18 percent. This horizon is mildly alkaline or moderately alkaline.

The C horizon is reddish yellow, yellowish red, reddish brown, or light reddish brown. It is fine sandy loam or loamy fine sand. It is mildly alkaline or moderately alkaline.

Ratliff series

The Ratliff series consists of deep, loamy soils on uplands. These soils formed in calcareous unconsolidated loamy sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Ratliff loam, in an area of Ratliff association, nearly level; from the intersection of U.S. Highway 385 and U.S. Highway 80 in Odessa, 13 miles north on U.S. Highway 385, 10 miles east on Texas Highway 158, 5.6 miles north on Farm Road 1788, 0.1 mile west, 4.3 miles south on oilfield road, and 5 feet west, in range:

A1—0 to 8 inches; brown (10YR 5/3) loam, dark brown (10YR 4/3) moist; weak fine granular and weak fine subangular blocky structure; slightly hard, friable, slightly sticky; common fine roots; common fine pores; many worm casts; calcareous; moderately alkaline; clear smooth boundary.

B21—8 to 24 inches; light brown (7.5YR 6/4) clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky; common very fine roots; common very fine pores; few films, threads, and bodies of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B22ca—24 to 45 inches; pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky; about 40 percent by volume of weakly cemented concretions and soft masses of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B23ca—45 to 60 inches; pink (7.5YR 7/4.) clay loam, light brown (7.5YR 6/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; hard, friable, sticky; about 30 percent, by volume, soft masses of calcium carbonate; calcareous; moderately alkaline; gradual wavy boundary.

B24ca—60 to 80 inches; pink (7.5YR 8/4) clay loam, pink (7.5YR 7/4) moist; weak coarse prismatic structure parting to weak subangular blocky; hard, friable, sticky; about 40 percent, by volume, soft masses and weakly cemented bodies of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 60 inches thick. Depth to the calcic horizon is 20 to 40 inches. The soil is calcareous and moderately alkaline.

The A horizon is brown or grayish brown. Texture is loam or fine sandy loam.

The B horizon is light brown, pale brown, or brown. It is loam or clay loam. Calcium carbonate ranges from few films and threads to 6 percent, by volume.

In the Bca horizon the secondary carbonates range from 15 to 50 percent, by volume, in the soft powdery to strongly cemented forms.

Reagan series

The Reagan series consists of deep, loamy soils on uplands. These soils formed in calcareous, loamy material. Slope ranges from 0 to 5 percent.

Typical pedon of Reagan silty clay loam, 0 to 1 percent slopes; from the intersection of U.S. Highway 385 and U.S. Highway 80 in Odessa, 7 miles south on U.S. Highway 385, and 100 feet west, in range:

A11—0 to 3 inches; light brown (7.5YR 6/4) silty clay loam, dark brown (7.5YR 4/2) moist; weak fine platy and weak fine subangular blocky structure; slightly hard, friable, sticky; common very fine roots; surface crust 1/8 inch thick; calcareous; moderately alkaline; clear smooth boundary.

A12—3 to 11 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 4/4) moist; moderate fine subangular blocky structure; slightly hard, friable, sticky; common very fine roots; about 8 to 10 percent by volume worm casts in the channels; calcareous; moderately alkaline; clear smooth boundary.

R21 11 to 24 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; slightly hard, friable, sticky; few fine roots; few films and threads of calcium carbonate and some small bodies of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B22—24 to 34 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, sticky; few very fine roots; about 10 to 12 percent, by volume, worm casts; about 4 to 6 percent, by volume, calcium carbonate; few strongly cemented bodies of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B23ea—34 to 60 inches; pink (5YR 7/4) silty clay loam, light reddish brown (5YR 6/4) moist; weak coarse prismatic structure parting to weak fine subangular blocky; hard, friable, sticky; about 40 percent, by volume, weakly to strongly cemented bodies of calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

R24ca—60 to 80 inches; reddish yellow (5YR 7/6) silty clay loam, reddish yellow (5YR 6/6) moist; weak coarse prismatic structure parting to weak fine subangular blocky; hard, friable, sticky; about 30 percent, by volume, weakly to strongly cemented bodies of calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to more than 60 inches in thickness. Depth to the calcic layer ranges from 23 to 38 inches. The soil is calcareous and moderately alkaline.

