SOIL SURVEY OF

Parmer County, Texas

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

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 who need the information, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1967–72. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. 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 Parmer County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, woodlands, and wildlife areas; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

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

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

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in alphabetic order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page number of the capability unit and the range site in which the soil has been placed.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those that have a moderate limitation can be colored yellow, and those that have a severe limitation can be colored red.

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

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Wildlife."

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

Community planners and others can read about soil properties that affect the choice of sites for dwellings and industrial buildings and for recreation areas in the sections "Engineering Uses of the Soils" and "Recreational Development."

Engineers and builders can find, under "Engineering Uses of the Soils," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

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

Newcomers in Parmer County will be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication and in the section "General Nature of the County."

Cover: Irrigated grain sorghum ready for harvest on Acuff loam, 0 to 1 percent slopes. Grain elevator and the city of Bovina are in the background.

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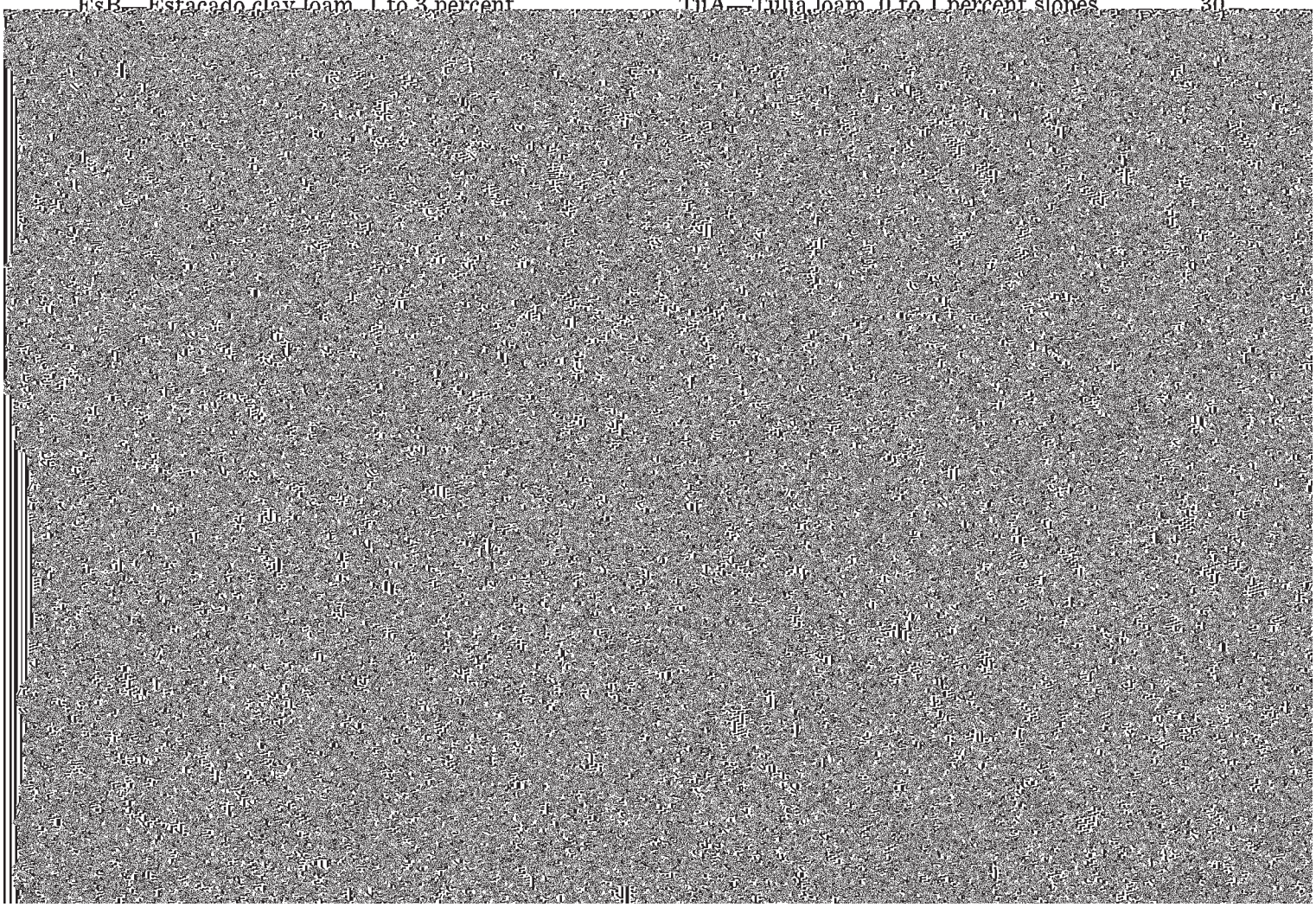
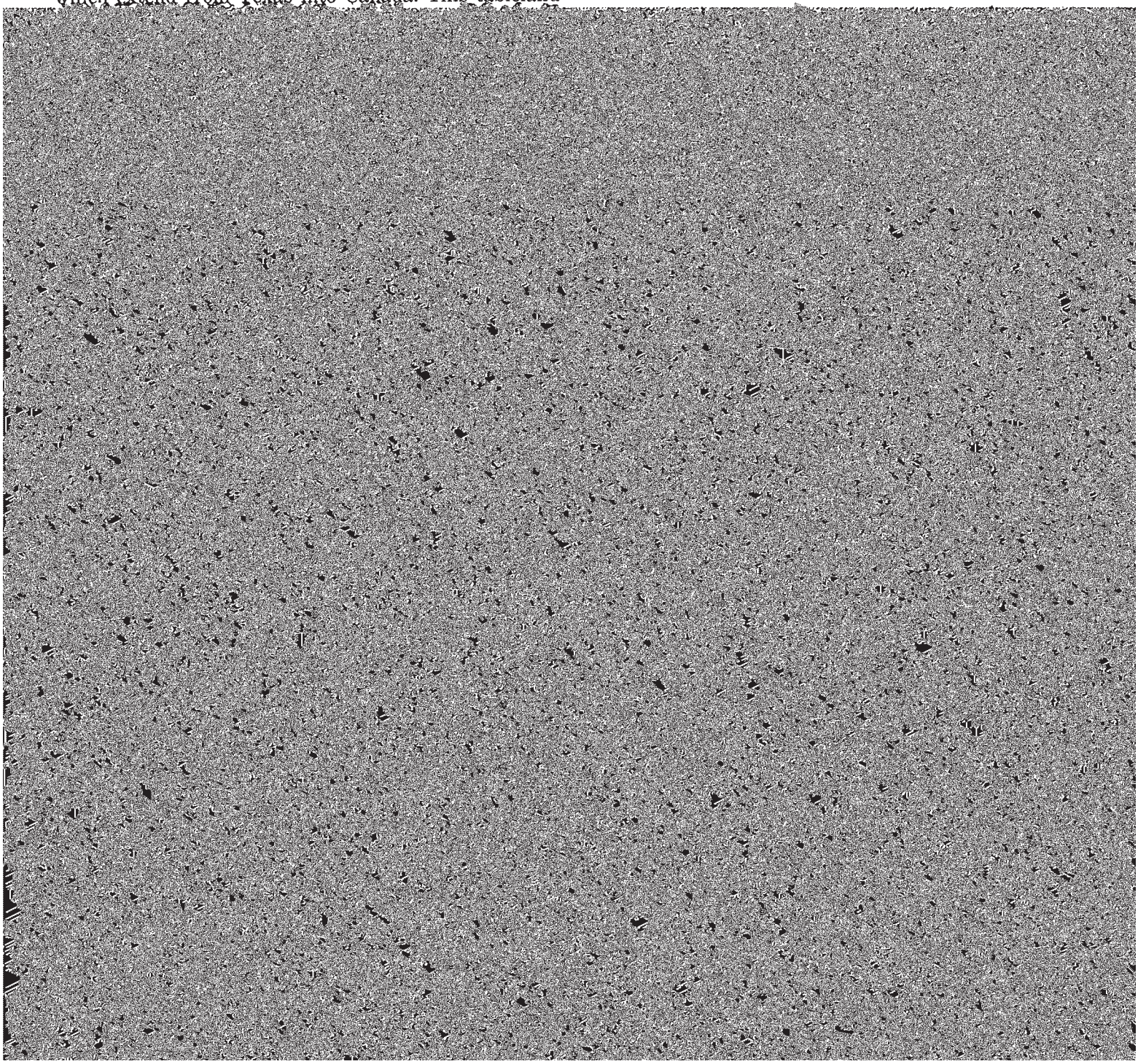


SOIL SURVEY OF PARMER COUNTY, TEXAS

BY HERBERT E. BRUNS, SOIL CONSERVATION SERVICE

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

PARMER COUNTY is on the western edge of the Texas Panhandle (fig. 1). It is in the southern part of the smooth tableland known as the High Plains which extend from Texas into Canada. This tableland



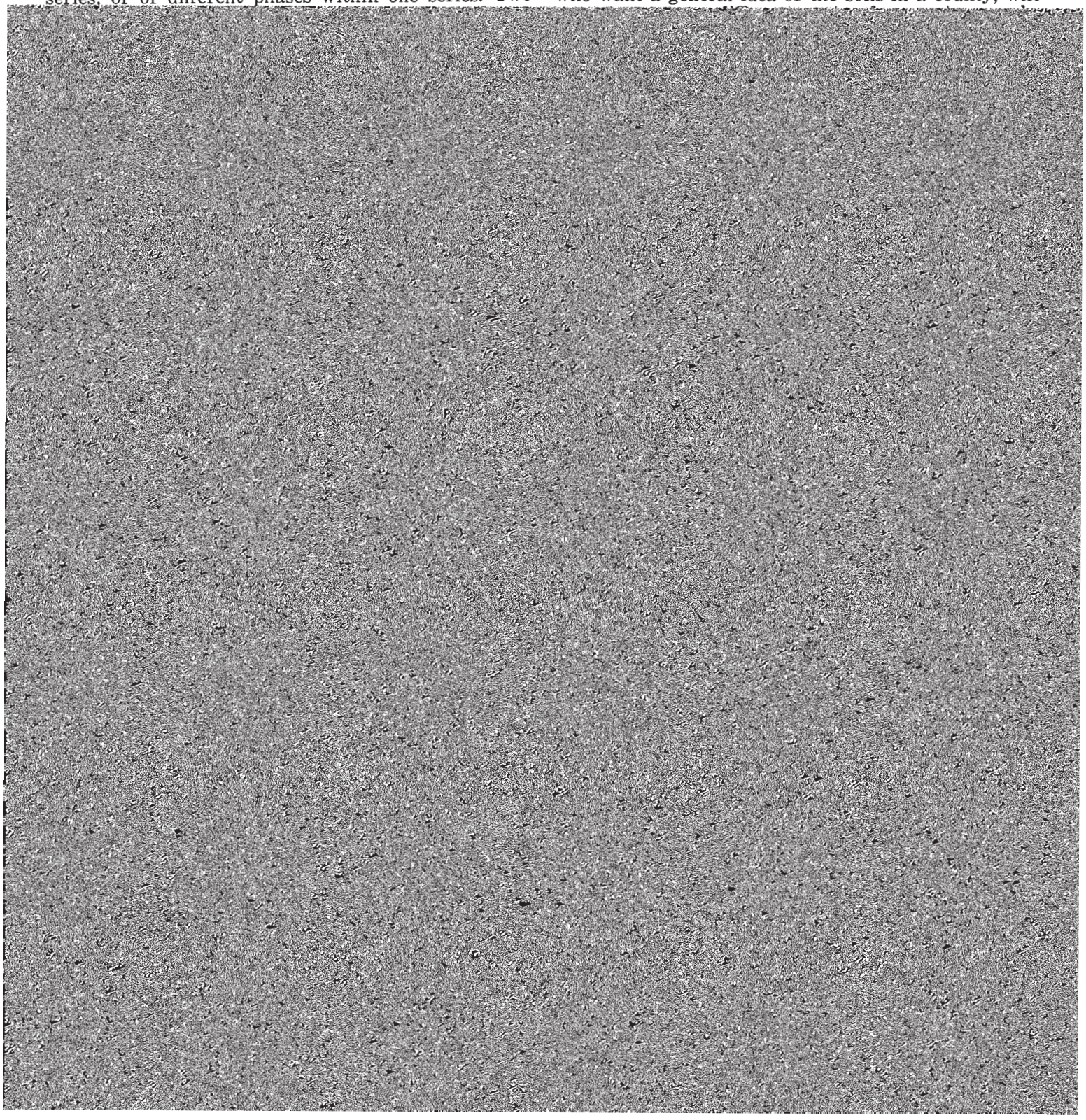
calves from their herds, run them as stockers if forage is available, and then place them in nearby feedlots.

ping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two

A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who



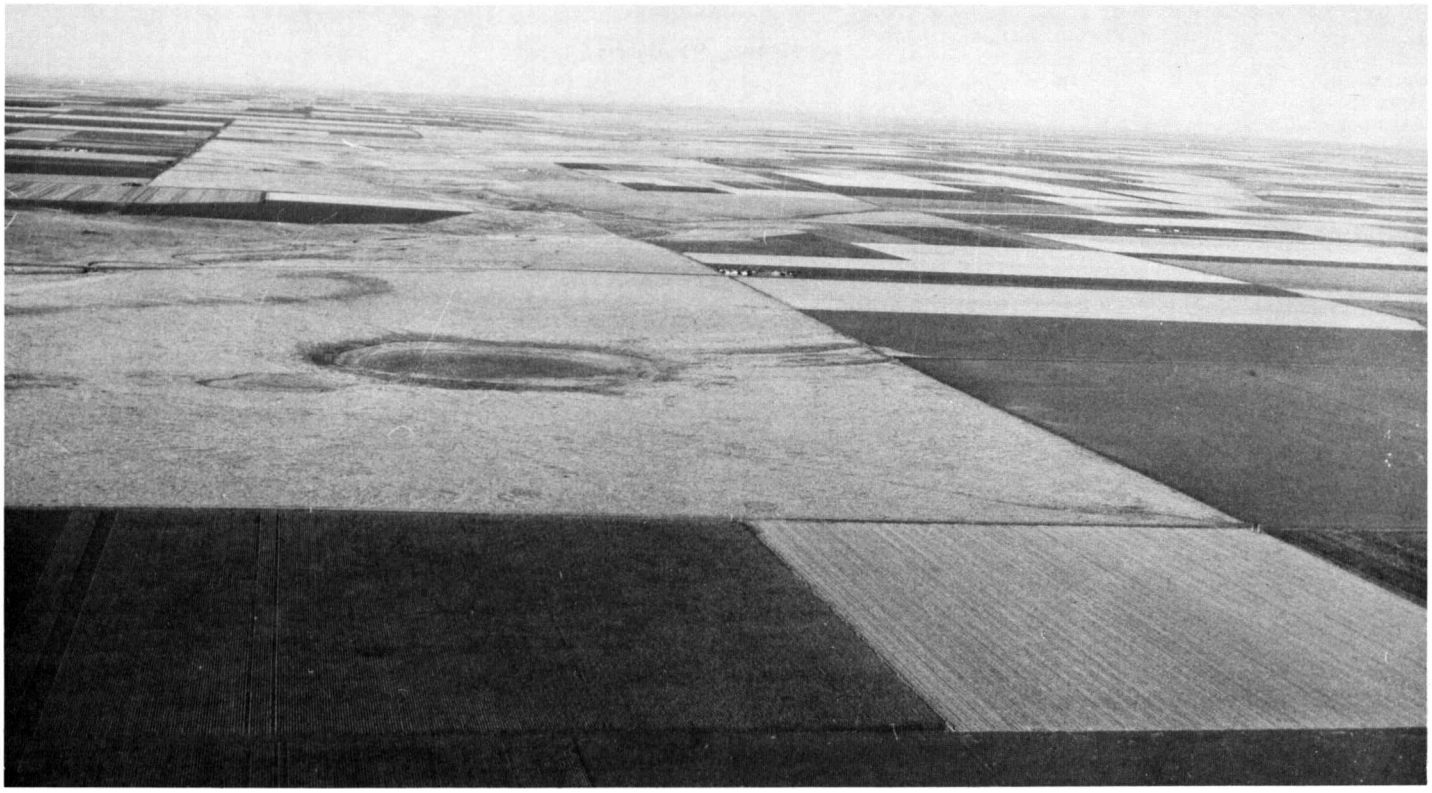
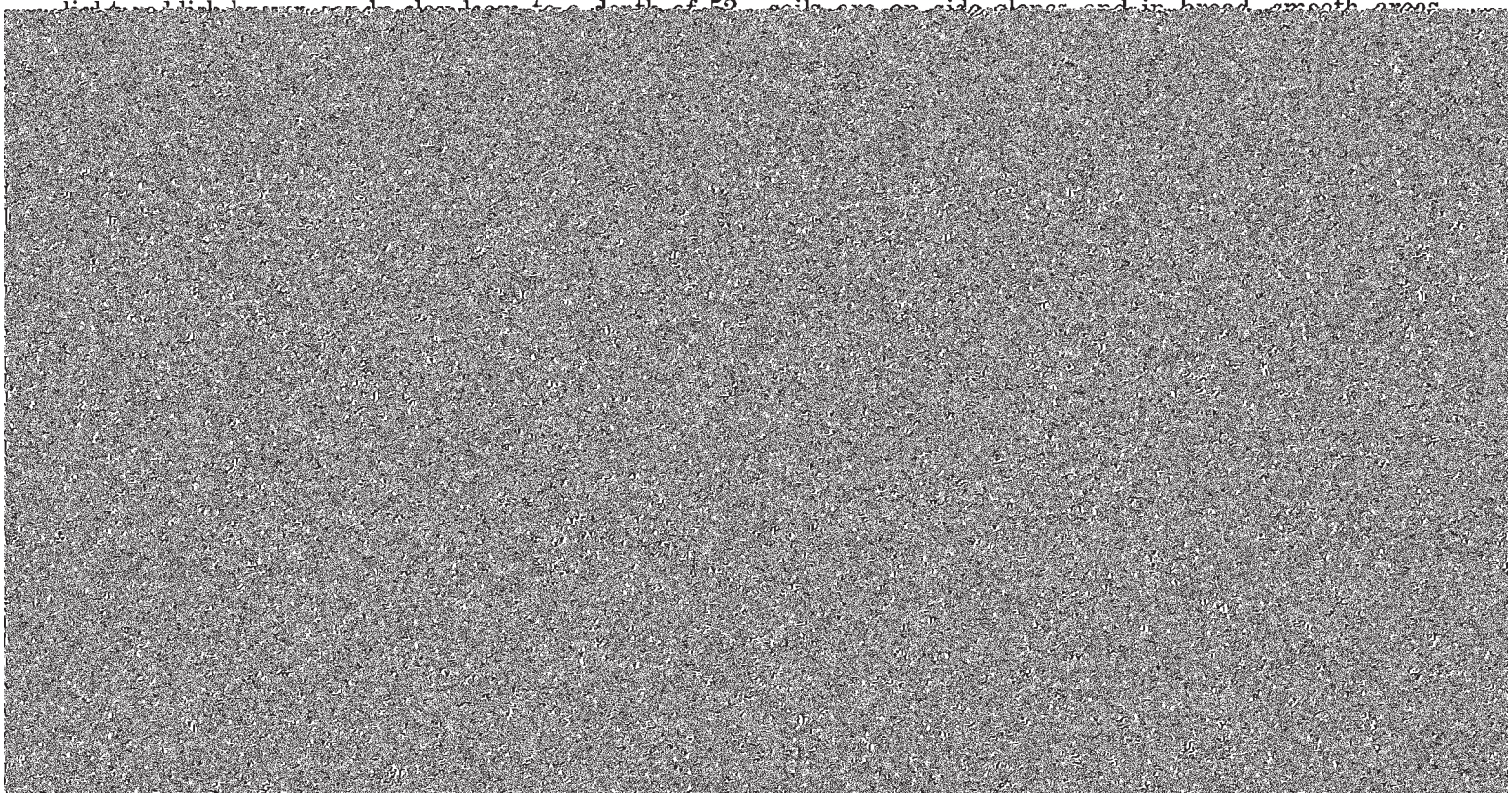


Figure 2.—**Nearly level soils and a playa basin in the Olton association.**

11 inches thick. Below this is about 5 inches of brown sandy clay loam. The next layer is yellowish-red and

Minor in this association are Estacado, Lipan, Olton, Randall, and Tulia soils. Estacado, Olton, and Tulia



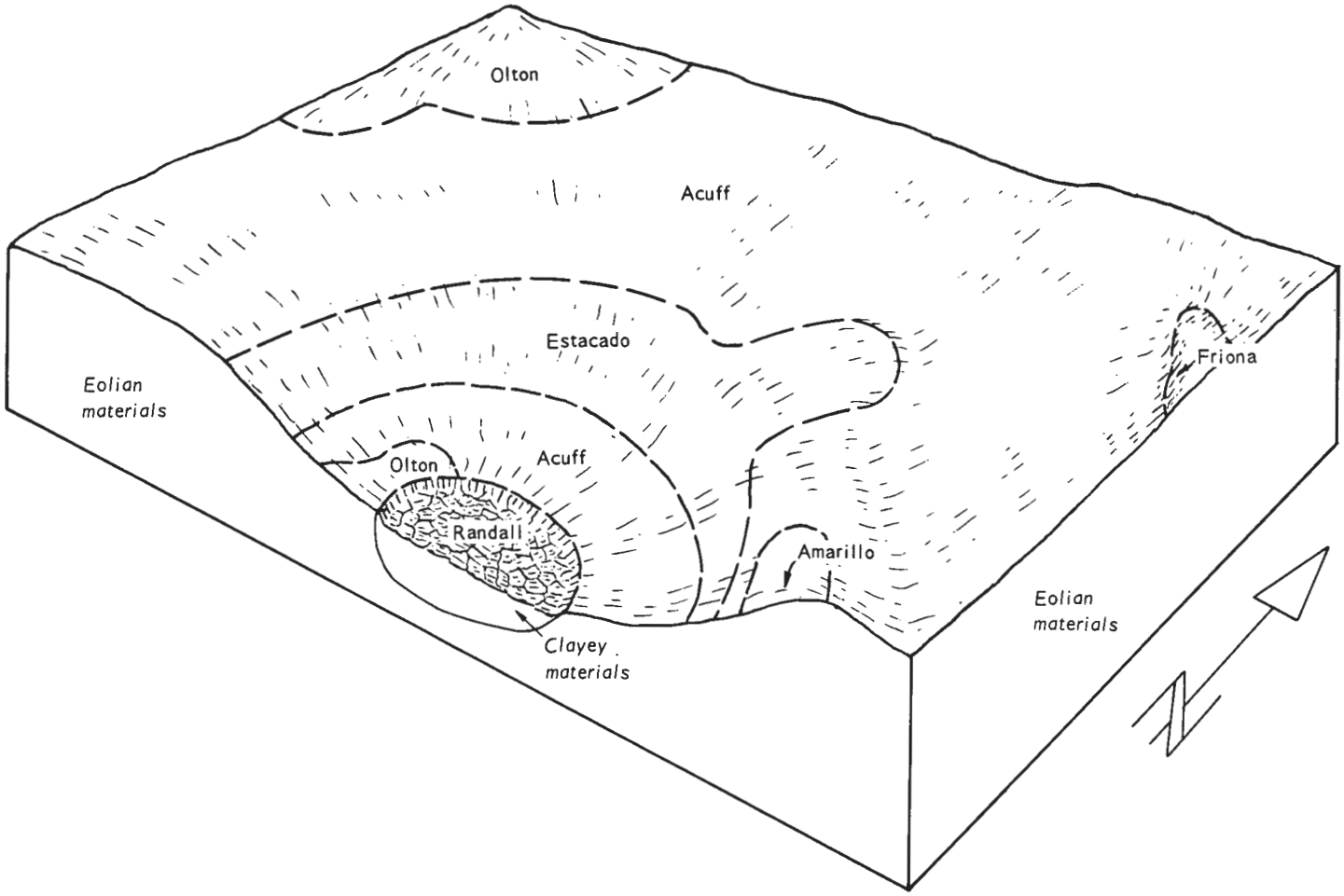


Figure 3.—**Typical pattern of soils and parent material in the Acuff association.**

Minor in this association are Acuff, Arvana, Bippus, Estacado, Olton, Posey, Randall, Tulia, and Zita soils. Acuff, Arvana, Estacado, Olton, and Posey soils are in the smooth areas. Also, Estacado, Posey, and Tulia soils are on side slopes of drainageways and playas. Bippus soils are on alluvial bottoms of drainageways. Randall soils are on playa bottoms, and Zita soils are on benches around depressions.

About 90 percent of this association is cultivated. Most areas are irrigated. Alfalfa, castorbeans, corn, cotton, grain sorghum, soybeans, and wheat are the main crops.

5. *Berda-Estacado-Bippus association*

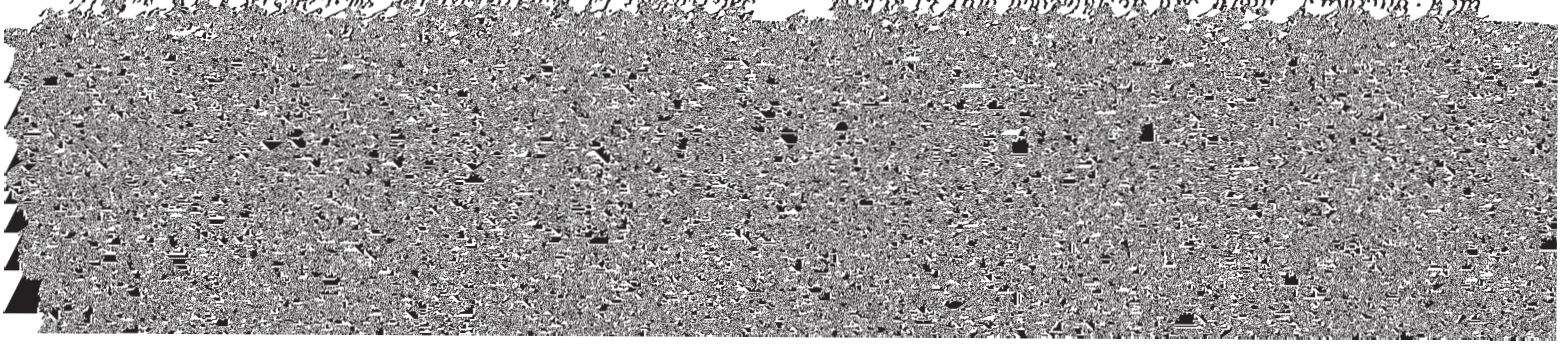
Nearly level to sloping noncalcareous to calcareous

rial is reddish-brown fine sandy loam to a depth of 63 inches.

Estacado soils have a surface layer of dark grayish-brown and brown clay loam about 13 inches thick. The next layer is brown and light-brown clay loam to a depth of 28 inches. Below this is about 15 inches of pink clay loam that is high in carbonates. The next layer is light-brown clay loam to a depth of 75 inches. Below this to a depth of about 90 inches is reddish-yellow clay loam.

Bippus soils have a surface layer of brown, very dark grayish-brown, and dark grayish-brown clay loam about 19 inches thick. The next layer is brown clay loam about 47 inches thick.

Minor in this association are Acuff, Amarillo, Kim



for dams, which could store limited amounts of water. This association has some potential as wildlife habitat for predators, furbearers, rodents, quail, and other small birds and mammals.

6. *Estacado-Tulia association*

Nearly level to gently sloping, calcareous, moderately permeable clay loams to loams on uplands

This association makes up about 1 percent of the county. It is about 58 percent Estacado soils, 15 percent Tulia soils, and 27 percent minor soils. About a third

otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of each series description is the soil profile; that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman

Acuff Series

The Acuff series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on smooth upland plains. These soils formed in eolian deposits.

In a representative profile the surface layer is brown loam about 11 inches thick (fig. 4). Below this is brown sandy clay loam about 5 inches thick. The next layer is yellowish-red and light reddish-brown sandy clay loam about 36 inches thick. Below this to a depth of about 80 inches is pink sandy clay loam.

Acuff soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow to medium.

These soils are well suited to native grass or to row crops. They can be used for many kinds of irrigated truck crops. Cotton, corn, grain sorghum, wheat, vegetables, soybeans, and alfalfa are the main crops.

Representative profile of Acuff loam, 0 to 1 percent slopes, 2 miles north of Farwell on a county road on New Mexico State line and 1 mile east on a field road, 40 feet east and 100 feet north of the southwest corner of sec. 45, blk. A:

A11—0 to 4 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak, very coarse, prismatic structure parting to weak, fine, subangular blocky and granular; somewhat platy structure in top ½ inch; hard, friable, slightly plastic; many fine roots; many fine and very fine pores and few medium pores; few worm casts; neutral; clear, smooth boundary.

A12—4 to 11 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate, coarse, prismatic structure parting to weak, fine and very fine, subangular blocky and granular; hard, friable, slightly sticky and plastic; many fine roots; many very fine and fine pores and common medium pores; common worm casts; mildly alkaline; clear, smooth boundary.

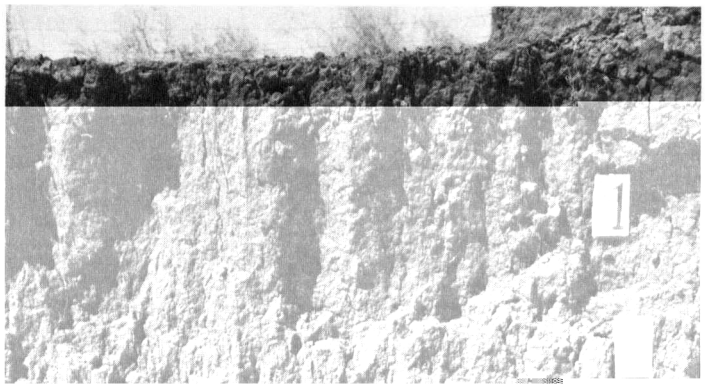
B21t—11 to 16 inches, brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate, coarse, prismatic structure parting to weak, fine, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and common medium pores; common worm casts; common, discontinuous, patchy clay films, mostly on faces of prisms; mildly alkaline; clear, smooth boundary.

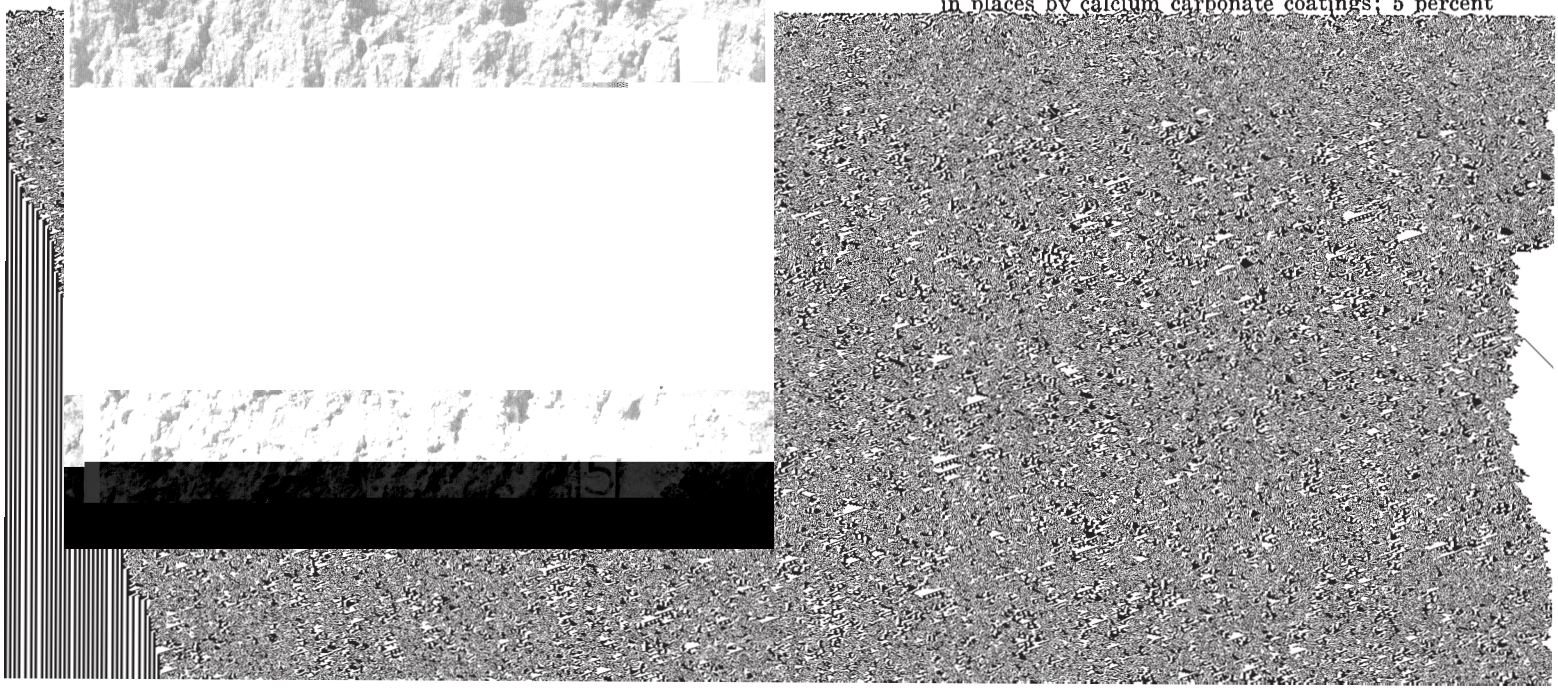
B22t—16 to 21 inches, yellowish-red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) moist; moderate, coarse, prismatic structure parting to weak, fine, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; common worm casts; common patchy clay films, mostly on faces of prisms; mildly alkaline; clear, smooth boundary.

B23t—21 to 28 inches, yellowish-red (5YR 4/8) sandy clay loam, yellowish red (5YR 3/8) moist; moderate, coarse and medium, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, sticky and plastic; common fine roots; many very fine and fine pores and few medium pores; few worm casts; common patchy clay films, mostly on faces of prisms; calcareous in lower part; moderately alkaline; gradual, smooth boundary.

B24t—28 to 40 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, coarse and medium, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, sticky and plastic; few fine roots; many very fine and fine pores and few medium pores; few worm casts; few patchy clay films on faces of prisms; few, fine, calcium carbonate concretions; 1 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, smooth boundary.

B25tca—40 to 52 inches, light reddish-brown (5YR 6/4) sandy clay loam, reddish brown (5YR 5/4) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; very hard, friable, sticky and plastic; few fine roots; many very fine and fine pores and few medium pores; few worm casts; common patchy clay films on faces of peds, masked in places by calcium carbonate coatings; 5 percent





The B25tca and B26tca horizons are light reddish brown, pink, or reddish yellow. The content of calcium carbonate is 30 to 60 percent, by volume. The B27t horizon is at a depth of 45 to 75 inches and is pink, reddish yellow, or yellowish red. Calcium carbonates in this horizon range from thin soft coatings and threads to vertical stringers that have cemented concretions.

Acuff loam, 0 to 1 percent slopes (AcA).—This soil is on broad, smooth plains. Most areas range from 10 acres to several thousand acres in size and are irregular in shape. This soil has the profile described as representative of the Acuff series.

Included with this soil in mapping are numerous, small, round spots of Estacado soils that are less than 1 acre to 2 acres in size (fig. 5). Also included are oval spots of Olton soils that are less than 5 acres in size and small areas of Friona soils. These included soils make up less than 2 percent of any mapped area.

This Acuff soil is used mostly for irrigated crops. Small areas are used as range. The hazard of soil blowing is moderate, and the hazard of erosion is slight. A few spots have been damaged by soil blowing.

Irrigation systems are needed that do not increase the hazard of erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, fertilizer and high-residue crops help to maintain good tilth. Capability units IIIe–4, dryland, and IIe–1, irrigated; Clay Loam range site.

Acuff loam, 1 to 3 percent slopes (AcB).—This gently sloping soil is in elongated, oval areas 10 to 900 acres in size.

The surface layer is brown loam about 12 inches thick. Below this is brown sandy clay loam about 6 inches thick. The next layer to a depth of about 36 inches is yellowish-red sandy clay loam that is calcareous in the lower part. Below this to a depth of about 72 inches is pink sandy clay loam that is about 45 percent calcium carbonate, by volume. The next layer is pink, calcareous sandy clay loam that is 15 percent calcium carbonate, by volume.

Included with this soil in mapping are small spots of Estacado soils and areas of Amarillo or Olton soils that are a few acres in size.

This Acuff soil is well suited to dryland crops. Many areas are irrigated, and small areas are in native range. The hazards of soil blowing and erosion are moderate.

In dryfarmed areas, terracing and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate.

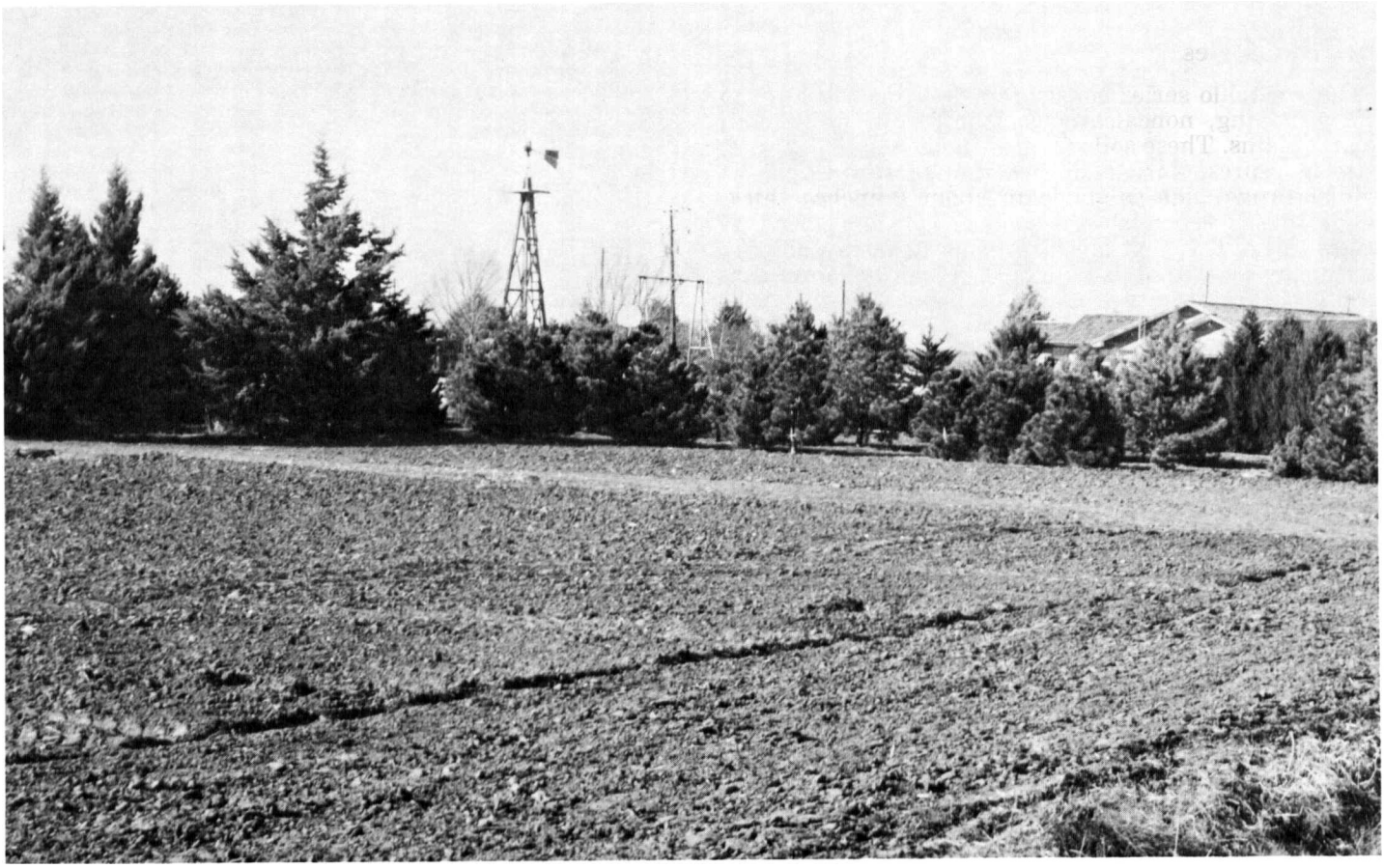


Figure 5.—**Windbreak on Acuff loam, 0 to 1 percent slopes. Included areas of Estacado soils have affected the growth of trees in the center of the windbreak.**

In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Capability units IIIe–2, dryland, and IIIe–2, irrigated; Clay Loam range site.

Acuff loam, 3 to 5 percent slopes (AcC).—This gently sloping soil is in crescent-shaped bands on the northwestern and eastern sides of playas and in oblong bands along sides of draws. Areas are 10 to 100 acres in size.

The surface layer is brown loam about 10 inches thick. Below this is brown sandy clay loam about 9 inches thick. The next layer is reddish-yellow and yellowish-red sandy clay loam about 21 inches thick. Below this is pink sandy clay loam about 39 inches thick. The next layer is yellowish-red sandy clay loam.

Included with this soil in mapping are a few spots of Estacado soils and areas of Olton soils that make up 3 to 5 percent of most mapped areas.

This Acuff soil is mostly in native grasses. The hazard of soil blowing is moderate, and the hazard of erosion is severe. In the few areas that are cultivated, about half of the surface layer has been removed by erosion.

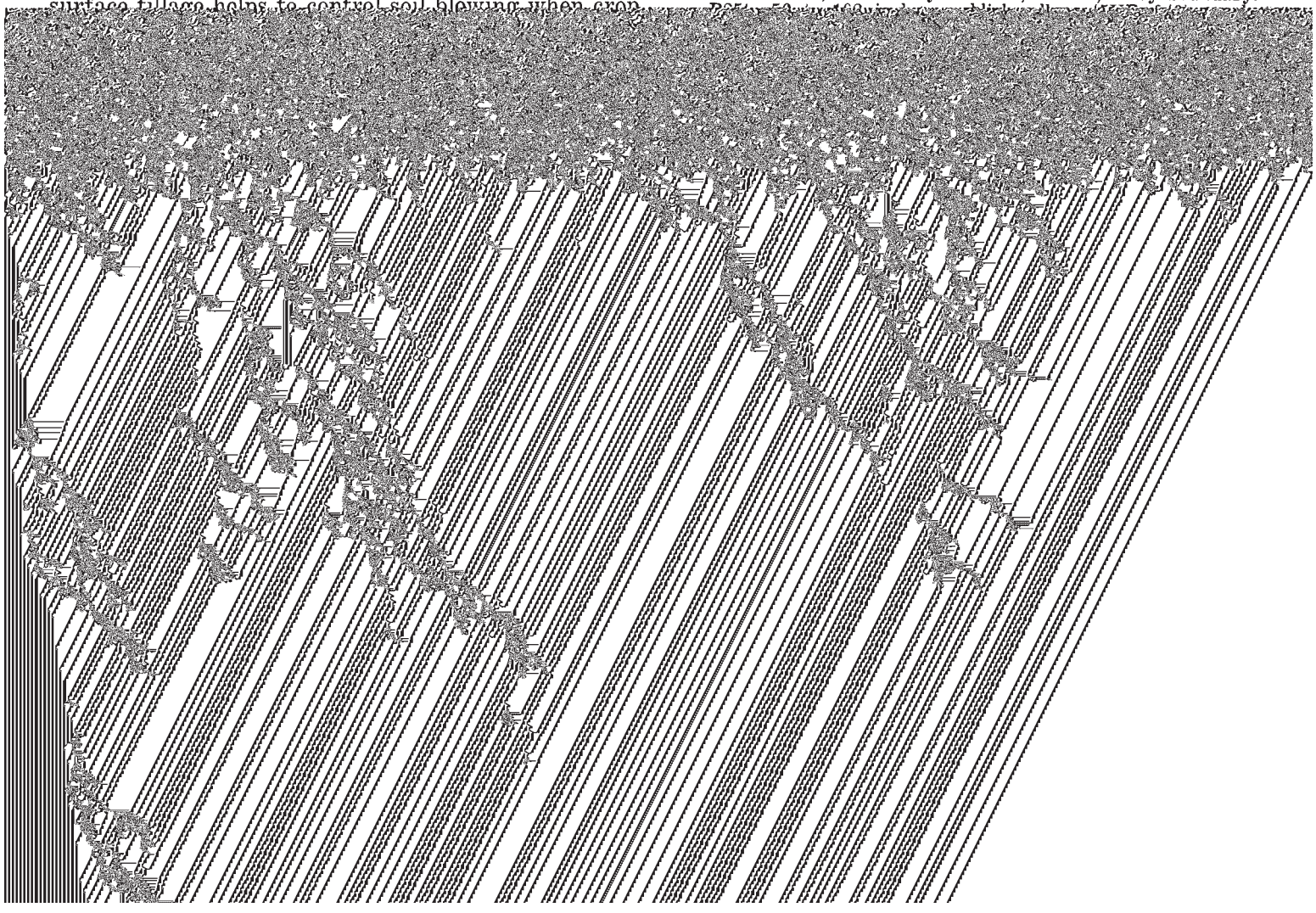
Using crop residue and level borders, terracing, and farming on the contour help to control erosion. Rough surface tillage helps to control soil blowing when crop

fine and very fine pores and few medium pores; many patchy clay films on faces of prisms; common worm casts; mildly alkaline; gradual, smooth boundary.

B22t—17 to 25 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, very coarse, prismatic structure parting to moderate, medium, subangular blocky and granular; very hard, friable, slightly sticky and plastic; many fine roots; many fine and very fine pores and few medium pores; many patchy clay films on faces of prisms; common worm casts; mildly alkaline; gradual, wavy boundary.

B23t—25 to 44 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, very coarse, prismatic structure parting to weak, coarse, subangular blocky; slightly hard, very friable; many fine roots; many fine and very fine pores and few medium pores; many patchy clay films on faces of prisms; few worm casts; many threads and films of calcium carbonate; few very fine concretions of calcium carbonate; 8 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy boundary.

B24tca—44 to 56 inches, pink (5YR 7/4) sandy clay loam, light reddish brown (5YR 6/4) moist; weak, fine, subangular blocky structure intermixed with 60 percent soft masses and caliche gravel; gravel nodules ½ centimeter to 2 centimeters in diameter; few fine roots; soil part of mass is porous; clay films on faces of peds are masked by carbonates; 60 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, wavy boundary.



damaged by soil blowing. In most cultivated areas, the finer particles in the plow layer have been scattered by the wind, which makes the surface layer in these areas somewhat sandier than the surface layer in grassed areas.

Irrigation systems are needed that do not increase the hazard of erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in some places. Leaving crop residue on the surface helps to control soil blowing. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, fertilizer and high-residue crops help to maintain good tilth (fig. 6). Capability units IIIe–3, dryland, and IIe–2, irrigated; Sandy Loam range site.

Amarillo fine sandy loam, 1 to 3 percent slopes (AmB). —This gently sloping soil is in elongated, oval areas 15 to 320 acres in size.

The surface layer is brown loam about 11 inches thick. The next layer to a depth of about 36 inches is yellowish-red sandy clay loam that is calcareous below a depth of 28 inches. Below this to a depth of about 69 inches is pink sandy clay loam that is about 45 percent calcium carbonate. The next layer is reddish-yellow, calcareous sandy clay loam.

Included with this soil in mapping are small spots of Posey soils and areas of Acuff soils that are a few acres in size. Also included are a few areas of a soil that has a surface layer of loam or loamy fine sand and small areas of soils that have been eroded so that the original surface layer has been removed.

This Amarillo soil is well suited to dryland crops. Many areas are irrigated. Small areas are in native range. The hazards of soil blowing and erosion are moderate.

In dryfarmed areas, terracing and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion and to conserve moisture. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Capability units IIIe–3, dryland, and IIIe–3, irrigated; Sandy Loam range site.

Amarillo fine sandy loam, 3 to 5 percent slopes (AmC). —This gently sloping soil is in crescent-shaped bands on the northwestern slopes bordering playas and in oblong bands along sides of draws. Most areas are 10 to 35 acres in size.

The surface layer is reddish-brown fine sandy loam about 9 inches thick. The next layer is reddish-brown

Figure 6.—**Harvesting upland cotton on irrigated Amarillo fine sandy loam, 0 to 1 percent slopes. This crop followed fertilized grain sorghum in the cropping system.**

and yellowish-red sandy clay loam about 25 inches thick. Below this is pink sandy clay loam about 15 inches thick. The next layer is light reddish-brown sandy clay loam about 14 inches thick. Below this is reddish-yellow sandy clay loam.

Included with this soil in mapping are a few spots of Posey soils, mostly less than 100 feet across, and a few areas of Olton soils that make up 3 to 5 percent of most mapped areas. Also included are areas, mostly less than 1 to 2 acres in size, that have been eroded so that the original surface layer has been removed and gullies have cut into the sandy clay loam areas below. A few areas that have about half the top layer are also in-

subangular blocky; very hard, friable, slightly sticky and plastic; few fine roots; many fine pores; few worm casts; common, thin, patchy clay films on faces of prisms; mildly alkaline; gradual, smooth boundary.

B22t—14 to 23 inches, reddish-brown (5YR 4/4) sandy clay loam, dark reddish brown (5YR 3/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; very hard, friable, slightly sticky and plastic; few fine roots; many fine pores; few worm casts; common, thin, patchy clay films on faces of prisms; few fine threads and films and few fine concretions of calcium carbonate; calcareous; moderately alkaline; clear, wavy boundary.

B23tca—23 to 26 inches, pink (5YR 7/4) sandy clay loam,

caliche (sandy clay loam), pink (5YR 7/3) moist; weak, coarse, subangular blocky structure; very hard, friable, slightly sticky and plastic; 70 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, wavy boundary.

B26tca—75 to 90 inches, reddish-yellow (5YR 6/6) sandy clay loam, yellowish red (5YR 5/6) moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; few patches of clay films on faces of peds; many, very fine to medium, soft masses and concretions of calcium carbonate; 55 percent calcium carbonate, by volume; calcareous; moderately alkaline.

Secondary carbonates are at a depth of 14 to 28 inches. The A horizon is 7 to 12 inches thick and is reddish brown or brown. It is less than 1 percent organic matter. The B21t horizon is 6 to 8 inches thick and is reddish brown or yellowish red. The B21t and B22t horizons are 18 to 30 percent clay. They are sandy clay loam in most places but range to fine sandy loam. The B22t horizon is reddish brown or yellowish red. The B23tca horizon is pink, yellowish red, or pinkish white, but in some profiles it is not above the B24cam horizon. The B24cam horizon is at a depth of 20 to 36 inches. It is 2 to 9 inches thick and is pink or pinkish white. It is 60 to 70 percent, by volume, calcium carbonate. The hardness of this horizon ranges from 3 to 5 on the Mohs scale in at least the upper ½ inch. In most places the B25ca horizon has nearly equal calcium carbonate content and is the same color as the B23tca horizon. The B26tca horizon is at a depth of 50 to 75 inches. It is reddish yellow or pink and has calcium carbonates that range from thin soft coatings and threads to vertical stringers that have cemented concretions.

Included with this soil in mapping are areas of Posey fine sandy loam, mostly less than 100 feet across. Small areas of Acuff, Amarillo, Friona, and Olton soils are also included.

This Arvana soil is used mostly for irrigated crops. A few areas are in native range. The hazard of soil blowing is moderate, and the hazard of erosion is slight. In most cultivated areas, the silt and clay in the plow layer have been scattered by the wind, which makes the surface layer in these areas somewhat sandier than the surface layer in grassed areas. Some material from the sandy clay loam lower layers has been mixed with that in the plow layer in places where plowing has been deep.

Leaving crop residue on the surface helps to control erosion and conserve moisture. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. In irrigated areas, fertilizer is needed to maintain tilth and crop production. A well-designed irrigation system is needed to control erosion (fig. 8). Capability units IIIe–3, dryland, and IIe–2, irrigated; Sandy Loam range site.