The A horizon is brown, light brown, or grayish brown.

The B horizon is light brown, pale brown, light yellowish brown, or brown. Secondary carbonates range from films and threads to about 6 percent, by volume.

The Bca horizon is reddish yellow, pink, or very pale brown. It is loam, silty clay loam, or silty clay. It is 18 to 50 percent, by volume, calcium carbonate.

Reakor series

The Reakor series consists of deep, loamy soils on uplands. These soils formed in calcareous unconsolidated loamy sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Reakor silty clay, in an area of Reakor association, nearly level; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 10.8 miles south on U.S. Highway 385, 0.1 mile east on oilfield road, and 150 feet south, in range:

A11—0 to 2 inches; light brownish gray (10YR 6/2) silty clay loam, dark yellowish brown (10YR 4/4) moist; weak fine platy and weak fine granular structure; slightly hard, friable, sticky; surface crust about 1/8 inch thick; common fine and very fine roots; common pores and worm casts; calcareous; moderately alkaline; clear smooth boundary.

A12—2 to 7 inches; light brownish gray (10YR 6/2) silty clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable, sticky; common fine roots; many pores and worm casts; few films and threads of calcium carbonate; calcareous; moderately alkaline; clear smooth boundary.

B21—7 to 28 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to moderate fine and medium subangular blocky; hard, friable, sticky; many pores and worm casts; calcareous; moderately alkaline; clear wavy boundary.

B22ca—28 to 48 inches; light brown (7.5YR 6/4) silty clay loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak fine medium subangular blocky; very hard, friable, sticky; about 35 to 40 percent, by volume, calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

R23ca—48 to 60 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak fine medium subangular blocky; very hard, friable, sticky; about 30 percent, by volume, calcium carbonate; calcareous; moderately alkaline; clear wavy boundary.

B24ca—60 to 80 inches; light brown (7.5YR 6/4) silty clay, brown (7.5YR 5/4) moist; weak coarse prismatic structure parting to weak medium subangular blocky; very hard, friable, sticky; about 5 percent, by volume, calcium carbonate; calcareous; moderately alkaline.

The solum ranges from 40 to more than 60 inches in thickness. Depth to secondary carbonates ranges from 20 to 40 inches. The soil is calcareous and moderately alkaline.

The A horizon is light brownish gray, brown, or light brown. It is silty clay loam or clay loam.

The B horizon in light brown, pale brown, or very pale brown. Secondary carbonates range from few to many films and threads.

The Bca horizon is light brown. It is silt loam, silty clay, or silty clay loam. Secondary carbonates range from 10 to 45 percent, by volume, mostly in the powdery to weakly cemented form.

Reeves series

The Reeves series consists of moderately deep, loamy soils on uplands. These soils formed over gypsiferous loamy sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Reeves loam, in an area of Holloman-Reeves association, nearly level; from the intersection of Texas Highway 329 and U.S. Highway 385 in Crane, 15.9 miles west on Texas Highway 329, 1.3 miles north on Farm Road 1053, 1.1 miles west, 0.3 mile south on oilfield road, and 90 feet east, in range:

A1—0 to 9 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) moist; weak fine granular and weak fine subangular blocky structure; slightly hard, friable, slightly sticky; common fine roots; many pores; few weakly cemented calcium carbonate concretions; calcareous; moderately alkaline; clear smooth boundary.

B2—9 to 27 inches; light brown (7.5YR 6/4) loam, brown (7.5YR 5/4) moist; weak fine prismatic structure parting to weak fine subangular blocky; slightly hard, friable, slightly sticky; few fine roots; many pores; many films and threads and few weakly cemented concretions of calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

C1cacs 27 to 36 inches; white (10YR 8/2) loam, light gray (10YR 7/2) moist; massive; about 50 percent, by volume, weakly cemented gypsum and calcium carbonate; calcareous; moderately alkaline; abrupt wavy boundary.