Berda Series

Figure 9.—**Profile of Berda loam.**

layer is about 21 inches of brown and light-brown, calcareous loam. The next layer is light reddish-brown, calcareous loam about 9 inches thick. The underlying material to a depth of about 80 inches is reddish-brown and pink fine sandy loam.

Berda soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is medium. Organic-matter content is low.

These soils are used mostly as range. They are not well suited to cultivation. Grain and forage sorghums are the main crops.

Representative profile of Berda loam, 5 to 8 percent

few, very fine to fine, rounded but etched concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B22—18 to 27 inches, light-brown (7.5YR 6/4) loam, brown (7.5YR 4/4) moist; weak, very coarse, prismatic structure parting to weak, fine, subangular blocky and granular; slightly hard, very friable, slightly plastic; common fine roots; very fine and fine pores and few medium pores; common worm casts; few very fine, fine, and medium, rounded but etched concretions of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

B23ca—27 to 36 inches, light reddish-brown (5YR 6/4) loam, reddish brown (5YR 5/4) moist; weak, coarse, subangular blocky and granular structure; slightly hard, very friable, slightly plastic; few fine roots; common worm casts; few, very fine, fine, and medium, rounded but etched concretions of calcium carbonate; few faint films of calcium carbonate; calcareous; moderately alkaline; gradual, smooth boundary.

C1—36 to 63 inches, reddish-brown (5YR 5/4) fine sandy loam, reddish brown (5YR 4/4) moist; weak, massive and single grained; slightly hard, very friable, slightly plastic; few fine roots; many fine and very fine pores and few medium pores; few, very fine to medium, rounded but etched concretions of calcium carbonate; calcareous; moderately alkaline; diffused, smooth boundary.

C2—63 to 80 inches, pink (5YR 7/4) fine sandy loam, light reddish brown (5YR 6/4) moist; weak, massive and single grained; slightly hard, very friable, slightly plastic; few fine roots; many fine and very fine pores and few medium pores; few, medium, rounded concretions of calcium carbonate; calcareous; moderately alkaline.

The A horizon is 6 to 14 inches thick. It is brown, grayish brown, dark grayish brown, and reddish brown. The B21, B22, and B23ca horizons are light yellowish brown, brown, light brown, yellowish brown, or light reddish brown. The C horizon is light reddish-brown, light-brown, pink, or reddish-brown loam or fine sandy loam.

Berda loam, 3 to 5 percent slopes (BeC).—This gently sloping soil is mostly on foot slopes in long, narrow areas. Most areas are about 400 to 800 feet wide, follow the contour of the side slopes of draws, and are 15 to 70 acres in size.

The surface layer is brown loam about 11 inches thick. The next layer is brown loam about 15 inches thick. Below this is about 12 inches of yellowish-brown clay loam. The underlying material to a depth of 84 inches is light-brown clay loam.

Included with this soil in mapping are small areas of Bippus soils on lower parts of slopes and Estacado soils on upper parts of slopes. Also included are a few small areas of Acuff, Olton, and Potter soils and areas of soils that are fine sandy loam.

ing soil is on foot slopes along draws. Areas are 20 to 800 acres in size. Slopes range from 5 to 8 percent, but they are mainly about 6 percent. This soil has the profile described as representative of the Berda series.

Included with this soil in mapping are spots of Potter soils that make up as much as 5 percent of the smaller mapped areas, areas of Posey soils that surround the Potter soils, and areas of Acuff loam. Areas of Berda loam, 3 to 5 percent slopes, that are on lower slopes are also included.

This Berda soil is used mostly as range (fig. 10). This soil is not suited to cultivation. The hazard of soil blowing is moderate, and the hazard of erosion is severe. Capability unit VIe–2, dryland; Hardland Slopes range site.

Bippus Series

The Bippus series consists of deep, friable, nearly level to gently sloping, noncalcareous, loamy soils. These soils formed in loamy outwash material along alluvial fans and valley fills.

In a representative profile the surface layer is brown, very dark grayish-brown, and dark grayish-brown clay loam about 19 inches thick. The next layer to a depth of 66 inches is brown clay loam.

Bippus soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is medium.

These soils are well suited to native grass or to row crops. Most areas are used as range, but a few areas are used for crops. Grain and forage sorghums are the main crops. These soils have potential for use as irrigated pasture.

Representative profile of Bippus clay loam, 0 to 1 percent slopes, 2 miles east of Hub on Texas Highway 86, 3.8 miles south on a county road, on the east side of the road, in range; 200 feet east and 30 feet south of the northwest corner of sec. 7, Kelly subdivision:

A11—0 to 2 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; weak, medium to thick, platy structure (due to cattle tramping and accumulation of layers); slightly hard, friable, slightly sticky and plastic; common fine roots; mildly alkaline; abrupt, smooth boundary.

A12—2 to 9 inches, very dark grayish-brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; weak, coarse, subangular blocky and granular structure; hard, friable, slightly sticky and plastic; common fine roots; many fine, medium, and coarse

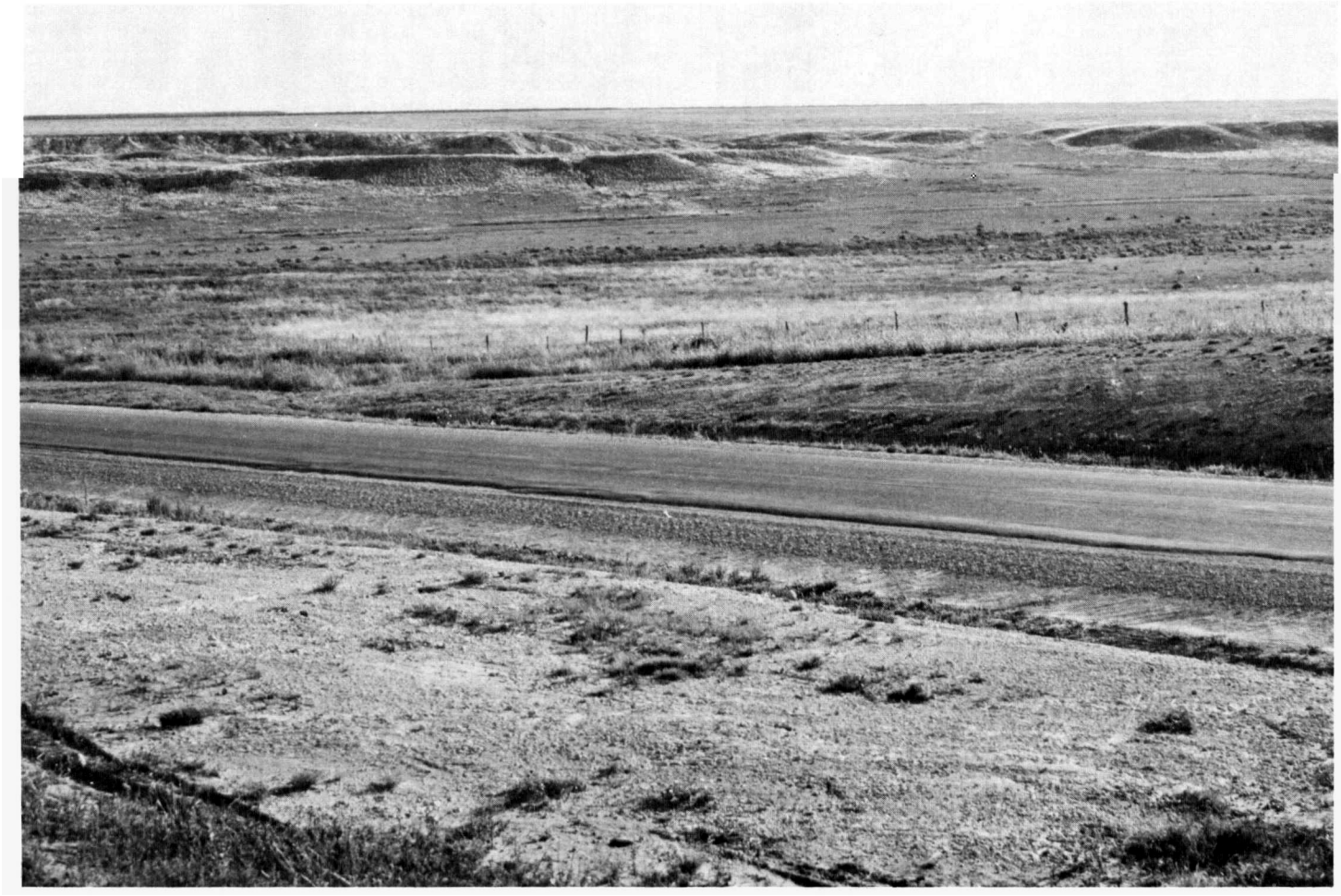


Figure 10.—**Berda loam, 5 to 8 percent slopes, in range along Running Water Draw. Berda soils are below the knobs of Potter soils on far side of draw.**

pores; few worm casts; mildly alkaline; clear, smooth boundary.

A13—9 to 19 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, prismatic and subangular blocky structure; hard, friable, slightly sticky and plastic; few fine roots; many worm casts; mildly alkaline; clear, smooth boundary.

B2—19 to 36 inches, brown (10YR 5/3) clay loam, dark brown (10YR 3/3) moist; moderate to weak, subangular blocky structure; hard, friable, slightly sticky and plastic; porous; threads and fine concretions of calcium carbonate; 8 percent calcium

nearly level soil is on old flood plains and bottom lands along draws and their tributaries. Areas are 200 feet to more than 2,000 feet wide and are as much as several miles in length along draws. This soil has the profile described as representative of the Bippus series.

Included with this soil in mapping are small spots of Pullman, Randall, and Spur soils. Also included are areas of soils that have a sandy clay loam surface layer and some small spots of soils that have an overwash of fine sandy loam or loam.

This Bippus soil is suited to dryfarmed or irrigated

consist of Berda soils. These nearly level soils consist of old flood plain deposits in draws along intermittent streams. Some areas are entirely Bippus soils, some are Spur soils, and some contain both soils. The areas form a nearly continuous strip that is mainly 200 to 400 feet wide but ranges from 600 to 800 feet in a few places. Slopes are 0 to 1 percent. Relief is uneven.

The Bippus soils have a surface layer of dark grayish-brown clay loam about 12 inches thick. Below this is brown clay loam about 23 inches thick. The next layer is yellowish-brown sandy clay loam about 10 inches thick. Below this to a depth of 69 inches is brown clay loam.

The Spur soils are in channels. They have the profile described as representative of the Spur series.

Included with these soils in mapping are a few depressions of dark-gray clay in channels and in a few other places.

The hazards of soil blowing and erosion are slight. These soils are flooded at least once every 4 to 10 years.

This mapping unit is not suited to cultivation. Almost all areas are used as range. In some areas of Spur soils, the plant cover is thick, but in other areas there is no plant cover. All areas of Bippus soils are thickly vegetated. Capability unit Vw–1, dryland; Valley range site.

Estacado Series

The Estacado series consists of deep, nearly level to gently sloping, calcareous, loamy soils on smooth uplands. These soils formed in eolian material.

In a representative profile the surface layer is dark grayish-brown and brown, calcareous clay loam about 13 inches thick (fig. 11). The next layer is brown and light-brown clay loam about 15 inches thick. Below this to a depth of 90 inches is pink, light-brown, and reddish-yellow clay loam.

Estacado soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is slight.

These soils are well suited to native grass or to row crops. Cotton, corn, grain sorghum, wheat, and soybeans are the main crops.

Representative profile of Estacado clay loam, 1 to 3 percent slopes, 3.5 miles northeast of Friona on U.S. Highway 60, 0.5 mile north on a county road, on the east side of the road; 1,400 feet south and 100 feet east of the northwest corner of sec. 26, T. 1 N., R. 4 E.:

Ap—0 to 8 inches, dark grayish-brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine and fine pores and few medium pores; few worm casts; few very fine concretions of calcium carbonate; 9 percent calcium carbonate, by volume; calcareous; moderately alkaline; abrupt, smooth boundary.

A1—8 to 13 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate, medium, subangular blocky and granular structure; hard, friable, slightly sticky and plastic; common fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few very fine concretions and few threads and films of calcium carbonate; 13 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

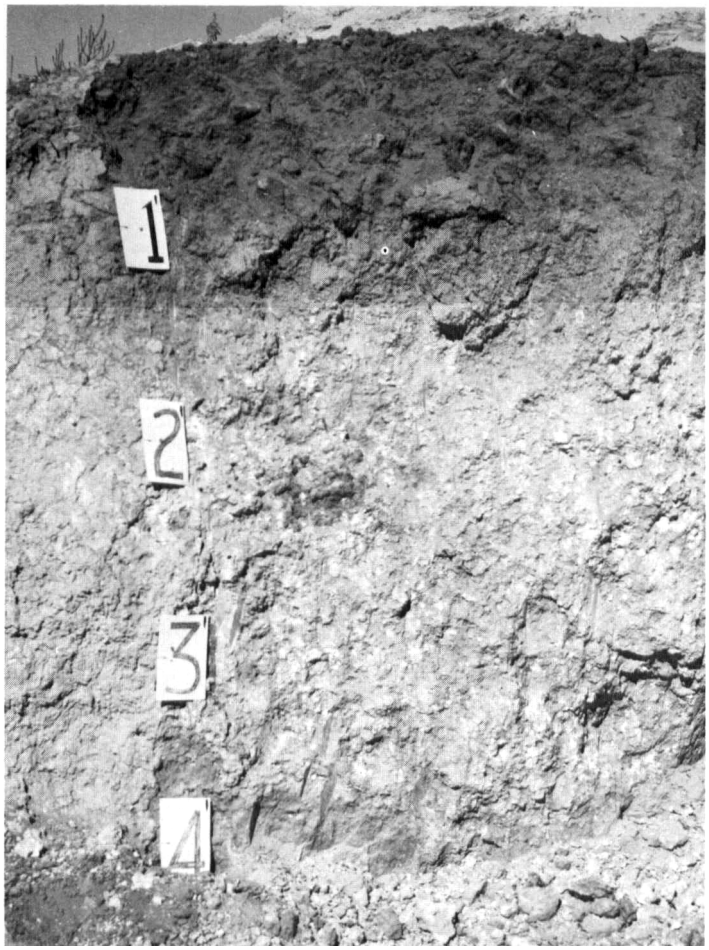


Figure 11.—**Profile of Estacado clay loam showing carbonates, which occur as soft masses and concretions below the surface layer.**

B21tca—13 to 19 inches, brown (7.5YR 5/2) clay loam, dark brown (7.5YR 4/2) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; hard, friable, slightly sticky and plastic; common fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few patchy clay films on faces of prisms; few very fine concretions and few threads and films of calcium carbonate; 21 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B22tca—19 to 28 inches, light-brown (7.5YR 6/4) clay loam, brown (7.5YR 4/4) moist; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; slightly hard, friable, slightly sticky and plastic; common fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few patches of clay films on faces of prisms; few very fine concretions of calcium carbonate; few threads and many faint patches of calcium carbonate; 21 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

B23tca—28 to 43 inches, pink (7.5YR 7/4) clay loam, light brown (7.5YR 6/4) moist; weak, coarse, prismatic structure parting to weak, coarse, subangular; slightly hard, friable, slightly sticky, plastic; few fine roots; many very fine pores, common fine pores, and few medium pores; few worm casts in upper part; few patchy clay films on faces of prisms;

many, medium and coarse, soft masses and common medium and few fine concretions of calcium carbonate; 35 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy

areas of soils that have a surface layer of loam are included, mostly in association with other loam soils.

About two-thirds of this Estacado soil is cultivated.

Figure 12.—**Grain sorghum stubble on Estacado clay loam. The stubble was left standing to help prevent soil blowing and to conserve moisture.**

cium carbonate. Below this is yellowish-red clay loam that extends to a depth of 80 inches.

Included with these soils in mapping are areas of Acuff, Bippus, and Olton soils.

The soils in this complex are used mostly as range. A few small areas are used for irrigated pasture (fig. 13). Some small areas are cultivated with large areas of other soils. The hazards of soil blowing and erosion are moderate.

Leaving crop residue on the surface helps to control soil blowing and erosion. Using diversion terraces and grassed waterways, farming on the contour, and terracing help to control erosion. Rough surface tillage helps to control soil blowing when crop residue is in-

These soils formed in loamy eolian material on smooth uplands.

In a representative profile the surface layer is brown loam about 8 inches thick (fig. 14). The next layer is brown and yellowish-red sandy clay loam about 23 inches thick. Below this is about 4 inches of pinkish-white, indurated and strongly cemented caliche. The next layer is pinkish-white sandy clay loam about 24 inches thick. Below this to a depth of about 84 inches is pink sandy clay loam.

Friona soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is slow to medium.

These soils are used mostly for crops. A few small

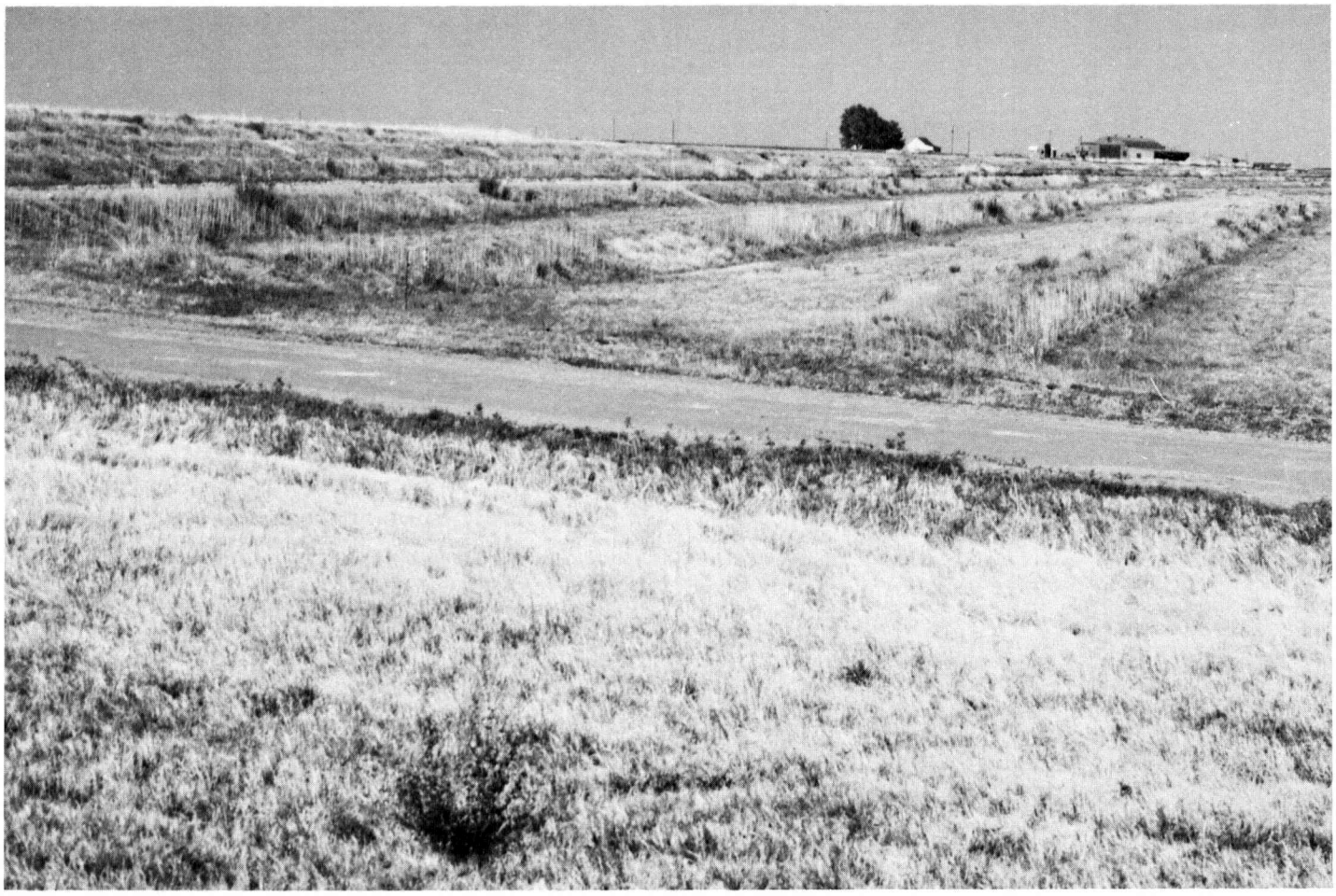


Figure 13.—**Irrigated pasture on bench-leveled Estacado-Posey complex, 3 to 5 percent slopes. A grassed waterway is in the foreground.**

B21t—8 to 15 inches, brown (7.5YR 4/2) sandy clay loam, dark brown (7.5YR 3/2) moist; moderate, coarse, prismatic structure parting to moderate, medium, subangular blocky; very hard, friable, slightly sticky and plastic; many pores; many worm casts; thin patchy clay films, mostly on faces of prisms; mildly alkaline; clear, smooth boundary.

B22t—15 to 26 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; moderate, coarse, prismatic structure parting to weak, fine, subangular blocky; hard, friable, slight sticky and plastic; many fine pores; common worm casts; patchy clay films on faces of prisms; noncalcareous; moderately alkaline; gradual, wavy boundary.

B23t—26 to 31 inches, yellowish-red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; weak, coarse, prismatic structure parting to weak, fine, subangular blocky; hard, friable, slightly sticky and plastic; many fine pores; common worm casts; thin patchy clay films, mostly on faces of prisms; few threads, films, and fine masses of calcium carbonate; calcareous; moderately alkaline; abrupt, wavy boundary.

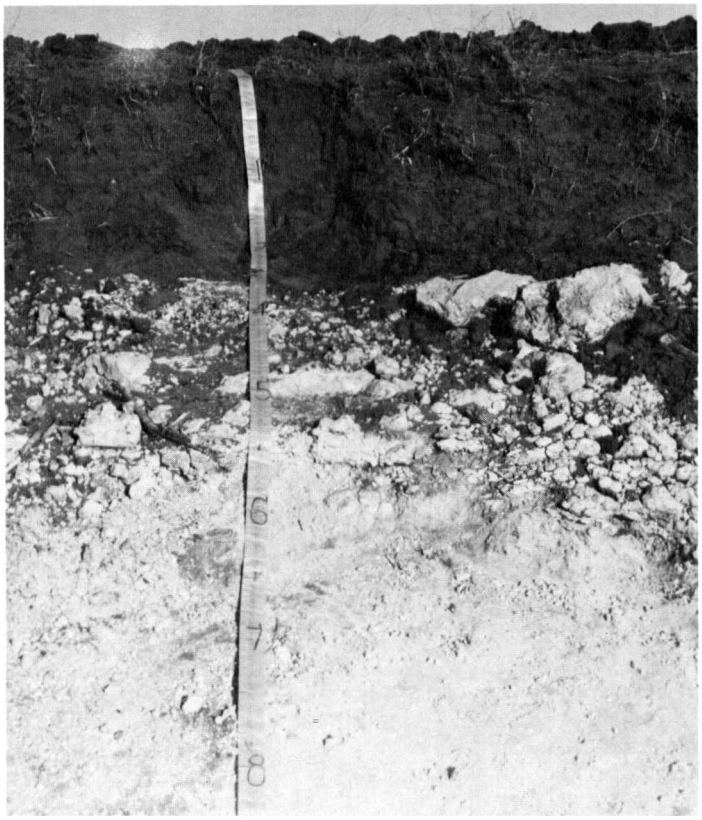
B24cam—31 to 35 inches, pinkish-white (7.5YR 8/2) caliche, indurated in upper part and strongly cemented in lower part; laminar and smooth in the upper surface; pendants of calcium carbonate as much as 1 centimeter long in the lower part; gradual, wavy boundary.

B25ca—35 to 59 inches, pinkish-white (7.5YR 8/2) sandy clay loam, pink (7.5YR 7/4) moist; weak, medium, subangular blocky structure; slightly hard, friable; about 50 percent calcium carbonate in soft powdery forms; calcareous; moderately alkaline; gradual, wavy boundary.

B26tca—59 to 84 inches, pink (5YR 7/4) sandy clay loam, reddish yellow (5YR 6/6) moist; weak, medium, subangular blocky structure; hard, friable, slightly sticky and plastic; common, very fine and fine pores; few, thin, patchy clay films on faces of peds; about 20 percent, by volume, soft masses and concretions of calcium carbonate; calcareous; moderately alkaline.

The B2cam horizon is 22 to 36 inches thick. Secondary carbonates are at a depth of 18 to 26 inches. The A horizon is 6 to 10 inches thick and is dark brown or brown. It is neutral or mildly alkaline. The B21t horizon is 4 to 9 inches thick. It is dark-brown or brown sandy clay loam or loam. The B22t and B23t horizons are reddish brown, yellowish red, reddish yellow, light brown, or brown. They are sandy clay loam, clay loam, or loam and are 25 to 35 percent clay. The B24cam horizon is 2 to 24 inches thick and is pink or pinkish white. It has a hardness of 3 to 5 on Mohs scale in at least the upper ½ inch. The B25ca horizon is pink, pinkish-white, light reddish-brown, light-brown, or reddish-yellow clay loam or sandy clay loam. It is 20 to 50 percent calcium carbonate, by volume. The B26tca and B27t horizons are red, reddish-yellow, or yellowish-red sandy clay loam to clay loam.

Friona loam, 0 to 1 percent slopes (FrA).—This nearly level soil is on broad, smooth plains that are mostly in



to caliche. These soils formed in calcareous loamy material on smooth uplands.

In a representative profile the surface layer is about 8 inches of dark grayish-brown, calcareous loam that has some caliche gravel, cobbles, and stones. The next layer is about 5 inches thick. It is about 80 percent pink caliche gravel, cobbles, and stones and 20 percent brown clay loam. The underlying material is indurated caliche in fractured sheets.

Kimbrough soils are well drained. Permeability is moderate, and available water capacity is very low. Runoff is slow to medium.

These soils are used as range. They are not suited to cultivation.

Representative profile of Kimbrough loam, 1 to 5 percent slopes, 6.75 miles east and 0.25 mile south of northwest corner of Parmer County or 10 miles west of Friona on Farm Road 1731, then 4.5 miles north on a county road, then 2.25 miles west on another county road and 1.25 miles north on a third county road, then about 1.5 miles northeast of the road, in range; 1,100 feet north and 1,350 feet west of the southeast corner of sec. 30, T. 2 N., R. 2 E.:

A1—0 to 8 inches, dark grayish-brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; weak, coarse, subangular blocky structure parting to weak, fine, subangular blocky and granular; hard, friable, slightly sticky and plastic; many fine roots; many very fine pores, common fine pores, and few medium pores; common worm casts; few gravel, cobble, or stone fragments of caliche; calcareous; moderately alkaline; abrupt, broken boundary.

C1ca—8 to 13 inches, pink (7YR 8/4) [illegible]

of indurated laminated caliche are on the surface in most areas.

the soil is noncalcareous to a depth of about 20 inches. Some areas of soils that have loamy strata at a depth

carbonate, by volume; calcareous; moderately alkaline; gradual, smooth boundary.

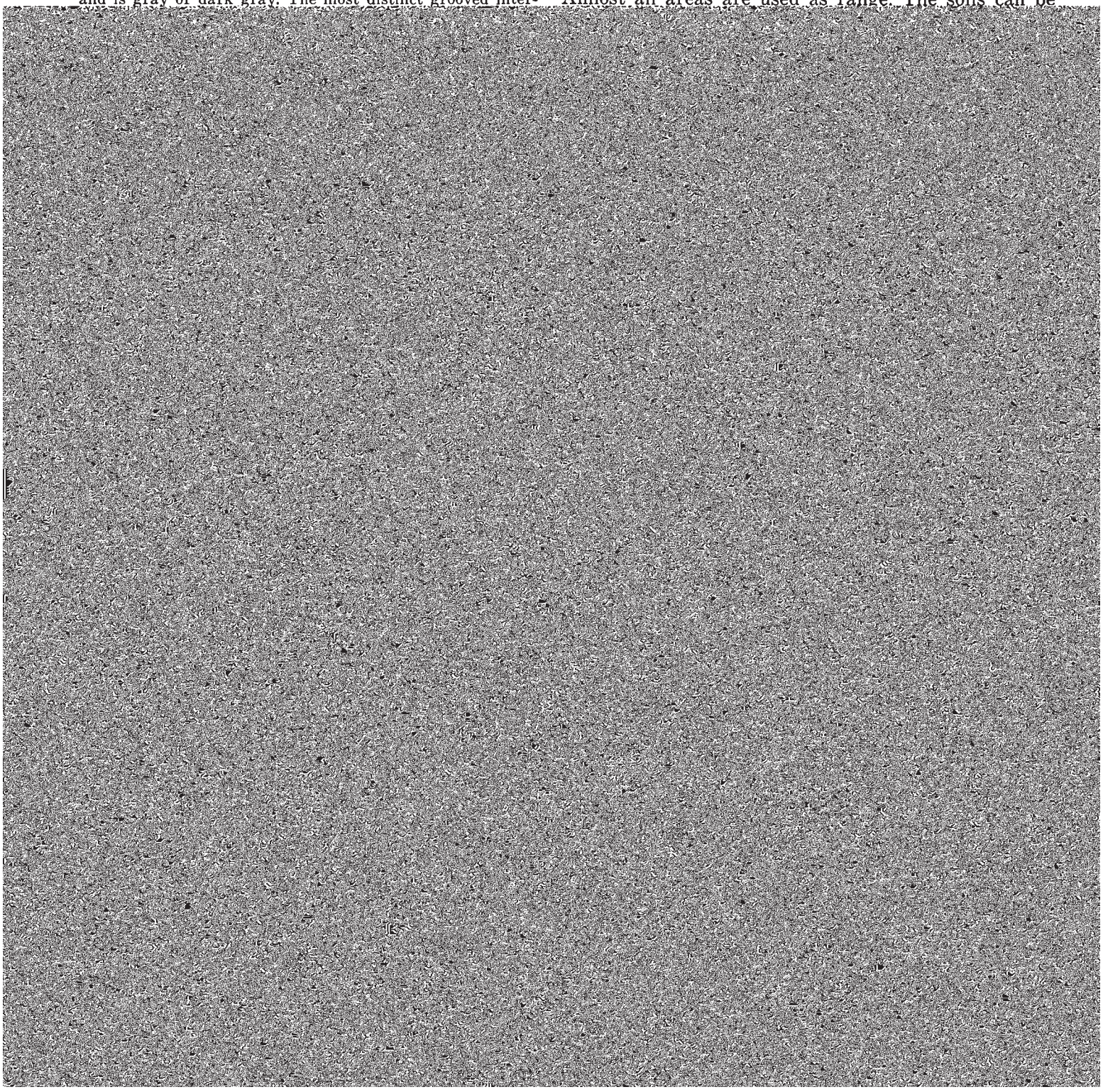
Cca—63 to 70 inches, white (10YR 8/1) clay, light gray (10YR 7/2) moist; weak, fine, subangular blocky structure; hard, friable, sticky and plastic; few fine roots; few fine and very fine pores; few, fine, broken chips of snail shells; few to many, fine, whitish soft lumps of calcium carbonate; few calcium carbonate threads; 16 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The A horizon ranges from 15 to 20 inches in thickness and is gray or dark gray. The most distinct grooved inter-

In a representative profile the surface layer consists of brown fine sandy loam about 13 inches thick. Below this is about 35 inches of reddish-brown fine sandy loam. The underlying material to a depth of 66 inches is reddish-brown fine sandy loam.

Mobeetie soils are well drained. Permeability is moderately rapid, and available water capacity is medium. Runoff is medium.

These soils are suited to native grass or to row crops. Almost all areas are used as range. The soils can be



plains that are ridged in some places. Areas are long and oval in shape and are parallel to areas of Likes loamy fine sand. The areas range from 10 to 250 acres in size, but they average more than 60 acres.

Included with this soil in mapping are small spots of Bippus soils and small dunes of Likes loamy fine sand.

This Mobeetie soil is in native grass. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Leaving crop residue on the surface helps to control soil blowing and erosion. In irrigated areas, a well-designed irrigation system is needed to control soil and water losses. In dryfarmed areas, farming on the contour and using terraces help to control erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–3, dryland, and IIIe–3, irrigated; Mixedland Slopes range site.

Olton Series

The Olton series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on smooth uplands. These soils formed in loamy eolian material.

In a representative profile the surface layer is brown is brown and reddish-brown clay loam about 19 inches thick. Below this is yellowish-red clay loam about 22 inches thick. The next layer to a depth of 76 inches is pinkish-white, calcareous clay loam.

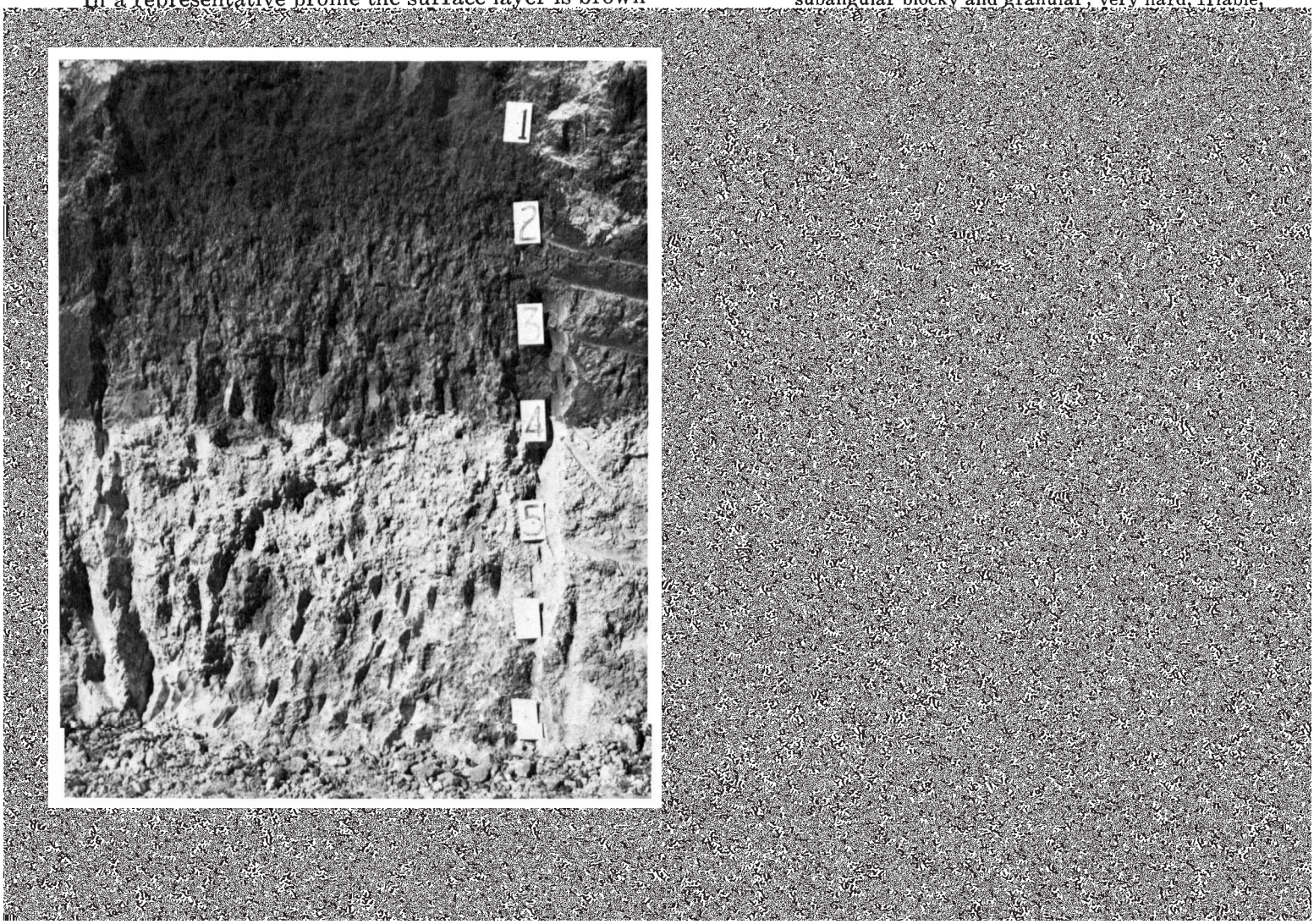
Olton soils are well drained. Permeability is moderately slow, and available water capacity is high. Runoff is very slow to slow.

These soils are well suited to native grass or to row crops. They can be used for irrigated truck crops. Cotton, corn, grain sorghum, wheat, soybeans, vegetables, and alfalfa are the main crops.

Representative profile of Olton clay loam, 0 to 1 percent slopes, 4 miles north of Lazbuddie on Farm Road 1172, then 0.5 mile west on a county road, on the north side of the road in an area of irrigated crops; 30 feet north and 2,000 feet west of the southeast corner of sec. 37, Kelly subdivision:

Ap—0 to 9 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; weak, medium, subangular blocky and granular structure; soft to slightly hard, very friable, slightly sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; few worm casts; neutral; abrupt, smooth boundary.

B21t—9 to 18 inches, brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate, medium and coarse, prismatic structure parting to weak, fine, subangular blocky and granular; very hard, friable,



is pink, pinkish white, reddish yellow, yellowish red, light reddish brown, or very pale brown. It is enriched with calcium carbonate.

Olton clay loam, 0 to 1 percent slopes (OtA).—This nearly level soil is on smooth plains. Areas range from 20 acres to several thousand acres in size. Slopes are less than 0.5 percent in most places. This soil has the profile described as representative of the Olton series.

Included with this soil in mapping are areas of Acuff, Estacado, and Pullman soils that are 5 acres or less in size. Oval areas of Acuff and Estacado soils are in most large areas of this Olton soil. Estacado soils are mostly small, round spots that make up less than 3 percent of most mapped areas and make up 15 percent in a few

In dryfarmed areas, leaving crop residue on the surface helps to control soil blowing and erosion. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–6, dryland, and IIe–1, irrigated; Clay Loam range site.

Olton clay loam, 1 to 3 percent slopes (OtB).—This gently sloping soil is on uplands. Most areas are around playas and along draws, but some areas are on low ridges above the main level of the plains. Areas range from about 15 to 350 acres in size, but they average about 90 acres. Slopes are dominantly about 2 percent.

This Olton soil is used mostly for crops. Most cultivated areas are irrigated. A few areas are used as native range. The hazard of soil blowing is slight, and the hazard of erosion is moderate. Runoff is slow.

Leaving crop residue on the surface helps to control soil blowing and erosion. Using terraces and farming on the contour help to control erosion. In irrigated areas, using fertilizer, managing crop residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed.

Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Rough surface tillage helps to control soil blowing when crop

Depth to the zone of distinct calcium carbonate accumulation ranges from 9 to 19 inches. The maximum visible carbonates are at a depth of 10 to 27 inches. The A horizon is 5 to 15 inches thick. It is brown, yellowish-red, dark grayish-brown, light reddish-brown, reddish-brown, or grayish-brown loam or fine sandy loam. The B21tca and B22tca horizons are pink, yellowish-red, reddish-yellow, brown, light-brown, reddish-brown, or light reddish-brown loam, sandy clay loam, or clay loam. They are 18 to 35 percent clay. The B21tca and B22tca horizons are 20 to 45 percent calcium carbonate, but they generally average 40 percent or less. The B23tca horizon is yellowish-red, reddish-yellow, or light reddish-brown sandy clay loam, clay loam, silty clay loam, or fine sandy loam.

Posey fine sandy loam, 0 to 1 percent slopes (PfA).—This soil is in slightly convex areas on smooth plains

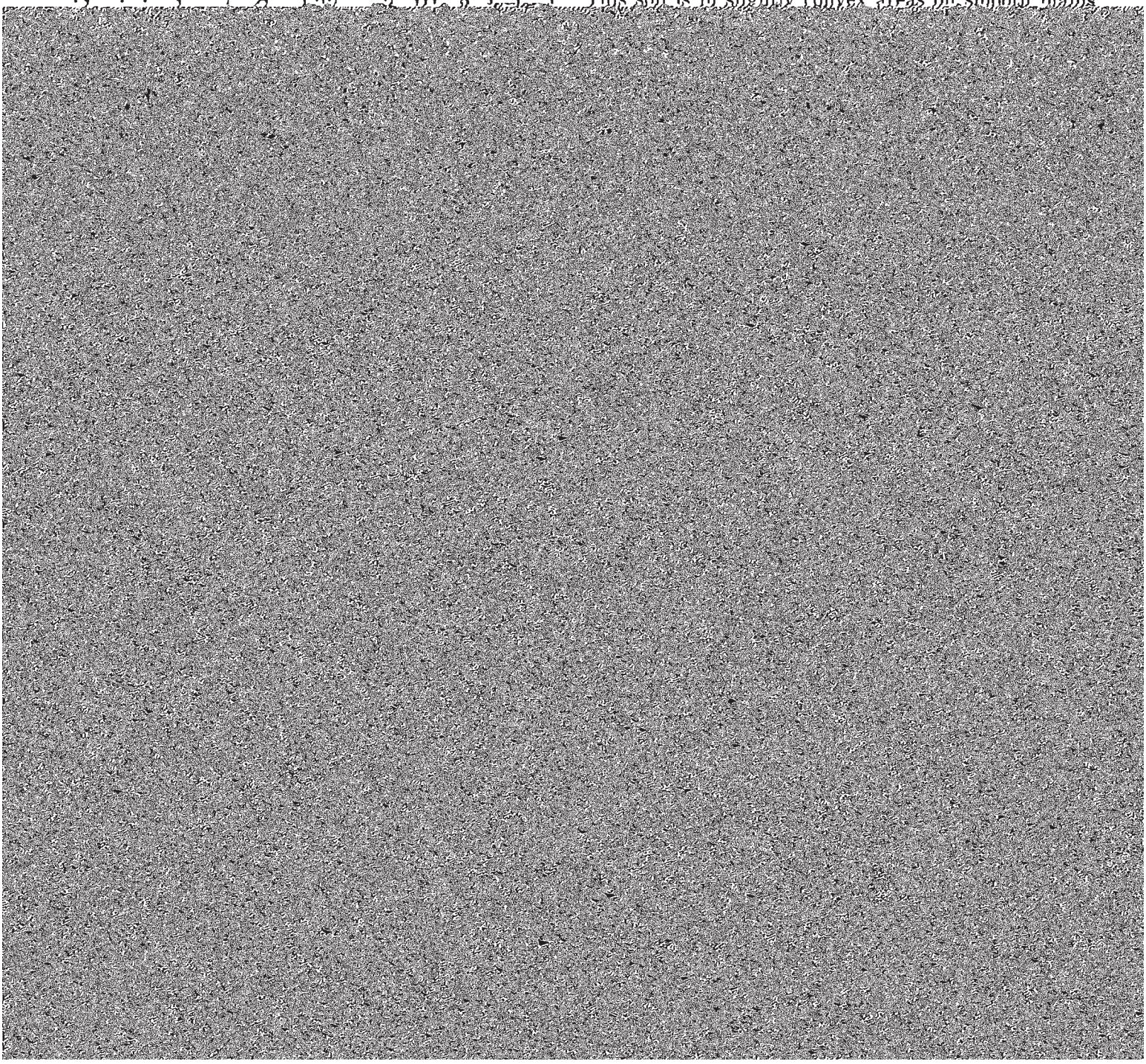


Figure 17.—**Young grain sorghum planted in wheat stubble on Posey fine sandy loam, 0 to 1 percent slopes.**

irrigated. The hazard of soil blowing is severe, and the hazard of erosion is moderate.

Using terraces and farming on the contour help to control erosion. Leaving residue from such crops as corn or sorghum on the surface helps to control soil blowing and erosion. In irrigated areas, using fertilizer, managing residue, rotating crops, and managing irrigation water in a well-designed irrigation system are needed to maintain tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate. Capability units IIIe–3, dryland, and IIIe–4, irrigated; Mixedland Slopes range site.

Posey-Berda complex, 5 to 8 percent slopes (PmD).—This complex is on foot slopes along draws and on side slopes of a few playa basins. It is about 50 percent Posey soils and soils that are similar to Posey soils, 35 percent Berda soils and soils that are similar to Berda soils, and 15 percent other soils. Most areas are about 50 acres in size, but areas range from 10 to 320 acres. The soils are in lower positions than Acuff, Estacado, Olton, and Pullman soils and in higher positions than Bippus and Spur soils.

Posey soils are in convex areas on the upper half of foot slopes. They have a surface layer of light reddish-layer is about 13 inches of light reddish-brown clay loam over about 19 inches of pink clay loam that is about 25 percent calcium carbonate. Next is reddish-yellow clay loam about 6 inches thick over 7 inches of pink clay loam that is about 38 percent calcium carbonate. Below this to a depth of 80 inches is yellowish-red clay loam.

Berda soils are in slightly concave areas on the lower part of side slopes. They have a surface layer of brown loam about 9 inches thick. The next layer is about 10 inches of brown loam that has many worm casts over about 9 inches of light reddish-brown loam. The underlying material is reddish-brown fine sandy loam that extends to a depth of 80 inches.

Included with these soils in mapping are areas of Bippus and Potter soils. Also included are a few areas of Posey soils that have a surface layer of clay loam, loam, or fine sandy loam and a few areas of Berda soils that have a surface layer of fine sandy loam or sandy clay loam.

The soils in this complex are used mostly as range. They are not suited to cultivation. A few small areas are in irrigated pasture. The hazard of soil blowing is moderate, and the hazard of erosion is severe.

is needed. Areas that are in pasture need grazing management, fertilization, frequent irrigation, and rotation grazing. Capability unit VIe–2, dryland; Hardland Slopes range site.

Potter Series

The Potter series consists of gently sloping to strongly sloping, calcareous, loamy soils that are very shallow to shallow to caliche. These soils formed on uplands in caliche beds of knobs and knolls.

In a representative profile the surface layer is about 12 inches of brown loam that has a few caliche fragments. The next layer is white, weakly cemented to indurated caliche about 12 inches thick. Below this to a depth of about 64 inches is white weakly cemented caliche.

Potter soils are well drained. Permeability is moderate, and available water capacity is low. Runoff is medium to rapid.

These soils are suited to use as native range.

Representative profile of Potter loam, 3 to 12 percent slopes, 0.05 mile south of Bovina on Farm Road 1731, then 0.5 mile west on field road, in range; 2,100 feet west and 3,000 feet north of the southeast corner of sec. 21, T. 7 S., R. 2 E.:

A11 0 to 6 inches, brown (10YR 5/3) loam, dark brown

that protrude from side slopes along draws. Areas are in bands that are 400 to 6,000 feet long, are 100 to 800 feet wide, and follow the contour of draws. Most areas are 5 to 70 acres in size.

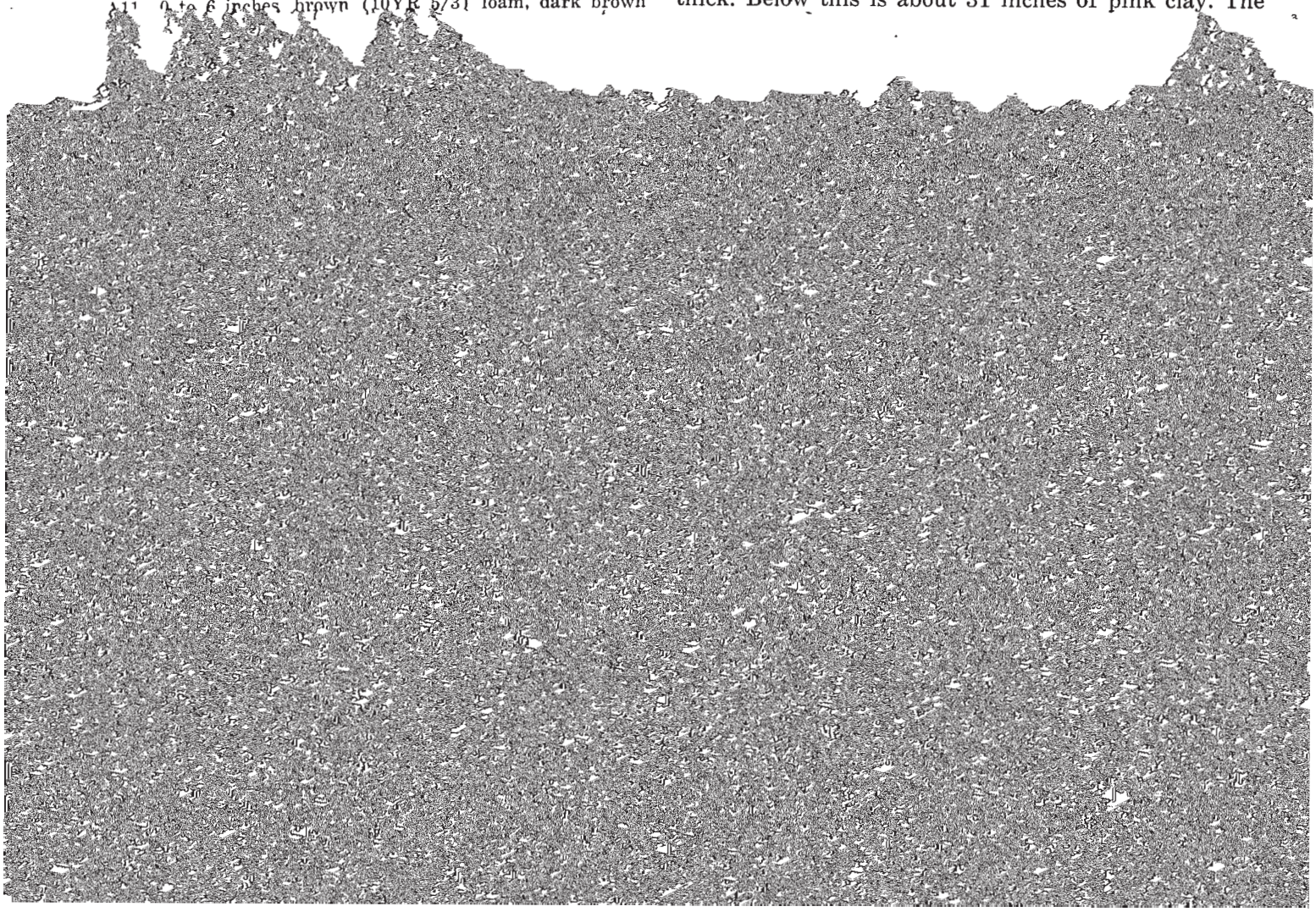
Included with this soil in mapping are small areas of Berda, Kimbrough, and Posey soils and some small spots of barren caliche outcrop. Also included are some areas of Potter soils that have a dark grayish-brown surface layer and a few spots of Potter soils that are 35 to 50 percent caliche fragments, by volume.

This Potter soil is not suited to cultivation. It is used mostly as range, but the grass cover is thin. This soil is a source of caliche in areas where the caliche beds are thick enough and are near the surface. Limitations are few for open pit mining. Caliche is mined in a few areas and used locally for roadbed material. Capability unit VIIs–1, dryland; Very Shallow range site.

Pullman Series

The Pullman series consists of deep, nearly level to gently sloping, noncalcareous, loamy soils on broad, smooth uplands. These soils formed in eolian material.

In a representative profile the surface layer is brown clay loam about 9 inches thick. The next layer is brown, reddish-brown, and yellowish-red clay about 39 inches thick. Below this is about 31 inches of pink clay. The



sticky and plastic; few fine roots; few very fine pores; few thin clay films on faces of peds; few organic stains; few iron stains; few films, threads, and coatings of calcium carbonate; few fine cemented concretions of calcium carbonate; calcareous; moderately alkaline; few noncalcareous spots; clear, wavy boundary.

B25tca—48 to 79 inches, pink (5YR 8/3) clay, reddish yellow (5YR 7/6) moist; weak, medium, subangular blocky structure; very hard, friable, slightly sticky and plastic; few fine roots; few fine and very fine pores; few, fine, cemented concretions of calcium carbonate; 40 percent calcium carbonate, by volume; calcareous; moderately alkaline; gradual, wavy boundary.