C2cacs 36 to 60 inches; pink (7.5YR 7/4) sandy loam, light brown (7.5YR 6/3) moist; massive; about 25 percent, by volume, weakly to strongly cemented gypsum and calcium carbonate; calcareous; moderately alkaline.

The solum is 20 to 40 inches thick over weakly cemented gypsum. The soil is calcareous and moderately alkaline.

The A horizon is light brown, pale brown, or light yellowish brown.

The B horizon is light brown, pink, pale brown, or light yellowish brown. It is loam or clay loam.

The Ccacs horizon is white, pink, very pale brown, or brown. It is loamy fine sand, sandy loam, or loam. It is 10 to 50 percent or more, by volume, soft to strongly cemented calcium sulfate and calcium carbonate crystals.

Slaughter series

The Slaughter series consists of shallow, loamy soils on uplands. These soils formed in calcareous loamy material and are underlain by indurated caliche. Slope ranges from 0 to 1 percent.

Typical pedon of Slaughter clay loam, in an area of Stegall-Slaughter association, nearly level; from the intersection of U.S. Highway 80 and U.S. Highway 385 in Odessa, 4.0 miles east on U.S. Highway 80, 2.6 miles north on Loop 338, 1.1 miles east on Spur 492, 0.7 mile north, 0.9 mile east, 0.2 mile north on oilfield road, and 200 feet west, in range:

A1—0 to 5 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure; hard, friable; common roots; common pores; noncalcareous; mildly alkaline; clear smooth boundary.

B2t—5 to 16 inches; reddish brown (5YR 4/3) clay, dark reddish brown (5YR 3/3) moist; moderate medium blocky and subangular blocky structure; very hard, firm; few fine roots; few fine pores; clay films on ped faces; noncalcareous; mildly alkaline; abrupt wavy boundary.

Ccam—16 to 28 inches; platy caliche that is indurated and laminar in the upper 2 inches. The caliche plates are smooth on upper surface and knobby or nodular beneath.

The solum is 9 to 20 inches thick over caliche.

The A horizon is brown. It is neutral and mildly alkaline.

The B2t horizon is reddish brown or yellowish red. It is clay loam or clay. It is neutral and mildly alkaline.

Depth to the Ccam horizon ranges from 9 to 20 inches. The laminar upper surface of the caliche ranges from 1/2 inch to 3 inches in thickness and has a hardness of 3 to 5 on the Mohs' scale.

Stegall series

The Stegall series consists of moderately deep, loamy soils on uplands. These soils formed in loamy and clayey sediments and are underlain by indurated caliche. Slope ranges from 0 to 1 percent.

Typical pedon of Stegall clay loam, in an area of Stegall-Slaughter association, nearly level; from the intersection of U.S. Highway 80 and U.S. Highway 385 in Odessa, 4.0 miles east on U.S. Highway 80, 2.6 miles north on Loop 338, 1.1 miles east on Spur 492, 0.7 mile north, 0.9 mile east on oilfield road, and 15 feet south, in range:

A1—0 to 6 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak fine subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky; common fine roots; common fine pores; noncalcareous; mildly alkaline; clear smooth boundary.

B21t—6 to 18 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate medium subangular blocky structure; very hard, firm, sticky and plastic; few fine roots; few fine pores; patchy clay films on ped faces; noncalcareous; moderately alkaline; gradual boundary.

B22t—18 to 30 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium blocky structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; few roots; few fine pores; continuous clay films on ped faces; noncalcareous; moderately alkaline; abrupt wavy boundary.

Ccam—30 to 58 inches; platy caliche that is indurated and laminar in the upper 2 inches. The caliche plates are smooth on upper surface and knobby or nodular beneath.

The solum is 20 to 36 inches thick over caliche that is laminar in the upper 2 inches. The lower surface of the caliche has pendants of strongly cemented calcium carbonate.

The A horizon is brown or dark grayish brown. It is neutral or mildly alkaline.