B26t—79 to 89 inches, reddish-yellow (5YR 7/6) clay loam, reddish yellow (5YR 6/6) moist; weak, medium, subangular blocky structure; friable, slightly sticky and plastic; many fine and very fine pores; few iron stains; few, fine, cemented concretions of calcium carbonate; 12 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum ranges from 80 inches to more than 120 inches in thickness. Secondary soft lime is at a depth of 15 to 28 inches. The A horizon is 5 to 11 inches thick. It is brown or dark grayish brown and ranges from neutral to moderately alkaline. The B21t and B22t horizons are brown or dark grayish brown. The B21t horizon is 4 to 15 inches thick. The B23t and B24t horizons are reddish-brown, yellowish-red, brown, or yellowish-brown clay. They are clay loam or silty clay loam at a lower depth in many places. The B25tca yellowish-red, or brown clay to clay loam. The B25tca horizon is 30 to 70 percent, by volume, calcium carbonate, mainly soft masses and concretions. The B26t horizon is reddish-yellow, yellowish-red, reddish-brown, or pink clay loam or silty clay loam.

Pullman clay loam, 0 to 1 percent slopes (PuA).—This nearly level soil is in a nearly continuous area on a plain. This plain is dotted with playas and depressional areas and is interrupted by entrenched draws. The surface is very slightly convex in most areas. Slopes average about 0.3 percent and face in a southeasterly direction in most places. This soil has the profile described as representative of the Pullman series.

Included with this soil in mapping are areas of Estacado soils 1 to 3 acres in size and areas of Olton soils in broad transitional areas between Olton and Pullman soils. Also included in large areas of this Pullman soil are areas of Pullman clay loam, 1 to 3 percent slopes, that are 3 acres or less in size and areas of Randall clay that are less than 4 acres in size. These soils make up less than 5 percent of the mapped area. Some areas of Pullman soils that have a surface layer of silty clay loam are also included, mostly in areas of range.

This Pullman soil is well suited to large-scale farming, and nearly all areas are cultivated. Small grain and sorghums are the main crops (fig. 18). Alfalfa.

few areas are in native range. The hazards of soil blowing and erosion are slight.

Terracing and contour farming are needed on long slopes to control erosion. Rotating crops and leaving crop residue on the surface help to control soil blowing and maintain soil tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate. In irrigated areas, using fertilizer, managing irrigation water in a well-designed irrigation system, and using a recovery system for runoff irrigation water are needed. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. Capability units IIIe–5, dryland, and IIs–1, irrigated; Clay Loam range site.

Pullman clay loam, 1 to 3 percent slopes (PuB).—This gently sloping soil is mostly in broad bands that border playa basins and surround the larger basins. Areas are 10 to 250 acres in size. The surface is smooth and slightly convex. Slopes are mainly 1 to 2 percent.

The surface layer is brown clay loam 9 inches thick. The next layer is brown clay about 27 inches thick. Below this is 7 inches of yellowish-red clay loam. The next layer is pink clay loam about 37 inches thick. Below this is reddish-yellow clay loam.

Included with this soil in mapping are areas of Estacado and Olton soils that are less than 5 acres in size. Also included, in areas where water concentrates or on lower slopes, are eroded areas 3 to 4 acres in size. A few areas of soils that have a surface layer of silty clay loam are included in areas of range.

This Pullman soil is well suited to cultivation, and most areas are cultivated. A few areas are in native range. The hazard of soil blowing is slight, and the hazard of erosion is moderate.

In dryfarmed areas, using terraces and farming on the contour help to control erosion. Leaving crop residue on the surface helps to control soil blowing and erosion and to maintain or improve soil tilth. Rough surface tillage helps to control soil blowing when crop residue is inadequate.

In irrigated areas, bench leveling or graded borders and a planned irrigation water management system help to control water and to prevent erosion. Diversion terraces, grassed waterways, and other erosion-control measures are needed in places. A recovery system for runoff irrigation water is needed. Using fertilizer and

most other uses. They are not cultivated unless some of the outside water is diverted or the playa can be drained. Row crops can be grown in areas that are drained, but the clay surface layer makes management difficult.

Representative profile of Randall clay, 9 miles north of Lazbuddie on Farm Road 1172, then 0.2 mile east on county road, then 0.2 mile northeast in range; 1,900 feet east and 1,400 feet north of the southwest corner sec. 16, T. 5½ S. R. 5 E.:

A1—0 to 18 inches, dark-gray (10YR 4/1) clay, very dark gray (10YR 3/1) moist; 3 inches of dark grayish-brown clay loam at the top of horizon; weak, coarse, blocky structure parting to moderate, fine, blocky; extremely hard, very firm, very sticky and plastic; pressure faces on surface of peds; few very dark grayish-brown cemented concretions 2 millimeters in diameter; mildly alkaline; diffuse, wavy boundary.

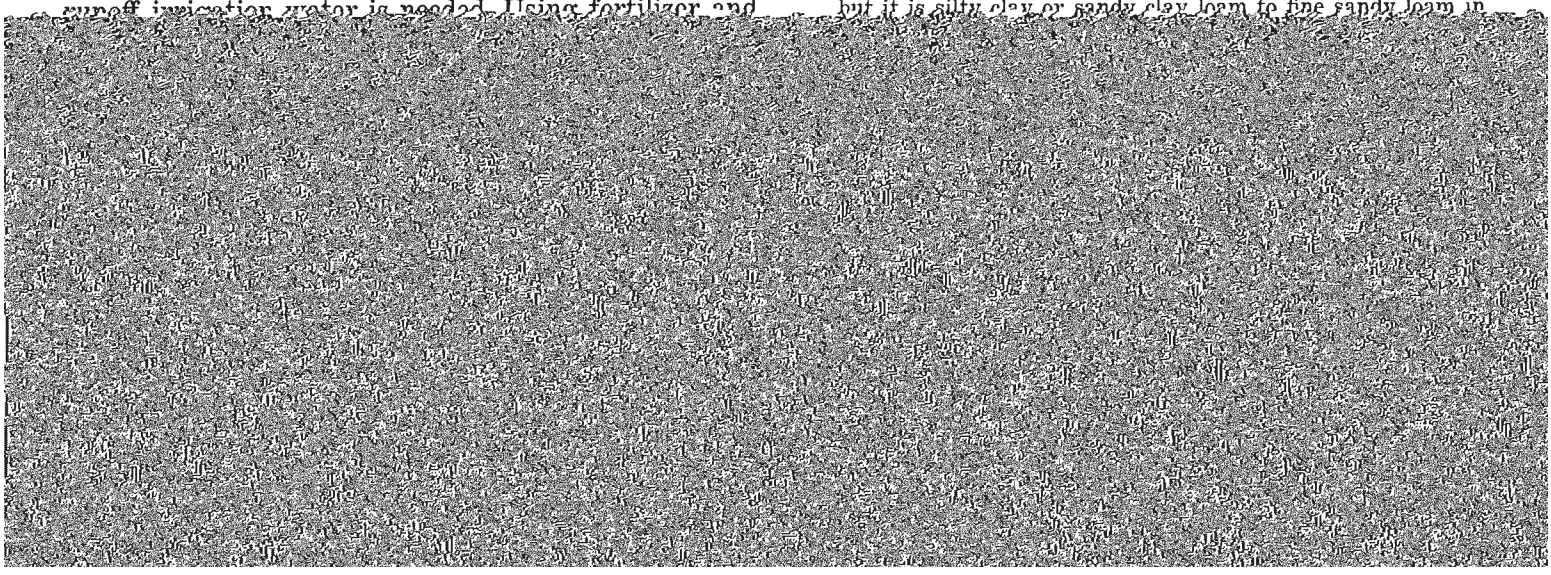
AC1—18 to 43 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; moderate, fine and medium, blocky structure; extremely hard, very firm, very sticky and plastic; wedge-shaped parallelepipeds that have long axis tilted about 30 degrees from the horizontal; pressure faces on surface of peds; few, fine, round, dark-brown concretions; intersecting slickensides; calcareous; moderately alkaline; diffuse, wavy boundary.

AC2—43 to 62 inches, gray (10YR 5/1) clay, dark gray (10YR 4/1) moist; weak, medium, blocky and subangular blocky structure; extremely hard, very firm, very sticky and plastic; few pressure faces; fewer wedge-shaped peds than in AC1 horizon; few dark-brown concretions, black inside; calcareous; moderately alkaline; diffuse, smooth boundary.

C1—62 to 77 inches, light brownish-gray (10YR 6/2) clay, grayish brown (10YR 5/2) moist; massive; extremely hard, very firm, very sticky and plastic; few grayish-brown concretions, black inside; calcareous; moderately alkaline; diffuse, smooth boundary.

C2—77 to 84 inches, light brownish-gray (10YR 6/2) silty clay, grayish brown (10YR 5/2) moist; massive; very hard, firm, sticky and plastic; calcareous; moderately alkaline.

Depth to loam material is more than 6 feet in most places; near the edge of playas, it is generally more than 40 inches. The A horizon varies in thickness as the microrelief varies. It is 6 inches thick in the center of knolls and more than 25 inches in depressions. It is mostly dark gray but is gray or very dark gray in a few places. The AC horizon is gray, dark gray, or grayish brown. The C horizon is brown, light brownish gray, light gray, or yellowish red. It is mostly clay, but it is silty clay or sandy clay loam to fine sandy loam in



inches to several feet of water that stands for several months in places. The hazard of soil blowing is moderate, and the hazard of erosion is slight.

Cattle do not graze the flooded playas, but these areas provide habitat for waterfowl and other wildlife. During extremely wet seasons, all vegetation except sedge and smartweed is drowned. Capability unit VIw–1, dryland; included in range site of surrounding soils.

Spur Series

The Spur series consists of deep, nearly level, calcareous, loamy soils. These soils formed in calcareous loamy alluvium in drainageways.

In a representative profile the surface layer is brown, calcareous loam about 11 inches thick. The next layer is light-brown, calcareous clay loam about 17 inches thick. The underlying material to a depth of about 80 inches is grayish-brown and light-gray clay loam.

Spur soils are well drained. Permeability is moderate, and available water capacity is high. Runoff is slow.

These soils are used mostly as native range. A few areas are planted to irrigated grasses. The soils are flooded at least once every 4 to 10 years.

In Parmer County, Spur soils are mapped only in undifferentiated units with Bippus soils.

Representative profile of Spur loam in an area of Bippus and Spur soils, frequently flooded, 5 miles east of Hub on Texas Highway 86, then 4.5 miles south on a county road, on the west side of the road, in range; 875 feet west and 3,800 feet south of the northeast corner of sec. 15, Kelly subdivision:

A1—0 to 11 inches, brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; weak, coarse, subangular blocky and granular structure; slightly hard, friable, slightly sticky; many fine roots; many very fine, fine, and medium pores; many worm casts; calcareous; moderately alkaline; gradual smooth

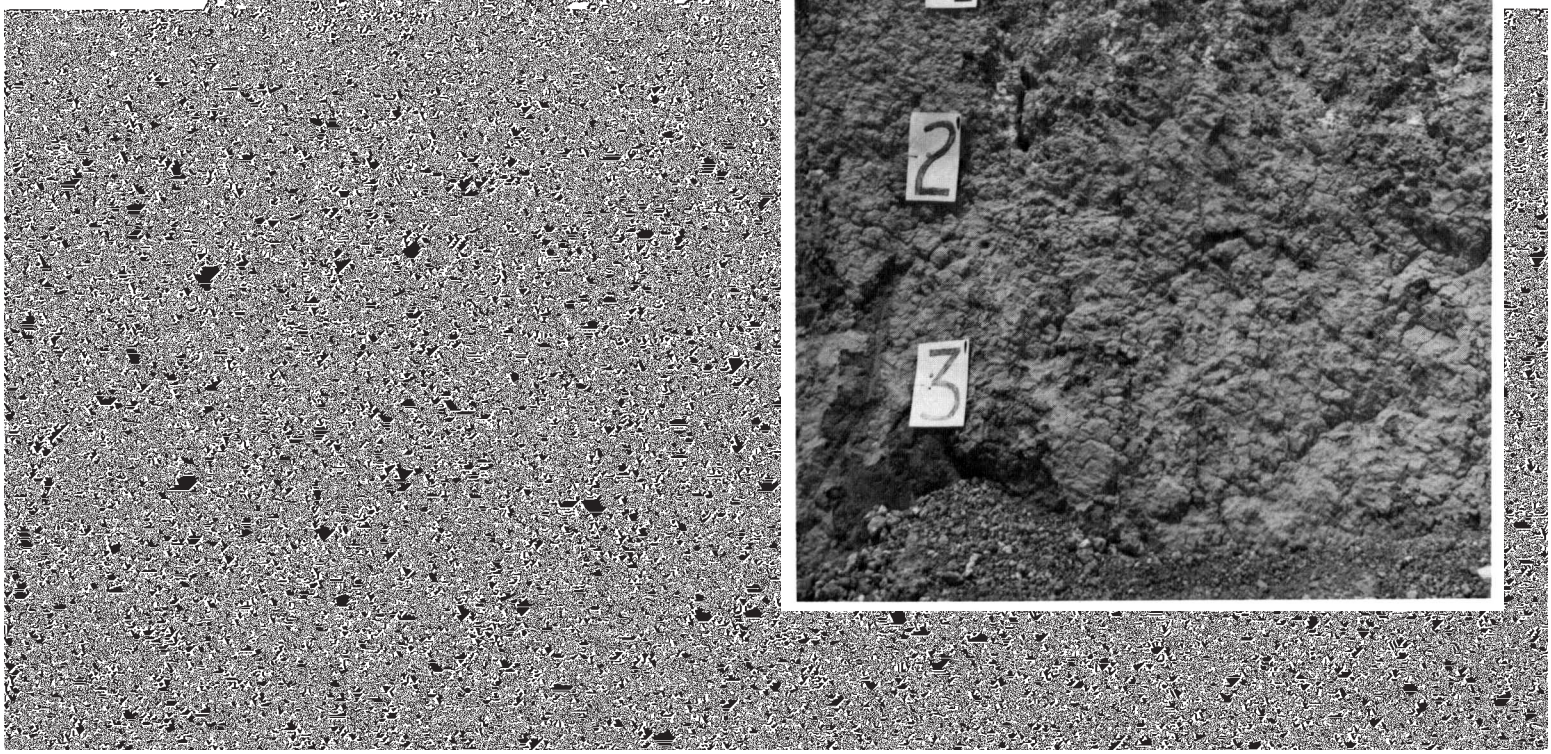
ish brown (10YR 5/2) moist; weak, fine, subangular blocky structure; hard, friable, slightly sticky and plastic; common fine and very fine pores; films of calcium carbonate on all peds; few threads of calcium carbonate; few, fine, soft lumps and concretions of calcium carbonate; 20 percent calcium carbonate, by volume; calcareous; moderately alkaline.

The solum ranges from 28 to 60 inches in thickness. The A horizon is 11 to 19 inches thick and is brown, dark grayish brown, or dark brown. The B horizon is brown, light brown, or reddish brown. It ranges from clay loam to sandy clay loam and is 25 to 35 percent clay. The C horizon is brown, grayish brown, very pale brown, light yellowish brown, light gray, white, pinkish white, pinkish gray, or reddish brown. This horizon is less clayey than the A and B horizons. It ranges from clay loam to sandy clay loam and has some fine sandy loam and loamy sand at greater depths.

Tulia Series

The Tulia series consists of deep, nearly level to gently sloping, calcareous, loamy soils on smooth upland plains. These soils formed in calcareous, loamy, eolian material.

In a representative profile the surface layer is grayish-brown loam about 9 inches thick over light brownish-gray clay loam about 8 inches thick (fig. 19). The next layer to a depth of 63 inches is very pale



brown and reddish-yellow clay loam. Below this to a depth of about 94 inches is yellowish-red clay loam.

Tulia soils are well drained. Permeability is moderate, and available water capacity is medium. Runoff is slow to medium.

brown, reddish-yellow, or yellowish-red clay loam to sandy clay loam.

Tulia loam, 0 to 1 percent slopes (TuA).—This nearly level soil is on plains in irregularly shaped spots or patches that are within large areas of Estacado clay

trol erosion. Capability unit IVe–2, dryland, and IIIe–4, irrigated; Hardland Slopes range site.

Tulia-Potter complex, 1 to 5 percent slopes (TwC).—This complex is 85 percent Tulia soils and 15 percent Potter soils. These gently sloping soils are on smooth, convex bands that mostly border playa basins but also border draws. Most areas range from 5 to 35 acres in size, but they average about 15 acres.

The Tulia soil is in areas surrounding the Potter soil. It has a surface layer of brown fine sandy loam about 5 inches thick. The next layer is 4 inches of light-brown sandy clay loam over 19 inches of pink sandy clay loam. Below this is 18 inches of reddish-brown clay loam. The next layer is light reddish-brown clay loam about 34 inches thick.

The Potter soil is on the middle or upper, steeper, more convex slopes. It has a surface layer about 9 inches thick of brown loam that has many caliche fragments and pebbles and a few other fragments. The underlying material is weakly cemented, white caliche about 12 inches thick.

Included with these soils in mapping are eroded spots, small gravelly areas, and a few outcrops of indurated, laminated caliche. Also included are areas of Kimbrough soils 1 acre to 2 acres in size.

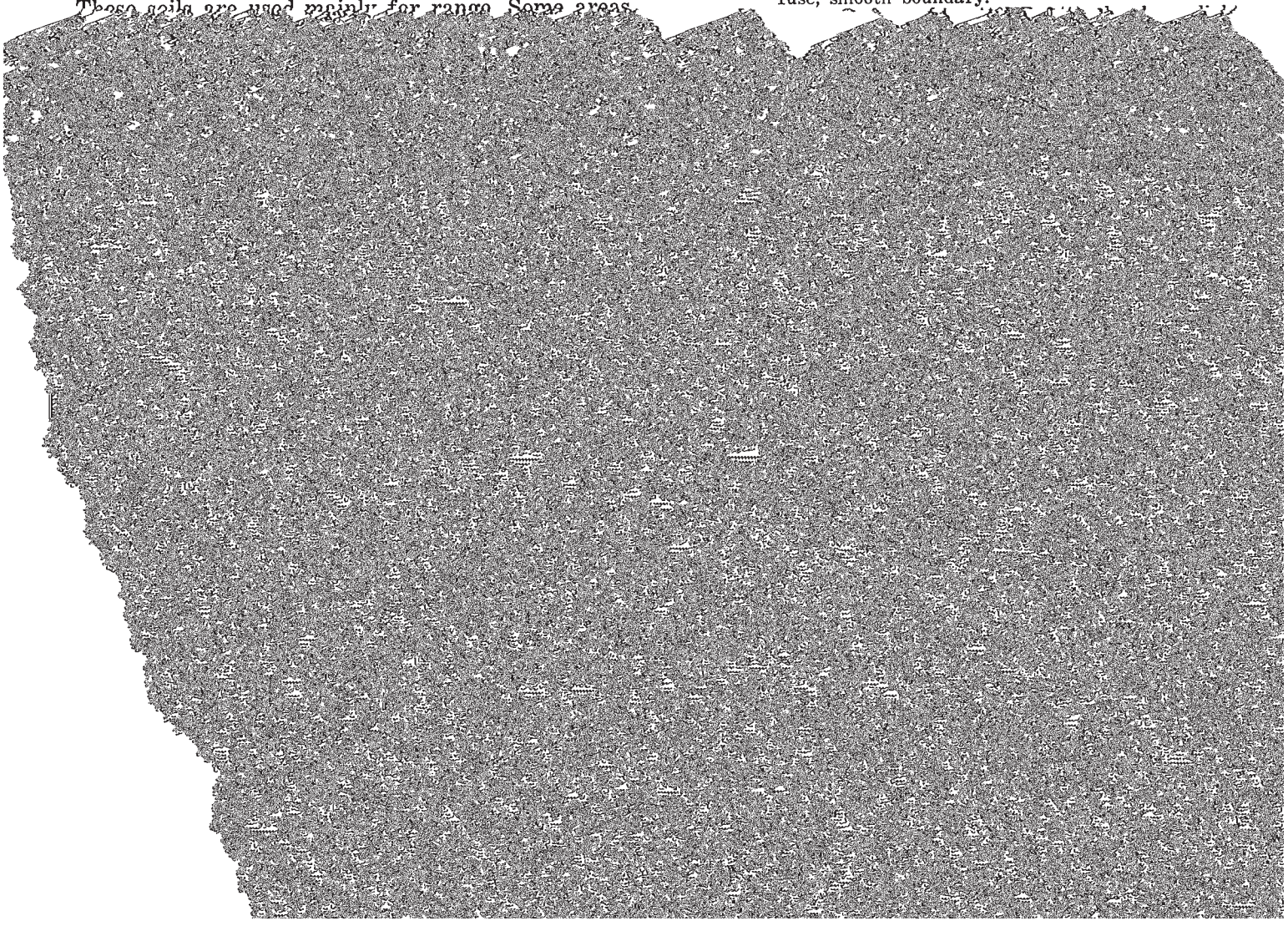
These soils are used mainly for range. Some areas

(10YR 3/3) moist; moderate, fine, granular structure; hard, very friable, slightly plastic; many very fine roots; many very fine and fine pores and few medium pores; few worm casts; mildly alkaline; abrupt, smooth boundary.

B2—7 to 20 inches, brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; common worm casts; calcareous; moderately alkaline; clear, smooth boundary.

B2ca—20 to 30 inches, light brownish-gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky and granular; very hard, friable, sticky and plastic; many fine roots; many very fine and fine pores and few medium pores; few worm casts; few films and threads and few, fine, soft masses and concretions of calcium carbonate; 15 percent calcium carbonate, by volume; calcareous; moderately alkaline; clear, smooth boundary.

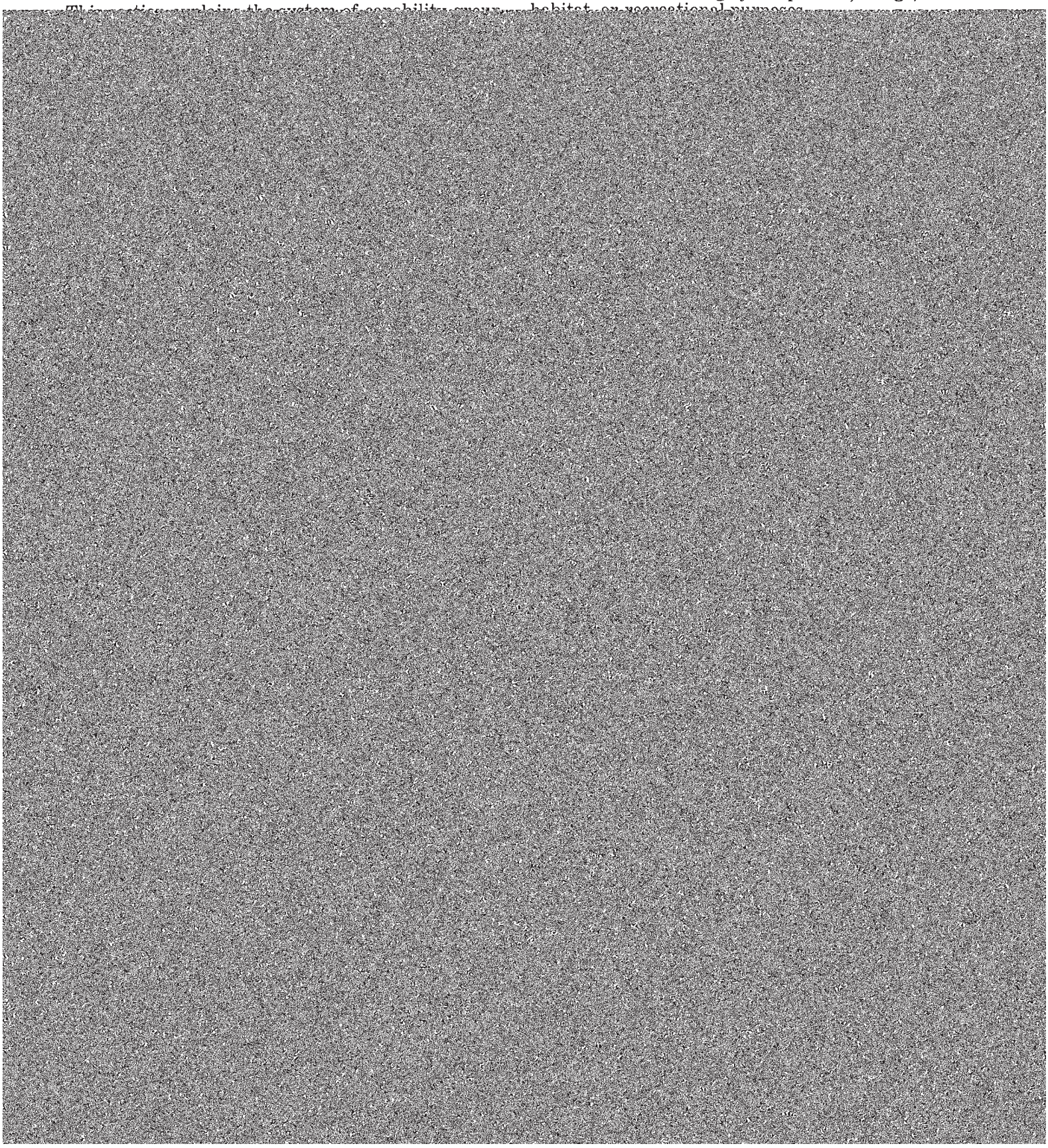
C1ca—30 to 55 inches, light-gray (10YR 7/1) sandy clay loam, light brownish gray (10YR 6/2) moist; massive; very hard, friable, slightly sticky and plastic; many fine roots; many very fine and fine pores; many threads, fine soft masses, and concretions of calcium carbonate; 20 percent calcium carbonate, by volume; calcareous; moderately alkaline; diffuse, smooth boundary.



Use and Management of the Soils

This section explains the system of capability groups

sion. These soils have other limitations, however, that restrict their use largely to pasture, range, wildlife habitat, or recreational purposes.



Unit IVe–3. Deep to very shallow, moderately permeable, gently sloping, calcareous to noncalcareous fine sandy loams to loams on uplands.

Unit IVe–4. Deep, moderately permeable, gently sloping, calcareous loams on uplands.

Subclass IVw. Soils are very severely limited for cultivation because of excess water.

Unit IVw–1. Deep, very slowly permeable, nearly level, calcareous clays in upland depressions.

Class V. Soils are subject to little or no erosion but have other limitations, impractical to remove, that limit their use largely to pasture or range or wildlife habitat.

Subclass Vw. Soils are flooded too frequently for cultivation; drainage or protection is not feasible.

Unit Vw–1. Deep, moderately permeable, nearly level, noncalcareous to calcareous clay loams to loams on bottom lands.

Class VI. Soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range or wildlife habitat.

Subclass VIe. Soils are severely limited, mainly by

calcareous loams to clay loams on uplands and bottom lands.

Unit IIe–2. Deep to moderately deep, moderately permeable, nearly level, noncalcareous fine sandy loams on uplands and bottom lands.

Subclass IIs. Soils have moderate limitations because permeability is very slow.

Unit IIs–1. Deep, very slowly permeable, nearly level, noncalcareous clay loams on uplands.

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

Subclass IIIe. Soils are subject to severe erosion if they are cultivated and not protected.

Unit IIIe–1. Deep, very slowly permeable, gently sloping, noncalcareous clay loams on uplands.

Unit IIIe–2. Deep, moderately permeable to moderately slowly permeable, gently sloping, calcareous to noncalcareous loams and clay loams on uplands and bottom lands.

Unit IIIe–3. Deep, moderately permeable to moderately rapidly permeable, nearly level to gently sloping, noncalcareous fine sandy

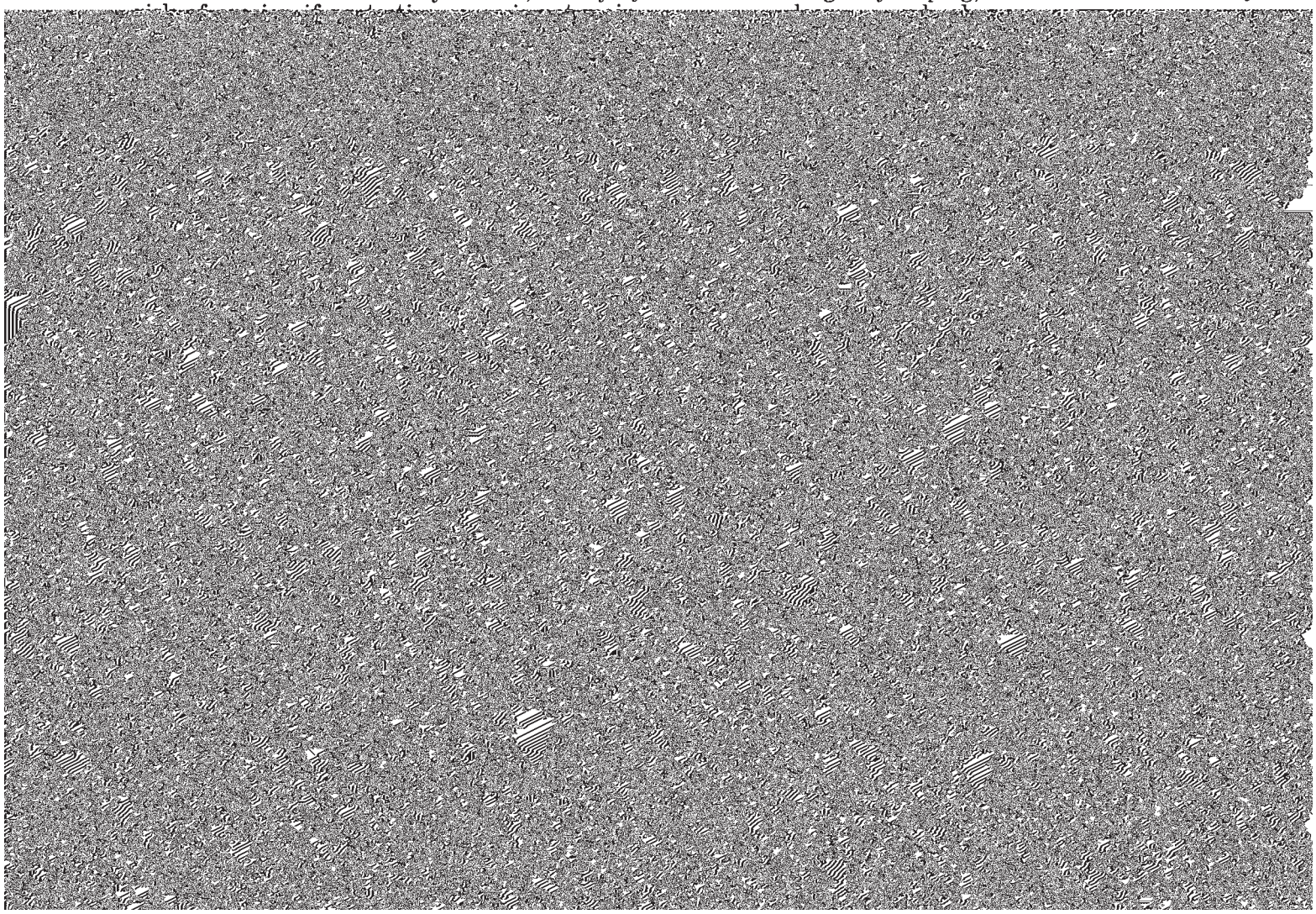


TABLE 2.—*Predicted average yields per acre of principal crops under a high level of management*

[Only the soils commonly used for crops are listed. Absence of data indicates that the particular crop is not grown on the soil specified]

Soil	Dry farmed			Irrigated			
	Wheat	Grain sorghum	Cotton	Wheat	Grain sorghum	Cotton	Alfalfa
	Bu	*Lb*	*Lb*	*Bu*	*Lb*	*Lb*	*Tons*
Acuff loam, 0 to 1 percent slopes	18	1,250	200	55	7,400	850	6
Acuff loam, 1 to 3 percent slopes	15	1,100	175	50	6,600	800	5
Acuff loam, 3 to 5 percent slopes	10	1,000	150				
Amarillo fine sandy loam, 0 to 1 percent slopes	15	1,250	200	55	7,200	850	5
Amarillo fine sandy loam, 1 to 3 percent slopes	13	1,000	175	50	6,400	750	4
Amarillo fine sandy loam, 3 to 5 percent slopes	10	800	150				3
Arvana fine sandy loam, 0 to 1 percent slopes	15	1,000	200	50	7,000	850	4
Berda loam, 3 to 5 percent slopes	10	800		35	3,600		
Bippus fine sandy loam, 0 to 1 percent slopes	20	1,250	250	55	7,200	850	5
Bippus clay loam, 0 to 1 percent slopes	15	1,200	225	55	7,400	800	6
Bippus clay loam, 1 to 3 percent slopes	12	1,000	200	50	6,600	800	5
Estacado clay loam, 0 to 1 percent slopes	15	1,200	175	55	7,400	850	5
Estacado clay loam, 1 to 3 percent slopes	15	1,100	150	45	6,000	800	4
Estacado-Posey complex, 3 to 5 percent slopes	10	500		30	3,500		3
Friona loam, 0 to 1 percent slopes	15	1,150	200	55	7,300	800	5
Lipan clay, depressional	15	850		45	5,700	700	5
Mobeetie fine sandy loam, 0 to 3 percent slopes	15	1,250	200	50	6,400	750	4
Olton clay loam, 0 to 1 percent slopes	15	1,100	200	55	7,600	850	6
Olton clay loam, 1 to 3 percent slopes	15	1,000	175	50	6,400	800	5
Posey fine sandy loam, 0 to 1 percent slopes	15	1,250	200	55	7,000	800	5
Posey fine sandy loam, 1 to 3 percent slopes	15	1,250	175	50	6,200	700	4
Pullman clay loam, 0 to 1 percent slopes	15	1,250	175	55	7,600	850	6
Pullman clay loam, 1 to 3 percent slopes	15	1,000	160	45	6,700	800	5
Tulia loam, 0 to 1 percent slopes	10	1,000	150	45	6,200	750	4
Tulia loam, 1 to 3 percent slopes	10	1,000	150	40	6,000	700	4
Tulia-Potter complex, 1 to 5 percent slopes	10	650		25	3,000	350	3
Zita loam, 0 to 1 percent slopes	15	1,000	200	55	7,300	850	5

table are soils that are used only as range or for recreational purposes.

Crops other than those shown in table 2 are grown in the county, but they are not listed because their acreage is small or reliable data on yields are not available.

The predicted yields given in table 2 can be expected if the following management practices are used:

For dryland—

1. Rainfall is effectively used and conserved.
2. Crop residue is managed to maintain soil tilth.
3. Tillage is minimal but timely.

enters the soils, determines the length of irrigation runs that the farmers use in most places. The smooth areas that dominate the High Plains are well suited to furrow irrigation. Most areas require only a little land leveling or smoothing before they are irrigated. Sprinkler irrigation systems are also used, mostly on loams and fine sandy loams. Water is pumped from irrigation wells into open ditches or underground pipelines. These ditches or pipelines convey the water to the high ends of fields, where it is turned into furrows. Some of the more sloping areas are leveled and irrigated by the border and furrow methods.

The wells draw water from the Ogallala Formation

rently are furnishing water to about 410,000 irrigated acres.

Grain sorghum, wheat, and cotton are the main irrigated crops in Parmer County, but smaller areas are used for corn, forage sorghum, sorghum silage, corn silage, soybeans, castor beans, irrigated pasture grasses, sugar beets, and vegetables.

The amount of vegetables grown in the county has been increasing in recent years. Vegetables are mostly grown in areas that are close to processing or packing sheds, although some are marketed at a considerable distance from farms.

The main vegetable crops are potatoes, lettuce, carrots, onions, cucumbers, cabbage, peppers, and cantaloups. Sugar beets are grown, and smaller areas are used for spinach, beans, pumpkins, eggplant, tomatoes, and watermelons. Average yields per acre on Pullman clay loam and Olton clay loam under good management are:

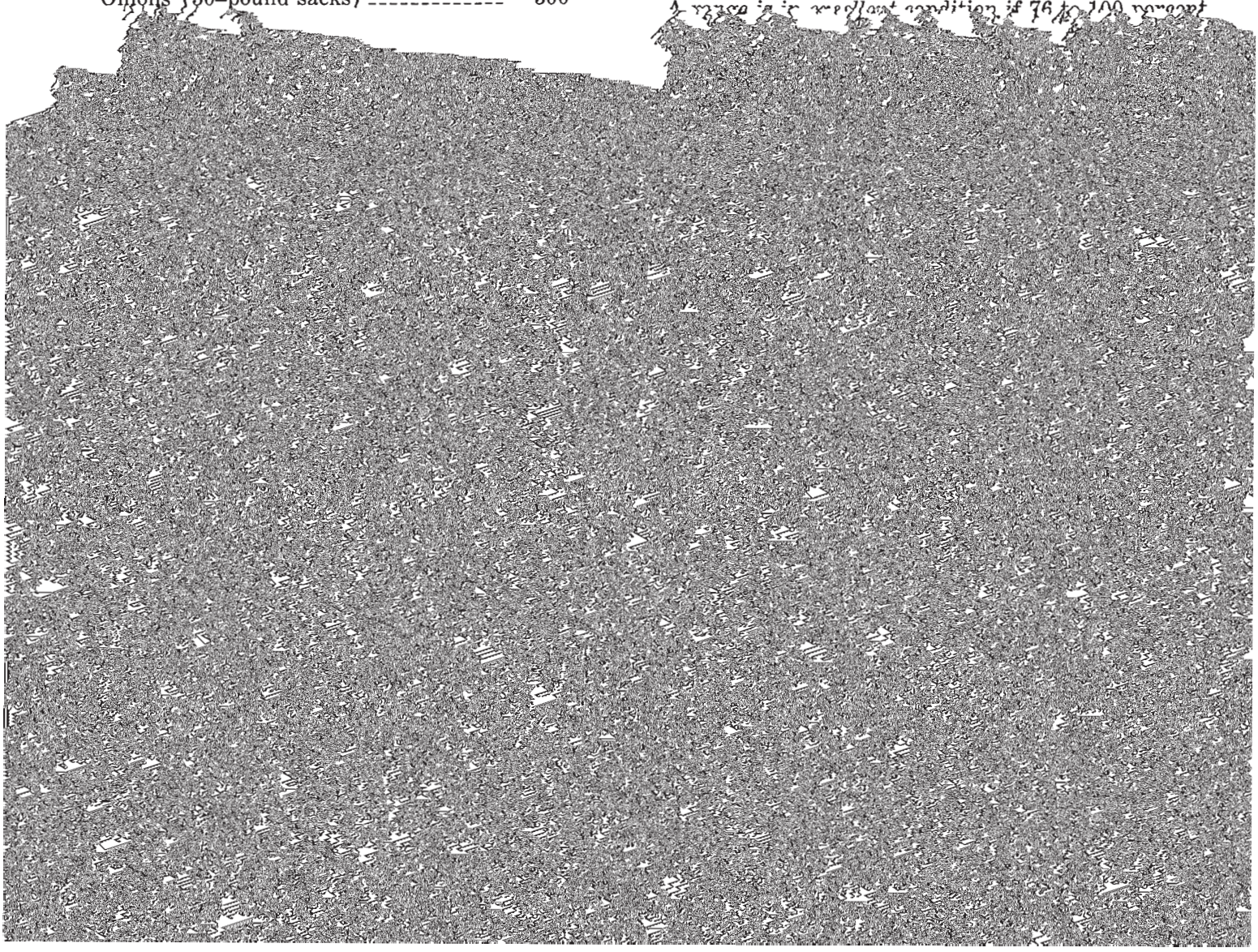
Potatoes (100–pound sacks)	190
Lettuce (cartons)	550
Carrots (tons)	10
Onions (50–pound sacks)	500

Decreasers are plants in the climax vegetation that tend to decrease in relative amount under close grazing. They generally are the tallest and most productive perennial grasses and forbs and the most palatable to livestock.

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

Invaders are plants that cannot compete with plants in the climax plant community for moisture, nutrients, and light. Hence, invaders come in and grow along with increasers after the climax vegetation has been reduced by grazing. Many are annual weeds, and some are shrubs that have some grazing value, but others have little value for grazing.

Four range condition classes are used to indicate the degree of departure from the potential, or climax, vegetation brought about by grazing or other uses. Range condition class indicates the present condition of the native vegetation on a range site in relation to the native vegetation that could grow there.



loams on uplands. Permeability is moderate to very slow, and available water capacity is medium or high. Runoff is very slow to medium. The hazard of soil blowing is slight to moderate, and the hazard of erosion is slight to severe. In many places the intake of moisture is reduced by surface crusting, and downward movement of moisture is slowed by compacted layers, or hoofpans.

The climax plant community is mainly short grasses and a few mid grasses. Its composition, by percentage of total weight, is approximately 50 percent blue grama, 20 percent buffalograss, 5 percent side-oats

lakes is mainly forbs and some short grasses. The composition, by percentage of total weight, is approximately 20 percent bur ragweed; 20 percent large spikesedge; 15 percent beakpod evening primrose; 15 percent Belvedere summer-cypress; 15 percent slimleaf goosefoot; 5 percent prostrate knotweed; 5 percent buffalograss; and 5 percent blue grama.

If the site is continuously heavily grazed, particularly during the growing season of April through July, most of the forbs decrease. Such plants as buffalograss, bluegrama, and little barley increase. Plant composition and production on this site are more dependent on

Where the site is in excellent condition, the average annual acre yield of air-dry herbage is 3,000 pounds in wet years and 1,500 pounds in dry years. Cattle use about 90 percent of this herbage.

SANDY LOAM RANGE SITE

This range site is made up of deep to moderately deep, nearly level to gently sloping fine sandy loams.

Permeability is moderate, and available water capacity is low to high. Runoff is slow to medium. The hazard of soil blowing is moderate, and the hazard of erosion is slight to moderate.

The climax plant community is a mixture of short, mid, and tall grasses and woody shrubs and forbs. Its composition, by percentage of total weight, is approximately 25 percent blue grama; 15 percent side-oats grama; 10 percent buffalograss; 5 percent little bluestem; 5 percent sand bluestem; 5 percent indiangrass; 5 percent silver bluestem; 20 percent other perennial grasses; 5 percent sand sagebrush; and 5 percent perennial forbs.

If the site is continuously heavily grazed by cattle, side-oats grama, blue grama, little bluestem, sand bluestem, indiangrass, and switchgrass decrease. Buffalograss, sand dropseed, silver bluestem, hairy grama, three-awns, catsclaw, sand sagebrush, and annual forbs increase. Mesquite, catsclaw, and some annuals invade.

Where this site is in excellent condition, the average annual acre yield of air-dry herbage is 2,400 pounds in wet years and 1,400 pounds in dry years. About 90 percent forage can be used by cattle.

VALLEY RANGE SITE

This range site is made up of deep, nearly level to gently sloping loams and clay loams to fine sandy loams on bottom lands (fig. 20). Permeability is moderate, and available water capacity is high. Runoff is slow to medium. The hazards of soil blowing and erosion are slight to moderate. Some areas of these soils are flooded at least once in 4 to 10 years. Most areas are not flooded.

The climax plant community is mainly short and mid grasses. Its composition, by percentage of total weight, is approximately 20 percent blue grama; 15 percent vine-mesquite; 15 percent buffalograss; 10 percent side-oats grama; 10 percent western wheatgrass; 5 percent alkali sacaton; 5 percent other perennial grasses; 10 percent woody plants; and 10 percent perennial forbs.

If the site is continuously heavily grazed by cattle, side-oats grama, blue grama, vine-mesquite, and west-

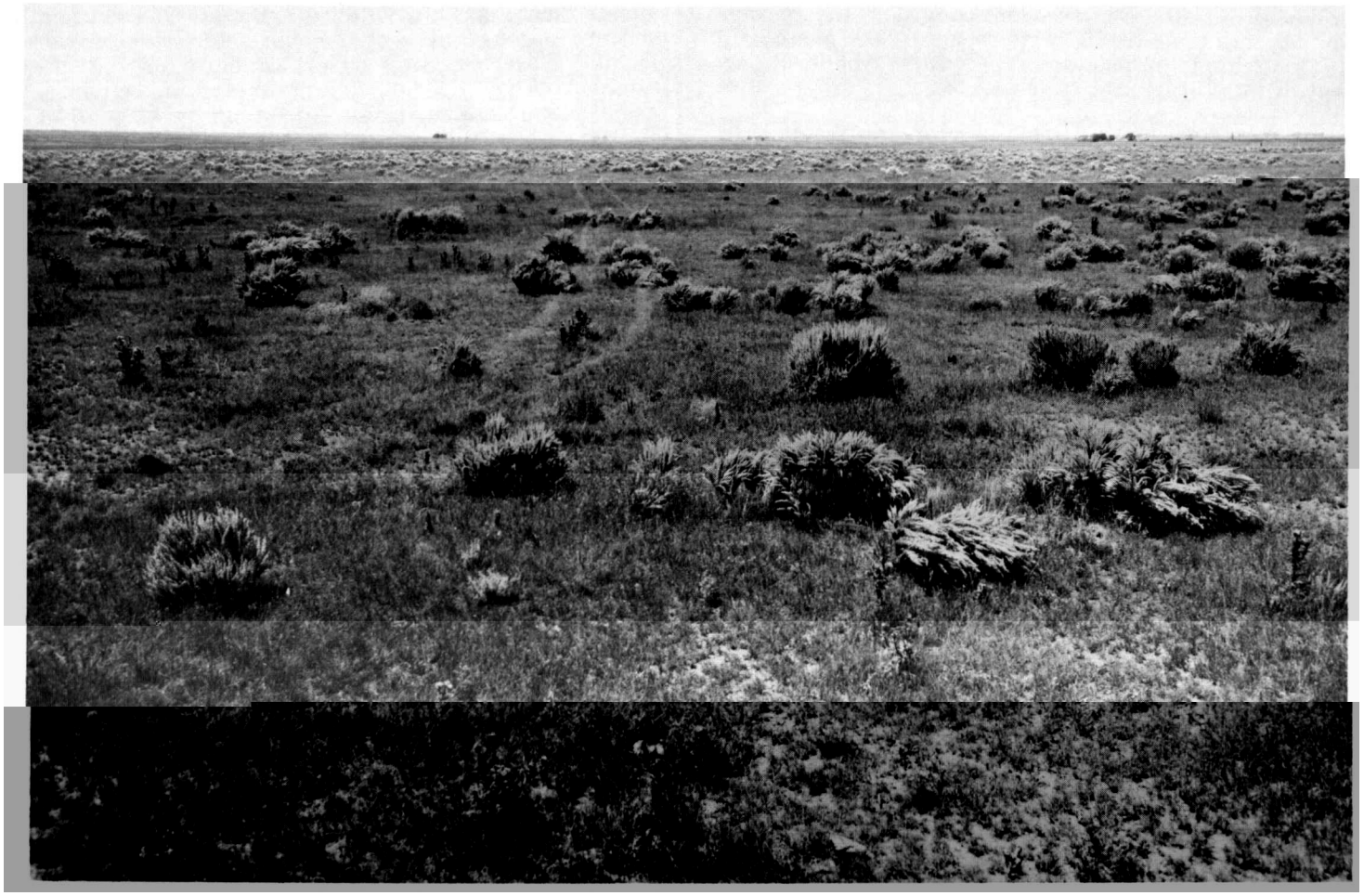


Figure 20.—**Bippus fine sandy loam in Valley range site.**

Such plants as buffalograss In table 3, the soils of Parmer County are rated ac-

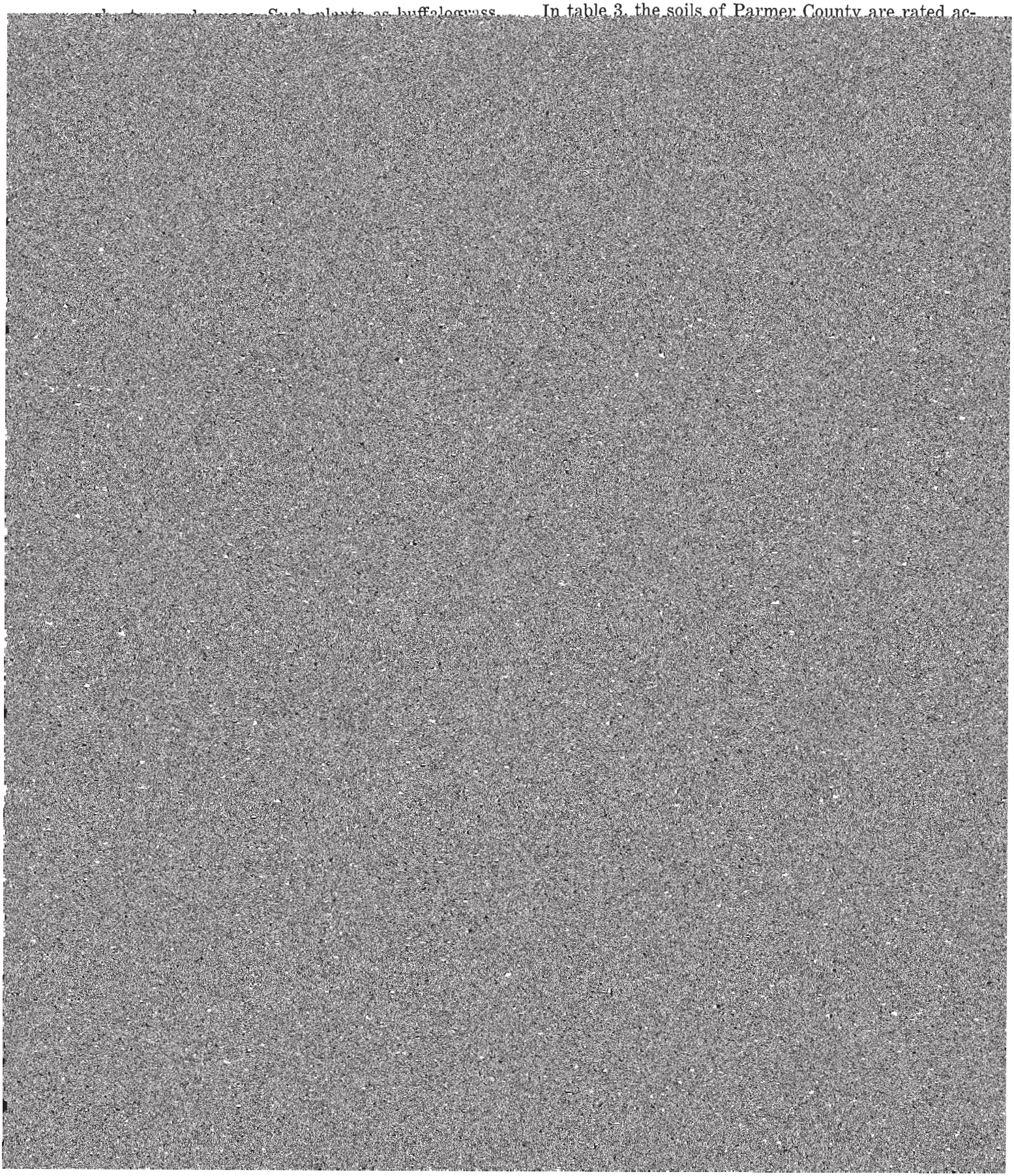


Figure 21.—Waterfowl on an intermittent playa lake on Randall clay.

than 5 feet deep, to create habitats that are suitable for waterfowl. Some are designed to be drained, planted, and then flooded; others are permanent impoundments that grow submersed aquatics.

Table 3 also rates soils according to their suitability as habitat for the three kinds of wildlife in the county —open-land, rangeland, and wetland wildlife. These ratings are related to ratings made for the elements of wildlife habitat. For example, soils rated very poor for shallow water developments are rated very poor for wetland wildlife. The kinds of wildlife for which the soils are rated in table 3 are briefly described in the following paragraphs.