The Bt horizon is reddish brown or brown. It is clay loam or clay. It ranges from noncalcareous and neutral through calcareous and moderately alkaline.

Depth to the Ccam horizon ranges from 20 to 36 inches The upper 1/2 inch to 3 inches is a smooth, laminar surface with hardness of 3 to 5 on Mohs' scale. The lower part has hardness of less than 3 on Mohs' scale.

The Stegall soils in this survey area receive slightly less precipitation than is typical for the series, but this does not affect the use and behavior of the soils.

Tencee series

The Tencee series consists of very shallow to shallow, loamy soils on uplands. These soils formed in calcareous loamy material. Slope ranges from 1 to 30 percent.

Typical pedon of Tencee very gravelly loam, in an area of Tencee association, undulating; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 9.5 miles north on U.S. Highway 385, 5.4 miles north on U.S. Highway 385 from its intersection with Farm Road 1233, and 12 feet west, in range:

A11ca—0 to 8 inches; light brown (7.5YR 6/4) very gravelly loam, dark brown (7.5YR 4/4) moist; weak platy and weak fine granular structure; slightly hard, friable; few fine and very fine roots, few large roots; about 40 percent by volume of angular and subrounded caliche fragments less than 3/4 inch across; calcareous; moderately alkaline; abrupt smooth boundary.

A12ca—8 to 15 inches; light brown (7.5YR 6/4) very gravelly loam, dark brown (7.5YR 4/4) moist; weak fine granular and weak fine subangular blocky structure; hard, friable; few fine and very fine roots; about 40 percent, by volume, caliche fragments less than 3 inches across; about 5 percent, by volume, caliche fragments 3 to 5 inches across that have pendants on the lower side; calcareous; moderately alkaline; abrupt wavy boundary.

C1cam—15 to 32 inches; white (10YR 8/2) indurated caliche with a laminar upper part and pendant below the laminar layer; massive with somewhat less hard material below; smooth wavy boundary.

C2ca—32 to 60 inches; white (10YR 8/2) gravelly loam, very pale brown (10YR 7/3) moist; massive; about 70 percent, by volume, soft powdery calcium carbonate.

The solum is 4 to 18 inches thick over caliche that is laminar in the upper 1/2 inch to 2 inches. Below the laminar layer the caliche is weakly cemented. The soil is calcareous and moderately alkaline.

The Aca horizon is light brown, brown, pale brown, pinkish gray, or light yellowish brown. It is very gravelly loam or very gravelly sandy loam.

The Ccam horizon is white or very pale brown. Depth to the Ccam horizon ranges from 4 to 18 inches. The caliche fragments range from less than 3/4 inch to 5 inches or more across.

The Cca horizon is at a depth of 20 to 60 inches.

Toyah series

The Toyah series consists of deep, loamy soils on flood plains. These soils formed in loamy alluvial material. Slope ranges from 0 to 1 percent.

Typical pedon of Toyah loam, in an area of Patrole-Toyah association; from the intersection of U.S. Highway 385 and Texas Highway 329 in Crane, 8.8 miles south on U.S. Highway 385, 3.2 miles west, 2.1 miles southwest, 0.8 mile west, 0.2 mile south, 1.3 miles west on ranch road, and 12 feet south, in range:

A1—0 to 16 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak fine subangular blocky structure; hard, friable, sticky; common fine roots; few very fine pores; calcareous; moderately alkaline; clear smooth boundary.

C1—16 to 30 inches; light brownish gray (10YR 6/2) loam, grayish brown (10YR 5/2) moist; many fine distinct yellowish brown and strong brown mottles; massive; hard, friable, sticky; many threads and soft bodies of calcium sulfate and other salts; few bedding planes; calcareous; moderately alkaline; gradual wavy boundary.

C2—30 to 55 inches; reddish brown (5YR 5/4) clay loam, reddish brown (5YR 4/4) moist; massive; hard, friable, sticky; many films, threads, and soft bodies of calcium sulfate and other salts; calcareous; moderately alkaline; gradual wavy boundary.