Open-land wildlife consists of birds and mammals that normally live in cropland, pastures, and open

Quail, pheasant, dove, meadowlark, jackrabbit, field sparrow, and fox are typical examples of open-land wildlife.

Rangeland wildlife consists of birds and mammals that normally live in areas of native grasses, forbs, and shrubs. Ground squirrel, prairie dog, coyote, and cottontail rabbit are typical examples of rangeland wildlife.

Wetland wildlife consists of birds and mammals that normally live in wet areas, marshes, and swamps. Ducks, geese, coots, gulls, killdeer, curlew, plover, and cranes are typical examples of wetland wildlife. In table 3 each of the soils are rated as poor or very poor. However, some of these soils would be rated fair to good for wetland wildlife if irrigation water were made

TABLE 3.—*Suitability of soils for elements of wildlife habitat and kinds of wildlife*

Soil series and map symbols	Elements of wildlife habitat						Kinds of wildlife		
	Grain and seed crops	Grasses and legumes	Wild herbaceous upland plants	Shrubs	Wetland food and cover	Shallow water areas	Openland wildlife	Rangeland wildlife	Wetland wildlife

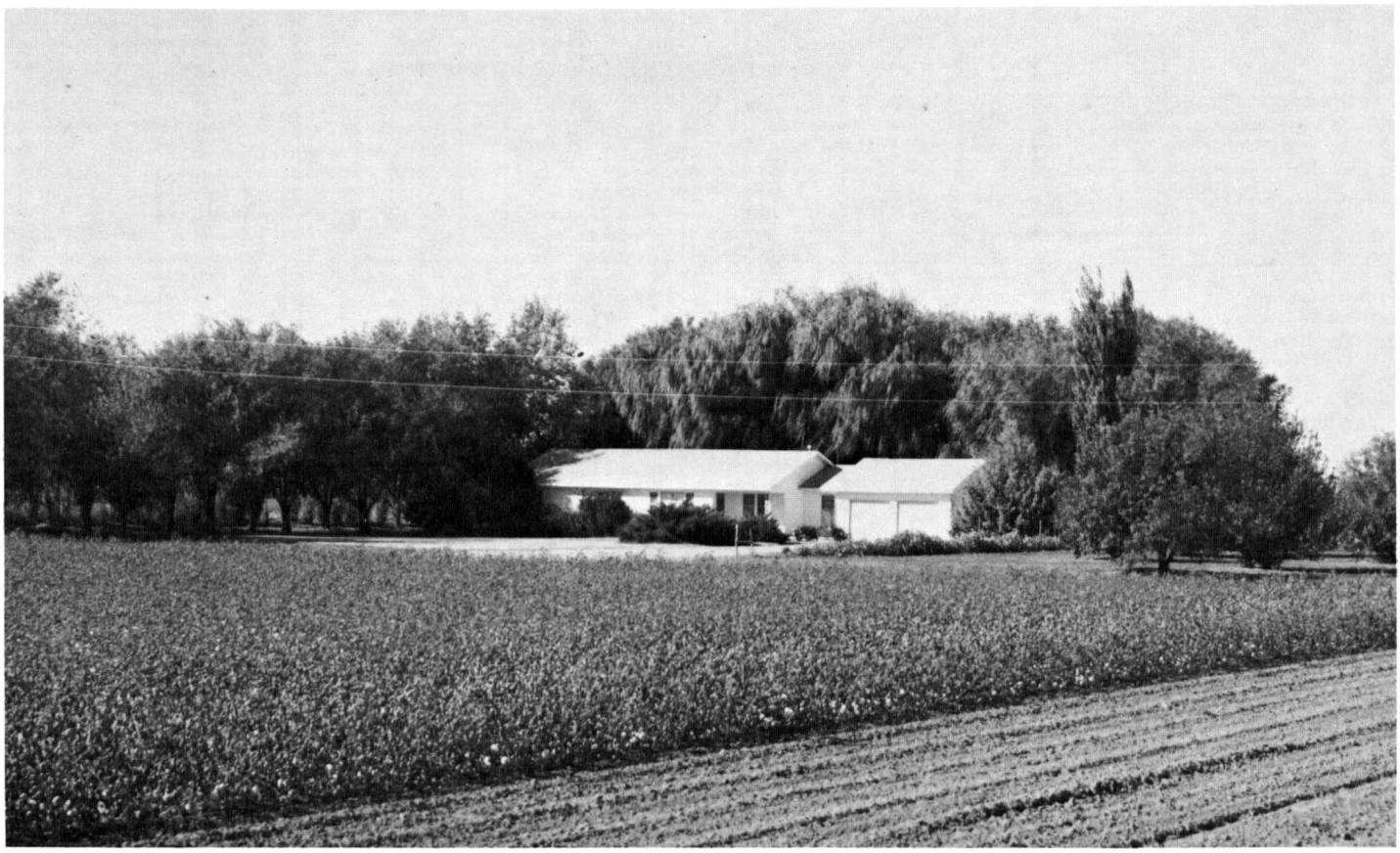


Figure 22.—**Farmstead windbreak of Chinese elm, poplar, desert-willow, and some fruit trees on Olton soils.**

benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among the soil properties most important in engineering are permeability, shear strength, compaction characteristics, compressibility, soil drainage condition, shrink-swell potential, grain-size distribution, plasticity, and reaction. Depth to the water table, depth to bedrock, and slope are also important. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 4 and 5 which show, respectively, several estimated soil properties significant to engineering and interpretations for various engineering uses.

This information, along with the soil map and other parts of this survey, can be used to make interpretations in addition to those given in table 5, and it also can be used to make other useful maps.

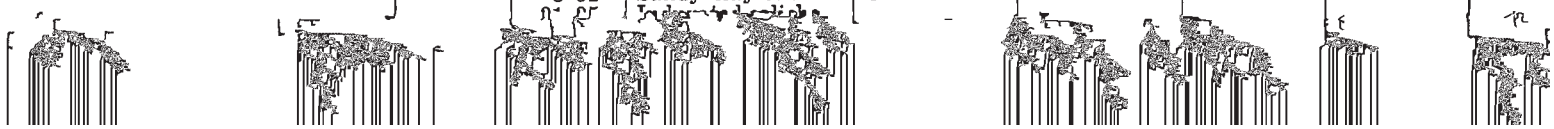
This information, however, does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to a depth greater than those shown in the tables, generally a depth of more than 6 feet. In addition, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have

TABLE 4.—*Estimates of soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soils. fully the instructions for referring to other series that appear in the first column of this table.

Soil series and map symbols	Hydrologic group	Depth from surface	Dominant USDA texture	Classification		Percentage passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
		In					
Acuff: AcA, AcB, AcC	B	0–11	Loam	CL	A–4 or A–6	100	100
		11–40	Sandy clay loam	CL	A–6 or A–7–6	100	100
		40–80	Sandy clay loam	CL	A–6	95–100	90–100
Amarillo: AmA, AmB, AmC	B	0–9	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	100	100
		9–44	Sandy clay loam	SC, CL, SM–SC, or CL–ML	A–6, A–4	100	100
		44–102	Sandy clay loam	SC or CL	A–6, A–4	90–100	90–99
Arvana: ArA	C	0–7	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	100	100
		7–26	Sandy clay loam	SC or CL	A–4 or A–6	100	100
		26–75	Indurated and soft caliche.				
		75–90	Sandy clay loam	CL, SC, CL–ML, or SM–SC	A–4 or A–6	95–100	90–100
Berda: BeC, BeD	B	0–6	Loam	SC or CL	A–4 or A–6	90–100	85–100
		6–36	Loam	SC or CL	A–4 or A–6	95–100	95–100
		36–80	Fine sandy loam	SM, ML, CL–ML, or SM–SC	A–4	90–99	85–95
*Bippus: BfA	B	0–10	Fine sandy loam	SM, SC, ML, CL, SM–SC, or CL–ML	A–2–4 or A–4	100	90–100
		10–30	Sandy clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
		30–40	Clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
		40–54	Fine sandy loam	SM, SC, ML, CL, SM–SC, or CL–ML	A–2–4 or A–4	100	90–100
		54–80	Sandy clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
BpA, BpB, Bs For Spur part of Bs, see Spur series.	B	0–19	Clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	95–100
		19–66	Clay loam	SC, SM–SC, CL, or CL–ML	A–4 or A–6	100	90–100
*Estacado: EsA, EsB, EtC For Posey part of EtC, see Posey series.	B	0–13	Clay loam	CL	A–6 or A–4	100	98–100
		13–28	Clay loam	CL	A–6 or A–7–6	95–100	95–100
		28–90	Clay loam	CL	A–6 or A–7–6	95–100	95–100
Friona: FrA	C	0–8	Loam	CL	A–4 or A–6	100	100
		8–31	Sandy clay loam	CL	A–6 or A–7–6	100	100



significant in engineering

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow care-
The symbol < means less than. Absence of data indicates that no estimate was made]

Percentage passing sieve—Contd.		Liquid limit	Plasticity index	Permeability [1]	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to uncoated steel
No. 40 (0.42 mm)	No. 200 (0.074 mm)			*In per hr*	*In per in of soil*	*pH*		
95–100	51–70	25–32	8–15	0.6–2.0	0.14–0.17	6.6–7.8	Low	Moderate.
95–100	65–75	30–45	15–25	0.6–2.0	0.15–0.18	7.4–8.4	Moderate	Moderate.
90–100	60–70	25–35	13–20	0.6–2.0	0.12–0.15	7.9–8.4	Low	Moderate.

TABLE 4.—*Estimates of soil properties*

Soil series and map symbols	Hydrologic group	Depth from surface	Dominant USDA texture	Classification		Percentage passing sieve—	
				Unified	AASHTO	No. 4 (4.7 mm)	No. 10 (2.0 mm)
		In					
Kimbrough: KmC	D	0–8	Loam	GM, GC, SM, SM–SC, SC, GM–GC	A–2–4 or A–4, A–1	55–85	50–80
		8–60	Indurated caliche, gravel, cobbles, and stones.				
Likes: LkD	A	0–9	Loamy fine sand	SM, SM–SC	A–2–4	90–98	90–98
		9–62	Fine sand	SM, SM–SC, or SP–SM	A–2–4, A–3	95–98	95–97
Lipan: Lp	D	0–48	Clay	CH	A–7–6	95–100	95–100
		48–70	Clay	CL or CH	A–7–6	95–100	95–100
Mobeetie: MoB	B	0–66	Fine sandy loam	SM, SM–SC, ML, CL–ML	A–4	95–98	90–95
Olton: OtA, OtB	C	0–9	Clay loam	CL	A–4 or A–6	100	95–100
		9–50	Clay loam	CL	A–6 or A–7–6	100	90–100
		50–76	Clay loam	CL	A–6	90–100	90–100
*Posey: PfA, PfB, PmD For Berda part of PmD, see Berda series.	B	0–11	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	98–100	95–100
		11–41	Sandy clay loam	SC, CL, CL–ML, or SM–SC	A–4 or A–6	85–100	90–98
		41–80	Sandy clay loam	CL	A–4 or A–6	95–100	90–95
Potter: PoE	C	0–12	Loam	ML or CL	A–4 or A–6	80–95	70–90
		12–64	Weakly cemented to indurated caliche.	GM, GC, SM, or SC	A–2, A–4, or A–6	30–80	25–75
Pullman: PuA, PuB	D	0–9	Clay loam	CL	A–7–6, A–6	100	100
		9–48	Clay	CL or CH	A–7–6	100	100
		48–89	Clay and clay loam.	CL	A–4 or A–6	95–100	90–100
Randall: Ra	D	0–84	Clay	CL or CH	A–7–6	100	100
Spur: Mapped only with Bippus soils.	B	0–11	Loam	CL	A–4 or A–6, A–7–6	100	95–100
		11–80	Clay loam	CL	A–4, or A–6	100	95–100
*Tulia: TuA, TuB	B	0–17	Loam and clay loam.	CL, SC, SM–SC, or CL–ML	A–4 or A–6	95–100	90–100
		17–94	Clay loam	CL, SC	A–4 or A–6	90–100	90–100
TwC For Potter part, see Potter series.	B	0–5	Fine sandy loam	SM or SM–SC	A–2–4 or A–4	95–100	90–100
		5–46	Sandy clay loam and clay loam.	CL	A–4 or A–6	95–100	90–100
		46–80	Clay loam	CL, SC	A–4 or A–6	90–100	90–100
Zita: ZcA	B	0–7	Loam	CL	A–4 or A–6	100	100
		7–30	Clay loam	CL	A–6 or A–7–6	98–100	98–100
		30–55	Sandy clay loam	SC or CL	A–6, A–4	90–100	90–99
		55–80	Clay loam	CL	A–6	90–100	80–90

[1] These ratings should not be confused with the coefficient "k" used by engineers.

significant in engineering—Continued

Percentage passing sieve—Contd.		Liquid limit	Plasticity index	Permeability [1]	Available water capacity	Reaction	Shrink-swell potential	Corrosivity to uncoated steel
No. 40 (0.42 mm)	No. 200 (0.074 mm)			*In per hr*	*In per in of soil*	*pH*		
40–65	20–40	<30	NP–10	0.6–2.0	0.10–0.15	7.9–8.4	Low	Moderate.
75–95	12–30	<25	NP–6	2.0–6.0	0.06–0.10	7.9–8.4	Very low	Low.
70–90	9–25	<25	NP–6	6.0–20.0	0.04–0.08	7.9–8.4	Very low	Low.
95–100	85–95	50–70	35–50	<0.06	0.15–0.20	7.9–8.4	Very high	High.
90–100	80–95	41–60	25–40	<0.06	0.15–0.20	7.9–8.4	Very high	High.
80–95	40–65	<25	NP–7	2.0–6.0	0.10–0.14	7.4–8.4	Very low	Low.
85–100	55–75	20–35	8–15	0.6–2.0	0.15–0.20	6.6–7.3	Low	Moderate.
90–100	70–85	35–50	15–30	0.2–0.6	0.15–0.20	7.4–8.4	Moderate	Moderate.
90–100	60–75	30–40	12–20	0.2–0.6	0.10–0.15	7.9–8.4	Moderate	Moderate.
85–95	25–45	<23	NP–5	2.0–6.0	0.10–0.15	7.9–8.4	Low	Moderate.
85–95	45–70	20–35	5–12	0.6–2.0	0.07–0.12	7.9–8.4	Low	Moderate.
85–95	51–75	25–40	8–15	0.6–2.0	0.12–0.16	7.9–8.4	Low	Moderate.
60–85	51–70	30–40	5–15	0.6–2.0	0.12–0.16	7.9–8.4	Low	Moderate.
20–60	13–49	30–40	5–15	0.6–2.0	0.01–0.04	7.9–8.4	Very low	Moderate.
95–100	70–90	35–50	15–30	0.2–0.6	0.14–0.18	6.6–8.4	Moderate	High.
95–100	80–95	45–60	25–35	<0.06	0.12–0.16	7.4–8.4	High	High.
90–100	80–95	35–50	20–30	0.06–0.2	0.12–0.16	7.9–8.4	Moderate	High.

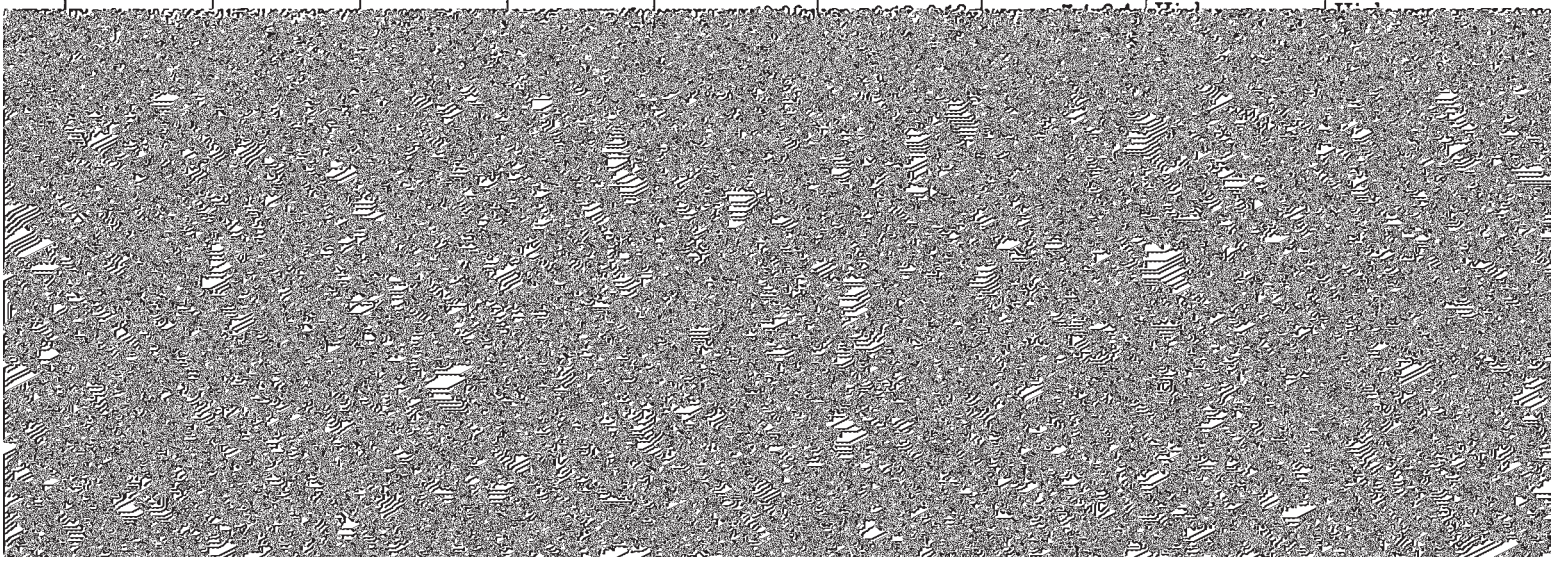


TABLE 5.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of this table. Some terms that describe restrictive soil soils]

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Acuff: AcA	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Severe: low strength.
AcB, AcC	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Severe: low strength.
Amarillo: AmA	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
AmB, AmC	Slight	Moderate: seepage.	Slight	Moderate: low strength.	Slight	Moderate: low strength.
Arvana: ArA	Severe: cemented pan.	Severe: cemented pan.	Slight	Moderate: cemented pan.	Moderate: cemented pan.	Moderate: low strength; cemented pan.
Berda: BeC, BeD	Slight	Moderate: slope; seepage.	Moderate: slope; too clayey.	Slight	Slight	Moderate: low strength.
*Bippus: BfA, BpA	Slight	Moderate: seepage.	Moderate: cutbanks cave.	Moderate: low strength.	Moderate: too clayey.	Moderate: low strength.
BpB	Slight	Moderate: seepage.	Moderate: cutbanks cave.	Moderate: low strength.	Moderate: too clayey.	Moderate: low strength.
Bs. For Spur part, see Spur series.	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods
*Estacado: EsA	Slight	Moderate: seepage.	Moderate: too clayey.	Moderate: low strength.	Moderate: too clayey.	Severe: low strength.
EsB, EtC. For Posey part of EtC, see Posey series, PfB.	Slight	Moderate: seepage.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Severe: low strength.
Friona: FrA	Severe: cemented pan.	Severe: cemented pan.	Moderate: cemented pan.	Moderate: cemented pan; low strength.	Moderate: cemented pan.	Severe: low strength.
Kimbrough: KmC	Severe:	Severe:	Severe:	Severe:	Severe:	Severe:

interpretations

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate

Degree and kind of limitation for—Continued	Suitability as a source of—	Soil features affecting—

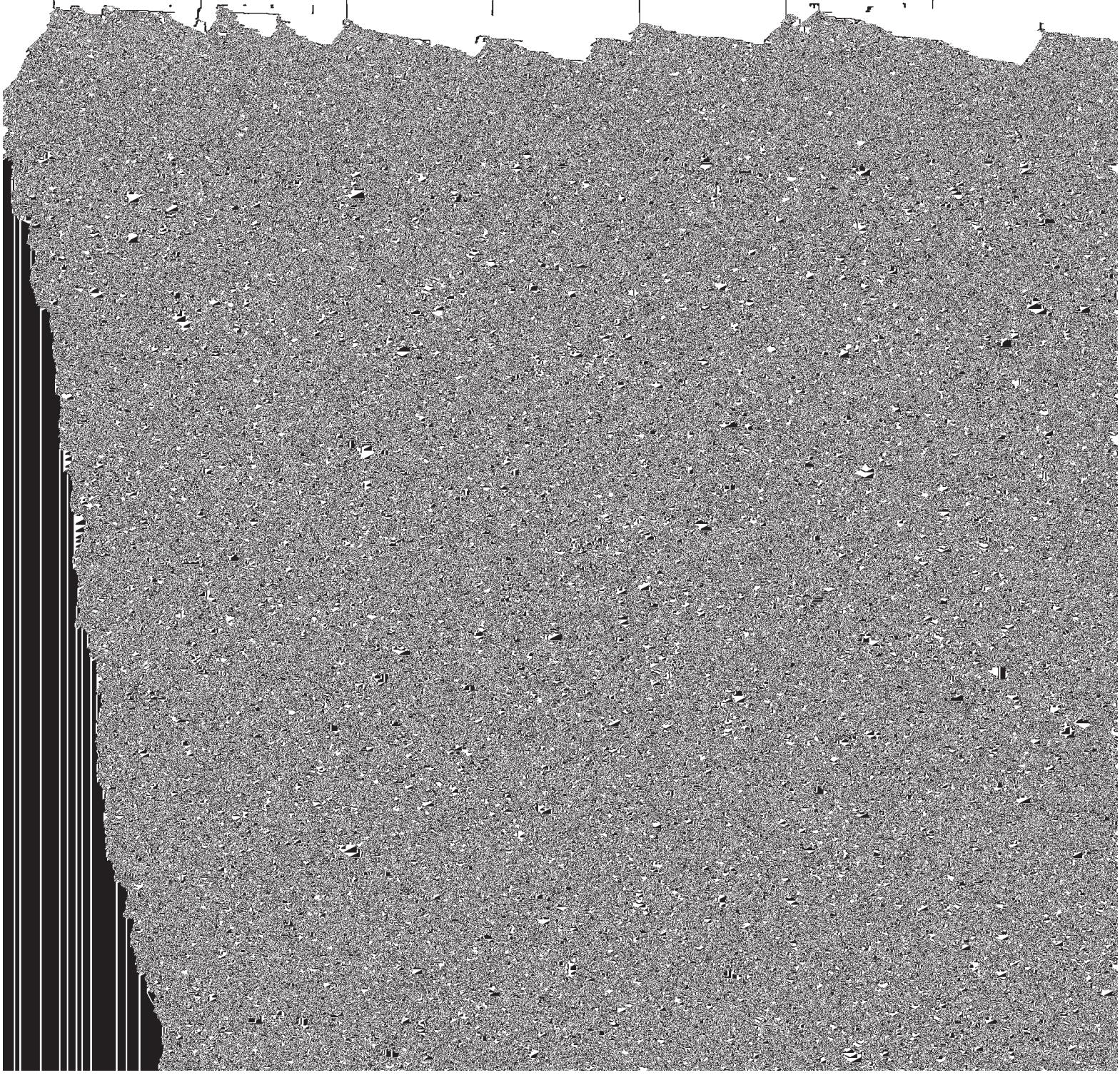


TABLE 5.—*Engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Lipan: Lp	Severe: percs slowly.	Slight	Severe: too clayey.	Severe: shrink-swell.	Severe: too clayey.	Severe: shrink-swell.
Mobeetie: MoB	Slight	Severe: seepage.	Slight	Slight	Severe: seepage.	Moderate: low strength.
Olton: OtA	Moderate:	Slight	Moderate: too	Moderate:	Moderate: too	Moderate: low

interpretations—Continued

Degree and kind of limitation for—Continued		Suitability as a source of—		Soil features affecting—		
Pond reservoir areas	Embankments, dikes, and levees	Road fill	Topsoil	Irrigation	Terraces and diversions	Waterways
Slight	Moderate: shrink-swell.	Poor: shrink-swell.	Poor: too clayey.	Slow intake	Not needed	Not needed.
Severe: seepage.	Moderate: piping; erodes easily.	Fair: low strength.	Good	Fast intake; slope.	Favorable	Erodes easily.
Moderate: seepage.	Moderate: piping.	Fair: low strength.	Fair: too clayey.	Favorable	Favorable	Favorable.
Moderate:	Moderate:	Fair: low strength	Fair: too clayey	Slope	Favorable	Favorable.

different meanings in soil science than in engineering. Many of these terms commonly used in soil science are defined in the Glossary.

Engineering classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified soil classification system (*2*), used by the SCS engineers, Department of Defense, and others, and the AASHTO system adopted by the American Association of State Highway and Transportation Officials (*1*).

In the Unified soil classification system, soils are classified according to particle-size distribution, plasticity index, liquid limit, and organic-matter content. Soils are grouped in 15 classes. There are 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 are designated by symbols for both classes; for example, CL-ML. The letters used in class designation mean; G, gravel, S, sand; M, silt; and C, clay. Clean sands are identified by SW or SP; sands that have fines of silt and clay by SM or SC; silt and clay that have a low liquid limit by ML and CL; and silt and clay that have a high liquid limit by MH and CH.

The AASHTO soil classification system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed 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. In group A–1 are gravelly soils of high bearing strength, the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet, the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided 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 additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The estimated AASHTO classification, without group index numbers, is given in table 4 for all soils mapped in the survey area.

Group A consists of soils that have a high infiltration rate even when thoroughly wetted. They are chiefly deep, well-drained to excessively drained sand or gravel, or both. These soils have a high rate of water transmission and a low runoff potential.

Group B consists of soils that have a moderate infiltration rate when thoroughly wetted. They are chiefly moderately deep to deep, moderately well drained to well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission and a moderate runoff potential.

Group C consists of soils that have a slow infiltration rate when thoroughly wetted. They are chiefly soils that have a layer that impedes downward movement of water or soils that have moderately fine texture to fine texture. These soils have a slow rate of water transmission and a high runoff potential.