IIC—65 to 60 inches; reddish brown (2.5YR 4/4) clay loam, dark reddish brown (2.5YR 3/4) moist; massive; hard, firm, sticky; many films, threads, and soft bodies of calcium sulfate and other salts; calcareous; moderately alkaline.

The soil ranges from 48 to more than 80 inches in thickness. The lower part has discontinuous bedding planes. It is calcareous and moderately alkaline throughout.

The A horizon is brown, dark grayish brown, or grayish brown. It is 10 to 20 inches thick. It is loam or clay loam.

The C horizon is light brownish gray, grayish brown, brown, reddish brown, or light reddish brown. It is loam or clay loam. It contains calcium sulfate and other salts. Some pedons have thin strata and mottles of olive and gray colors in the upper part of the C horizon. Some pedons have clay or silty clay strata below a depth of 40 inches.

Triomas series

The Triomas series consists of deep, loamy soils on uplands. These soils formed in eolian sediments. Slope ranges from 0 to 3 percent.

Typical pedon of Triomas loamy fine sand, 0 to 3 percent slopes; from the intersection of Texas Highway 302 and U.S. Highway 80 in Odessa, 23 miles northwest on Texas Highway 302, 3.0 miles south on Farm Road 2019, 1.1 miles south, 0.3 mile east, 0.7 mile south, 1.0 mile southeast, 2.1 miles south, 1.1 miles west, 0.4 mile south, 2.0 miles west on oilfield road, and 50 feet southwest, in range:

A11—0 to 6 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; single grained; loose nonsticky; common very fine roots; neutral; gradual smooth boundary.

A12—6 to 18 inches; reddish brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/4) moist; weak fine subangular blocky structure; loose, nonsticky; common very fine roots; neutral; clear smooth boundary.

B21t—18 to 46 inches; yellowish red (2.5YR 5/6) sandy clay loam yellowish red (5YR 4/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; hard friable, sticky; few fine roots; few very fine pores; patchy clay films on ped faces; neutral; gradual smooth boundary.

B22t—46 to 65 inches; red (2.5YR 5/6) sandy clay loam, red (2.5YR 4/6) moist; moderate coarse prismatic structure parting to moderate medium subangular blocky; very hard, friable, sticky, few fine pores; patchy clay films on ped faces; neutral; gradual smooth boundary.

B23t—65 to 75 inches; reddish yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; hard friable sticky; few very film pores; patchy clay films on ped faces; films and threads of calcium carbonate; about 2 to 4 percent, by volume, calcium carbonate; mildly alkaline; clear smooth boundary.

B24tca—75 to 80 inches; reddish yellow (5YR 7/6) sandy clay loam, reddish yellow (5YR 6/6) moist; moderate coarse prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky; patchy clay films on ped faces; about 25 percent, by volume, calcium carbonate; weakly to strongly cemented bodies of calcium carbonate; calcareous; moderately alkaline.

The solum is more than 60 inches thick. The calcic horizon is below a depth of 60 inches.

The A horizon is brown or reddish brown. It is noncalcareous.

The Bt horizon is yellowish red, red, reddish yellow, or light reddish brown. It is sandy loam or sandy clay loam. It ranges from noncalcareous and neutral or mildly alkaline in the upper part through calcareous and moderately alkaline in the lower part.

The Btca horizon is reddish yellow or pink. It is sandy clay loam. It is calcareous and moderately alkaline. It ranges from 2 to 25 percent, by volume, calcium carbonate in the soft powdery form to strongly cemented pebbles.

Upton series

The Upton series consists of very shallow to shallow, loamy soils on uplands. These soils formed in calcareous, loamy sediments. Slope ranges from 1 to 5 percent.

Typical pedon of Upton gravelly loam, in an area of Upton-Reagan association, gently undulating; from the intersection of Farm Road 1601 and Interstate Highway 20 in Penwell, 2.0 miles south on Farm Road 1601, 0.1 mile east, 0.4 mile south, 0.5 mile east, 0.2 mile north, 0.4 mile east, 02 mile north on oilfield road, and 50 feet east, in range:

A1—0 to 6 inches; brown (10Y R 5/3) gravelly loam, dark brown (10YR 4/3) moist; weak fine granular and weak fine subangular blocky structure; slightly hard, friable, slightly sticky; common very fine roots; about 15 percent, by volume, cemented caliche pebbles, mostly less than 1 inch across; calcareous, moderately alkaline; gradual smooth boundary.

B2—6 to 16 inches; pale brown (10YR 6/3) gravelly clay loam, brown (10YR 5/3) moist; weak fine subangular blocky structure; hard, friable, sticky; common very fine roots; about 25 percent, by volume, cemented caliche pebbles and fragments, mostly less than 3 inches across; calcareous; moderately alkaline; abrupt smooth boundary.

C1cam—16 to 32 inches; white caliche plates that are laminar in the upper 1/2 inch; caliche plates are strongly cemented; abrupt wavy boundary.

C2ca—32 to 80 inches; pink (5YR 8/3) weakly to strongly cemented caliche; about 50 percent by volume of caliche pebbles with a few cobble- and stone-sized fragments.

The solum is 7 to 20 inches thick over indurated caliche. Below the C1cam horizon the caliche is weakly cemented.

The A horizon is brown, light brownish gray, or pinkish gray. It is calcareous and moderately alkaline.

The B horizon is pale brown, brown, light brown, or pinkish gray. It is loam or clay loam, and coarse fragments vary from 15 to 30 percent. It is calcareous and moderately alkaline.

The Ccam horizon consists of caliche plates with a laminar upper surface 1/2 inch thick. The plates range from 3 to 10 inches across and from 1 to 3 inches in thickness.

The Cca horizon consists of weakly to strongly cemented caliche.

Wickett series

The Wickett series consists of moderately deep, sandy soils on uplands. These soils formed over indurated caliche. Slope ranges from 1 to 5 percent.

Typical pedon of Wickett loamy fine sand, in an area of Wickett association, gently undulating; from the intersection of U.S. Highway 80 and U.S. Highway 385 in

Odessa, 16.5 miles west on U.S. Highway 80, 0.1 mile north, 0.6 mile west on oilfield road, and 2.5 feet east, in range:

A1—0 to 12 inches; reddish brown (5YR 5/4) loamy fine sand, reddish brown (5YR 4/4) moist; single grained; loose, nonsticky; common very fine to fine roots; noncalcareous; mildly alkaline; clear smooth boundary.

B2t—12 to 28 inches; yellowish red (5YR 5/6) fine sandy loam, yellowish red (5YR 4/6) moist; moderate coarse prismatic structure parting to weak fine subangular blocky; slightly hard, friable; few clay films, sand grains coated and bridged with clay; noncalcareous; mildly alkaline; abrupt wavy boundary.

C1cam—28 to 40 inches; indurated platy caliche that is laminar in the upper 1/8 inch and strongly cemented in the lower part; clear wavy boundary.

C2ca—40 to 60 inches; weakly cemented caliche; massive; about 50 percent or more, by volume, visible calcium carbonate.

The solum ranges from 20 to 40 inches in thickness over indurated caliche that is laminar in the upper 1/8 inch. Below the laminar layer, the caliche material is weakly to strongly cemented.

The A horizon is reddish brown or brown. It is noncalcareous and mildly alkaline. It is loamy fine sand or fine sandy loam.

The Bt horizon is yellowish red or reddish brown. It is fine sandy loam or loam. It is noncalcareous and mildly alkaline to moderately alkaline.

The Ccam horizon consists of a laminar upper layer with indurated or strongly cemented caliche. The laminar layer ranges from 1/8 inch to 3 inches thick.

The Cca horizon is weakly cemented caliche that begins 24 to 50 inches below the surface.

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(4) United States Department of Agriculture. 1965. Predicting rainfall-erosion losses from cropland east of the Rocky Mountain. Agric. Res. Serv., U.S. Dep. Agric. Handb. 282, 47 pp.

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Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having 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 plant growth is restricted.

Alluvium. Material. such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	inches
Very low	0 to 3
Low	3 to 6
Medium	6 to 9
High	More than 9

Bedding planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial. eolian, lacustrine, or marine sediments.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A moil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Caliche. A more or less cemented deposit of calcium carbonate in soils of warm-temperate, subhumid to arid areas. Caliche occurs as soft, thin layers in the soil or as hard, thick beds just beneath the solum, or it is exposed at the surface by erosion.

Cemented pan. Indurated pan having a hard, brittle consistency because the particles are held together by some cementing substance.

Clay. As a moil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a moil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Climax vegetation. The stabilized plant community on a particular site, The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. Mineral or rock particles up to 3 inches (2 millimeters to 7.5 centimeters) in diameter.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex, soil. A mapping unit of two or more kinds of soil occurring in such an intricate pattern that they cannot be shown separately on a soil map at the selected scale of mapping and publication.

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.
Control reaction. The part of the soil on which classification is bases. The thickness varies among different kinds of soil, but for many it is 40 or 80 inches (1 or 2 meters).
Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.
Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.
Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.
Deferred grazing. A delay in grazing until range plants have reached a specified stage of growth. Grazing is deferred in order to increase the vigor of forage and to allow desirable plants to produce seed. Contrasts with continuous grazing and rotation grazing.
Depth to rock. Bedrock at a depth that adversely affects the specified use.
Diversion (or diversion terrace). A ridge of earth, generally a terrace. built to protect downslope areas by diverting runoff from its natural course.
Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not

continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients, as for example in "hillpeats" and "climatic moors."

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Excess salts. Excess water soluble salts. Excessive salts restrict the growth of most plants.

Fast intake. The rapid movement of water into the soil.

Favorable. Favorable soil features for the specified use.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May,* for example, means that flooding can occur during the period November through May. Water standing for short periods after rainfall or commonly covering swamps and marshes is not considered flooding.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Forage. Plant material used as feed by domestic animals. Forage can be grazed or cut for hay.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Gilgai. Typically, the microrelief of Vertisols—clayey soils having a high coefficient of expansion and contraction with changes in moisture content. Commonly a succession of microbasins and microknolls in nearly level areas or of microvalleys and microridges parallel with the slope.

Gravel. Rounded or angular fragments of rock up to inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gypsum. Hydrous calcium sulphate.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major *horizons* of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon,

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered, but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants are those that follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones. Rock fragments 10 inches (2.5 centimeters) or more across. Large stones adversely affect the specified use.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Low strength. Inadequate strength for supporting loads.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A sod having a pH value between 6.6 and 7.3.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are *very slow* (less than 0.06 inch), *slow* (0.06 to 0.20 inch), *moderately slow* (0.2 to 0.6 inch). *moderate* (0.6 to 2.0 inches), *moderately rapid* (2.0 to 6.0 inches), *rapid* (6.0 to 20 inches), and *very rapid* (more than 20 inches).

Phase, soil. A subdivision of a soil series or other unit in the soil classification system based on differences in the soil that affect its management. A soil series, for example, may be divided into phases on the bases of differences in slope, stoniness, thickness, or some other characteristic that affects management. These differences are too small to justify separate series.

pH value. (See Reaction, soil). A numerical designation of acidity and alkalinity in soil.

Piping. Moving water of subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent, good, fair,* and *poor.* The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction. soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	11.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth. Shallow root zone. The soil is shallow over a layer that greatly restricts roots. See Root zone.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged in stream channels from a drainage area. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Small stones. Rock fragments 3 to 10 inches (7.5 to 25 centimeters) in diameter. Small stones adversely affect the specified use.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0 to 0.5 millimeter); *medium sand* (0.5 to 0.25 millimeter); *fine sand* (0.25 to 0.10 millimeter); *very fine sand* (0.10 to 0.05 millimeter); *silt* (0.005 to 03)02 millimeter); and *clay* (less than 0.002 millimeter).

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of 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 characteristics of the soil are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular. Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 2.5 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

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, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay.* and *clay.* The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Tables

The Tables in this soil survey contain information that affects land use planning in this survey area. Current data tables may be available within the Web Soil Survey.

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