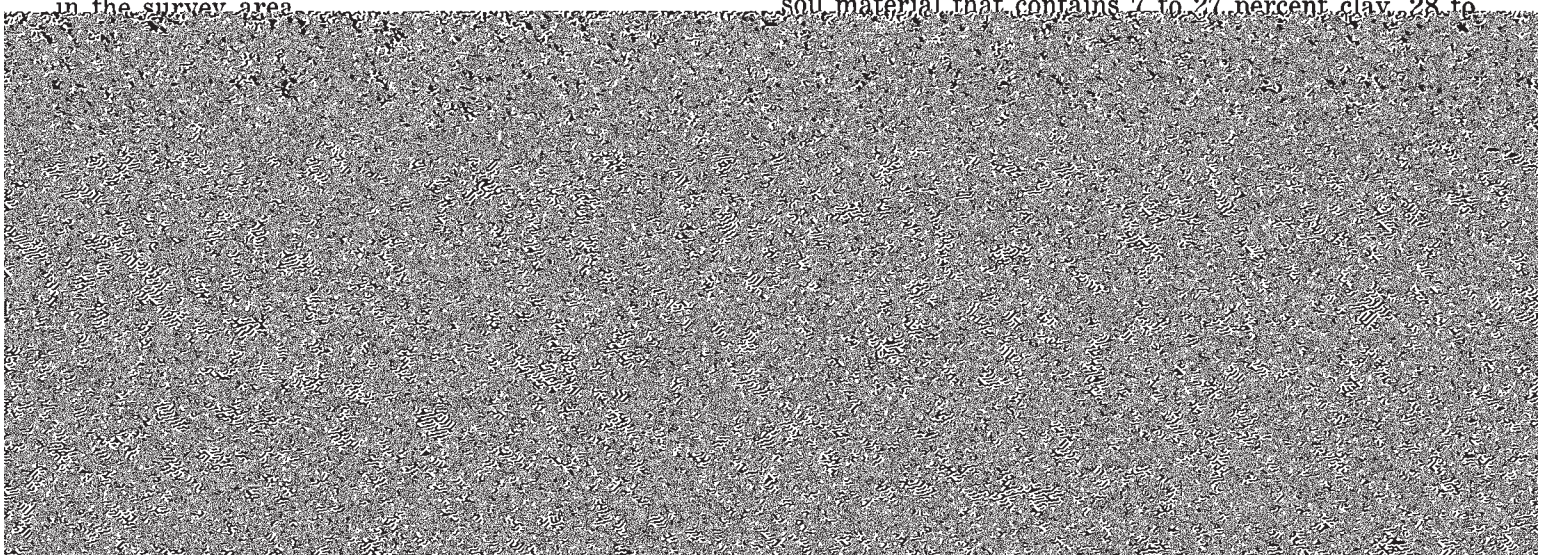
Group D consists of soils that have a very slow infiltration rate when thoroughly wetted. They are chiefly clay soils that have a high swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. These soils have a very slow rate of water transmission and a very high runoff potential.

Depth to bedrock is the distance from the surface of the soil to the upper surface of the rock layer. A column was not included in the table, because none of the soils in Parmer County have bedrock at the depth investigated except the following soils, which have indurated caliche at the depths indicated: Arvana soils, 20 to 36 inches; Friona soils, 22 to 36 inches; Kimbrough soils, 5 to 13 inches; and Potter soils, 5 to 12 inches.

Depth from surface gives the depth in inches for the major distinctive layers of the soil profile.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years. This column was not included in the table, because none of the soils in Parmer County have a high water table.

Soil texture is described in table 4 in the standard terms used by the U.S. Department of Agriculture. These terms take into account relative percentages of sand, silt, and clay in soil material that is less than 2.0 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to

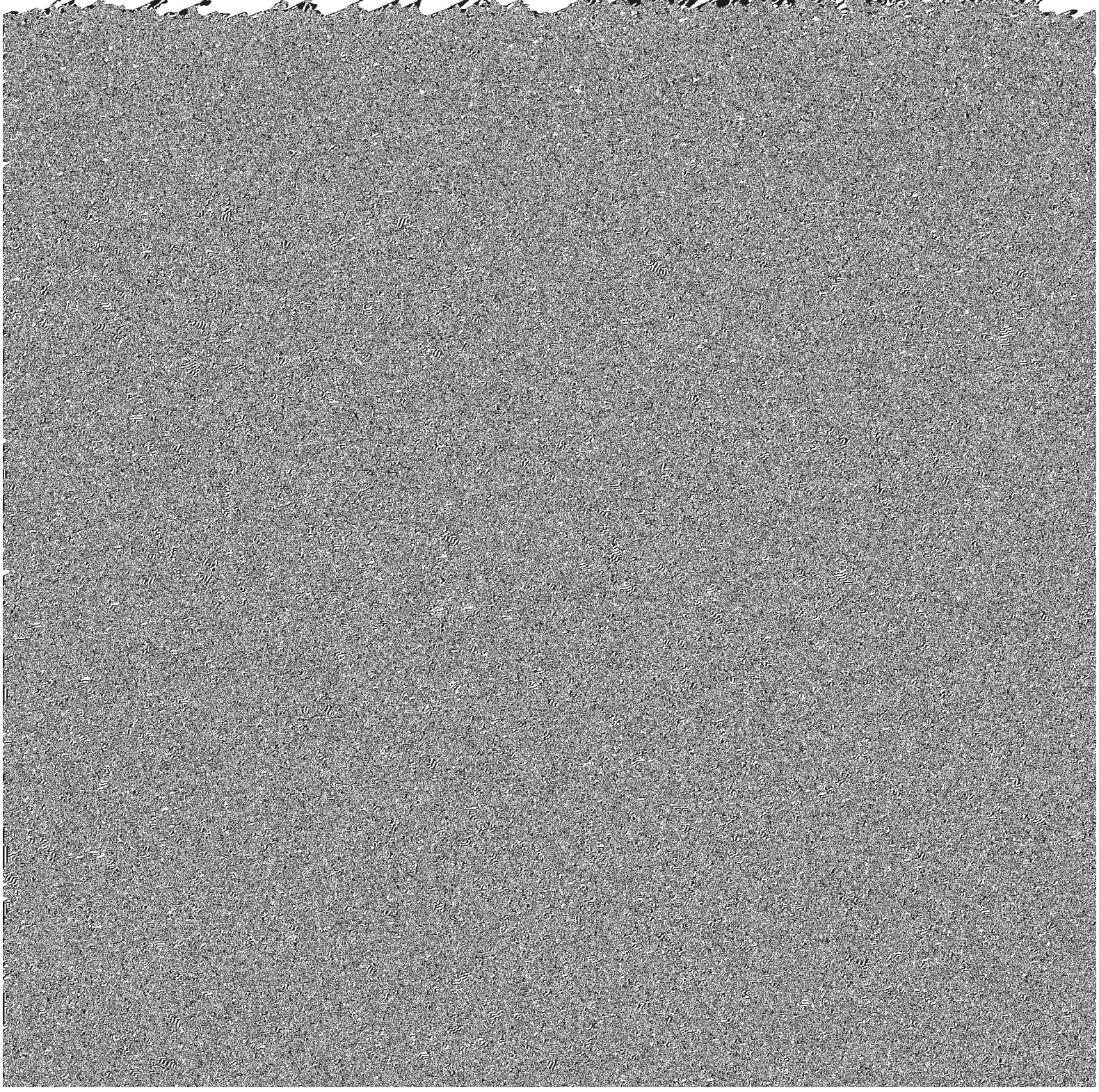


tent at which the soil material changes from the semisolid to plastic state, and the liquid limit from a plastic to a liquid state. The plasticity index is the numerical difference betwen the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 4.

Permeability is that quality of a soil that enables

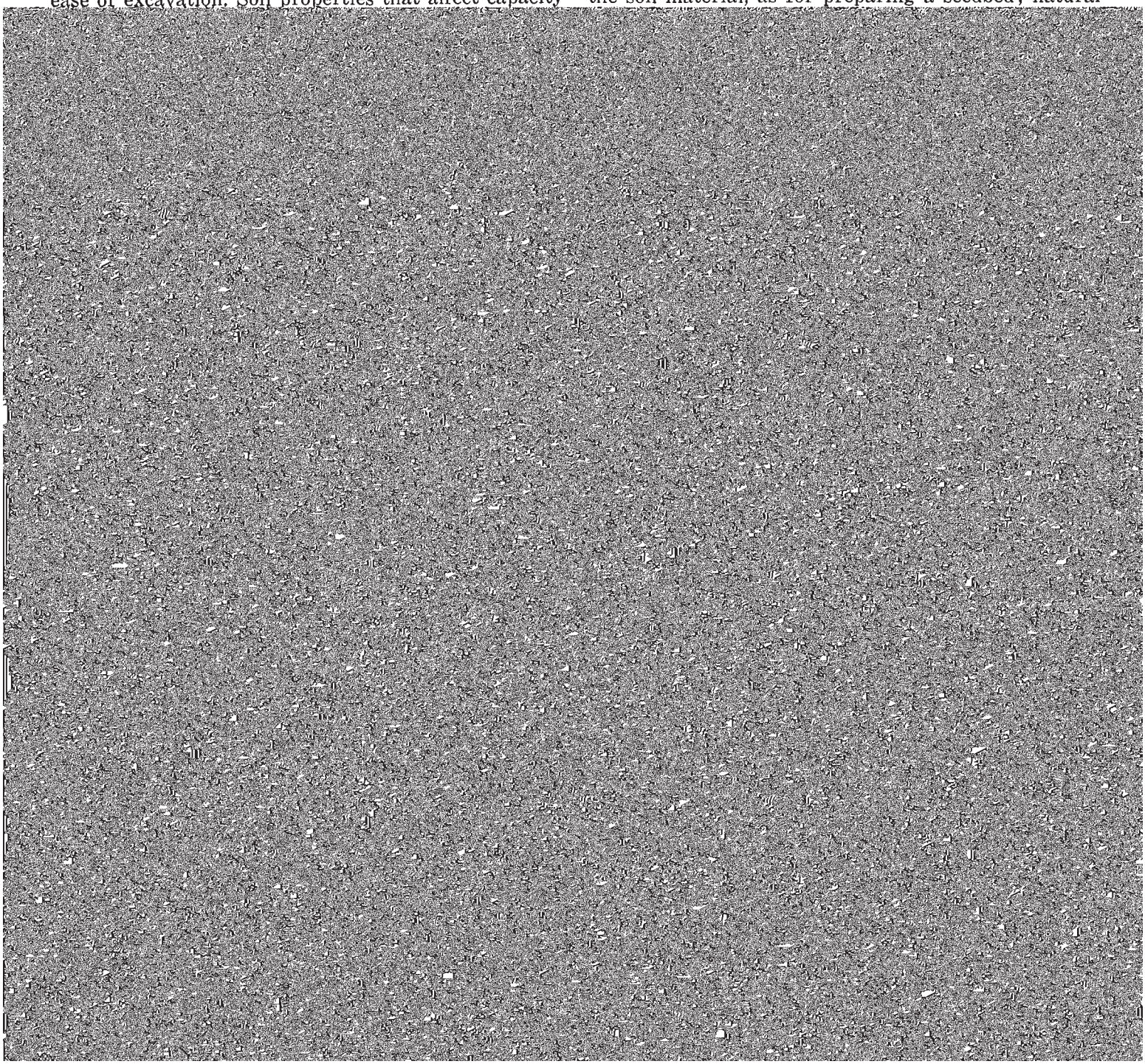
of the ground water and (2) later and slower loss of elevation that results from oxidation of organic materials. The maximum possible loss of surface elevation is called *potential subsidence*. A column for subsidence was not included in the table, because subsidence is no problem in soils of the county.

Engineering interpretations



transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or from a high water table.

Dwellings without basements, as rated in table 5, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load, and those that relate to ease of excavation. Soil properties that affect capacity



performance of a soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Sand and gravel are used in great quantities in many kinds of construction. A column was not included in the table, however, because the soils of Parmer County are not good sources of sand and gravel.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material, as for preparing a seedbed; natural

Recreational Development

Knowledge of soils is necessary for planning, developing, and maintaining areas used for recreation. In table 6 the soils of Parmer County are rated according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails.

Factors of Soil Formation

Soil is produced by the action of soil-forming factors on material deposited or accumulated by natural forces. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate

TABLE 6.—*Degree of limitation and soil properties affecting recreational development*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring to other series that appear in the first column of this table. Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil series and map symbols	Camp areas	Picnic areas	Playgrounds	Paths and trails
Acuff:				
AcA, AcB	Slight	Slight	Slight	Slight.
AcC	Slight	Slight	Moderate: slope	Slight.
Amarillo:				
AmA, AmB	Slight	Slight	Slight	Slight.
AmC	Slight	Slight	Moderate: slope	Slight.
Arvana: ArA	Slight	Slight	Slight	Slight.
Berda:				
BeC	Slight	Slight	Moderate: slope	Slight.
BeD	Slight	Slight	Severe: slope	Slight.
*Bippus:				
BfA	Slight	Slight	Slight	Slight.
BpA, BpB	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
Bs	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
For Spur part, see Spur series.				
*Estacado: EsA, EsB, EtC	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
For Posey part of EtC, see Posey series, PmD.				
Friona: FrA	Slight	Slight	Slight	Slight.
Kimbrough: KmC	Slight	Slight	Severe: depth to rock.	Slight.
Likes: LkD	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy; slopes.	Moderate: too sandy.
Lipan: Lp	Severe: percs slowly; too clayey.	Severe: too clayey	Severe: percs slowly; too clayey.	Severe: too clayey.
Mobeetie: MoB	Slight	Slight	Slight	Slight.
Olton: OtA, OtB	Moderate: percs slowly.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
*Posey:				
PfA, PfB	Slight	Slight	Slight	Slight.
PmD	Slight	Slight	Severe: slope	Slight.
For Berda part, see Berda series, BeD.				
Potter: PoE	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Pullman: PuA, PuB	Moderate: percs slowly.	Moderate: too clayey.	Moderate: percs slowly.	Moderate: too clayey.
Randall: Ra	Severe: floods	Severe: floods	Severe: floods	Severe: too clayey.
Spur: Mapped only in an undifferentiated group with Bippus series.	Severe: floods	Moderate: floods	Severe: floods	Slight.
*Tulia:				
TuA, TuB	Slight	Slight	Slight	Slight.
TwC	Slight	Slight	Moderate: slope	Slight.
For Potter part, see Potter series.				
Zita: ZcA	Slight	Slight	Slight	Slight.

and Randall soils. Randall soils formed in beds of clay settlings in playa basins. Likes soils formed in wind-blown material that has lime and that washed from Ogallala Sand and then was blown into place during windy, dry periods. Berda soils formed in calcareous colluvium that has settled on slopes along draws that are below escarpments.

Climate

The climate of Parmer County is uniform, but its effects have been modified locally by relief and runoff. Randall soils are clays that formed in playas. Because rainfall is low and there are long, dry periods, soil development is slow. Except in irrigated areas, the soils are seldom wet below the root zone, and as a result, many have a horizon of calcium carbonate accumulation. Leaching has not removed free lime from the upper layers of Berda, Estacado, Kimbrough, Likes, Lipan, Posey, Potter, and Tulia soils.

Climate has affected the formation of some of the soils through the action of strong winds. The Likes soils formed from strongly calcareous, sandy, wind-blown sediments. These sediments were washed and then blown into their present position by westerly winds. More climatic data are given in the section "General Nature of the County."

Plant and animal life

Plants, earthworms, micro-organisms, and other forms of animal life that live on and in the soil contribute to soil development. The kinds of organisms are determined mainly by climate and parent material.

In Parmer County, climate has limited the kind of vegetation mainly to grasses. The kind of parent material in which the soils formed determined whether the grasses would be tall, as on the sandy soils, or

and clay particles have been blown from the plow layer. Use of heavy machinery and untimely tillage have compacted the soils and, thus, have slowed the infiltration of water and air. Irrigation has drastically changed the natural moisture regime in some areas.

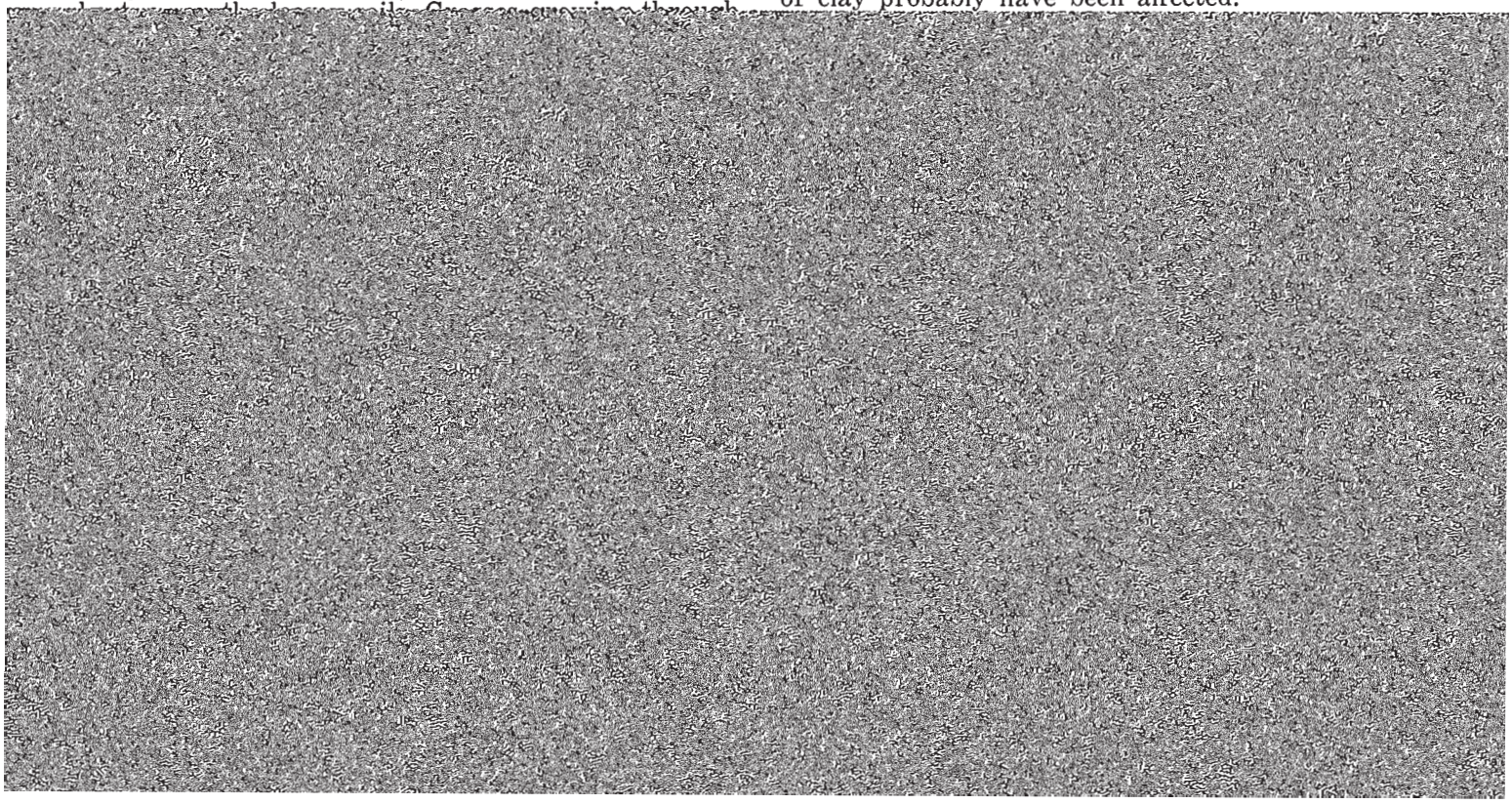
Relief

Relief influences the formation of soils mostly through its effect on drainage and runoff. If other factors of soil formation are equal, the degree of profile development depends mainly on the average amount of moisture that enters and passes through the soil. Steep soils absorb less moisture than less sloping ones, and they are more susceptible to erosion. Therefore, they generally have a thinner, less developed profile.

Some soils in the county, such as Acuff, Olton, and Pullman soils, are nearly level or gently sloping. Most of the moisture from rainfall has penetrated those soils; therefore, relief has not been a limiting factor in the development of a soil profile.

In contrast, Potter soils have been strongly influenced by relief. Because these soils are gently sloping to sloping, runoff is rapid and geologic erosion is active. Rainfall penetrates to only a limited depth; therefore, the vegetation is sparse. Vegetation, time, and climate can produce and sustain only a very shallow to shallow soil. To a lesser extent than in Potter soils, relief has affected the formation of a profile in Berda and Posey soils because runoff is constantly wearing away the upper part of the soil profile as fast as it is formed.

Randall soils are also affected to some extent by relief. They are somewhat poorly drained and are covered by water for long periods. Consequently, some of the minerals in those soils, especially iron and manganese, have been changed and the kinds and amounts of clay probably have been affected.



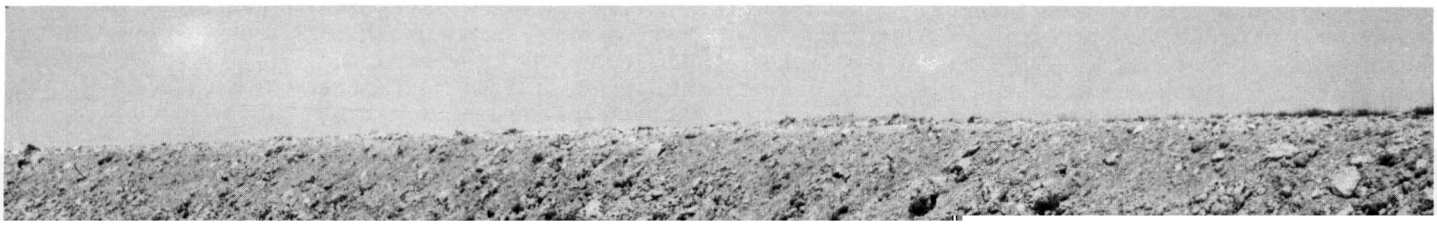


Figure 23.—**Profile of Pullman clay loam, 0 to 1 percent slopes, showing wavy boundary of Btca horizon and dark, irregularly shaped nests, or krotovinas.**

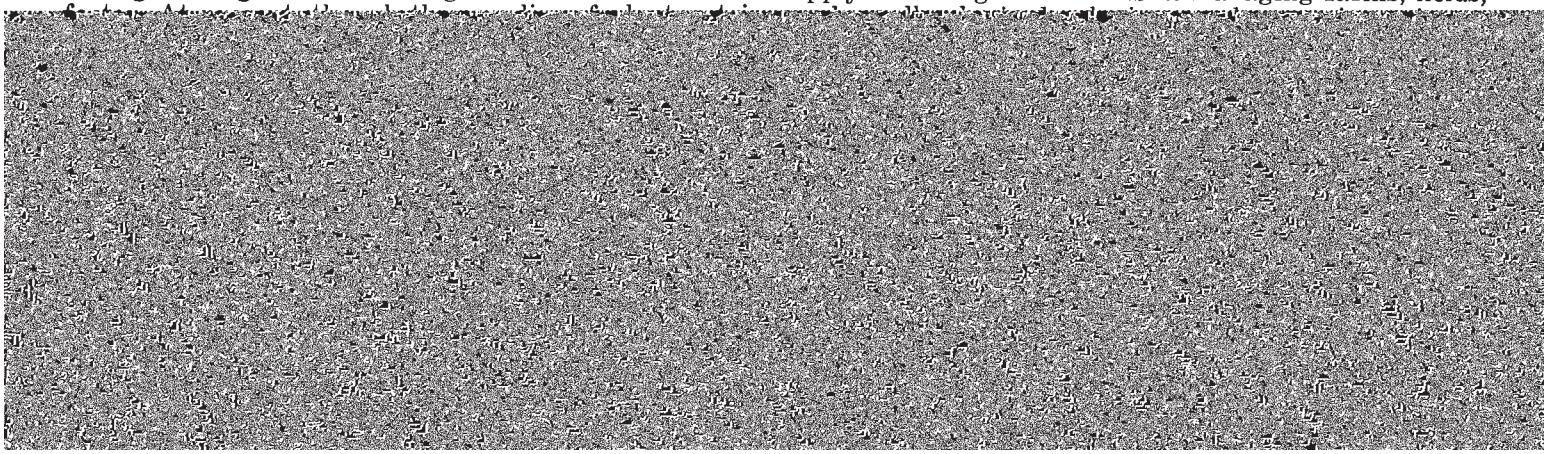
soils do not show the full effects of their environment. They have weakly expressed horizons.

Because Randall soils are clayey, time probably has had little influence on their development. Parent material and relief have been the dominant factors in their formation. The profile of those soils will probably not change much in the future unless some change takes place in the environment.

Irrigation probably has affected soil formation through changes that it brings about in the climatic

ables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields,



are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. In table 7, the soil series of Parmer County are placed in four categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER: Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Ent-i-sol).

The six orders to which the soils of Parmer County belong are Alfisols, Aridisols, Entisols, Inceptisols, Mollisols, and Vertisols.

Alfisols have a light-colored surface layer that is low in organic matter, a clay-enriched B horizon, an accumulation of aluminum and iron, and a base saturation of more than 35 percent.

Aridisols have a light-colored surface layer that is low in organic matter, and they have inadequate moisture to mature a crop without irrigation in most years.

Entisols have little or no evidence of development of pedogenic horizons.

Inceptisols have a light-colored surface layer that is low in organic matter, but they lack a clay-enriched B horizon.

Mollisols have a dark-colored surface layer that is high in organic matter, and they have a base saturation of more than 50 percent.

Vertisols are clayey soils that have deep, wide cracks during a part of each year in most years.

SUBORDER: Each order is divided into suborders that are based primarily on those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or the absence of waterlogging or soil differences that result from the climate or vegetation. The names of suborders have two syllables. The last syllable indicates the order. An example is *Aquent* (*Aqu,* meaning water or wet, and *ent,* from Entisol).

GREAT GROUP: Each suborder is separated into great groups on the basis of uniformity in the kinds and sequence of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated; those that have

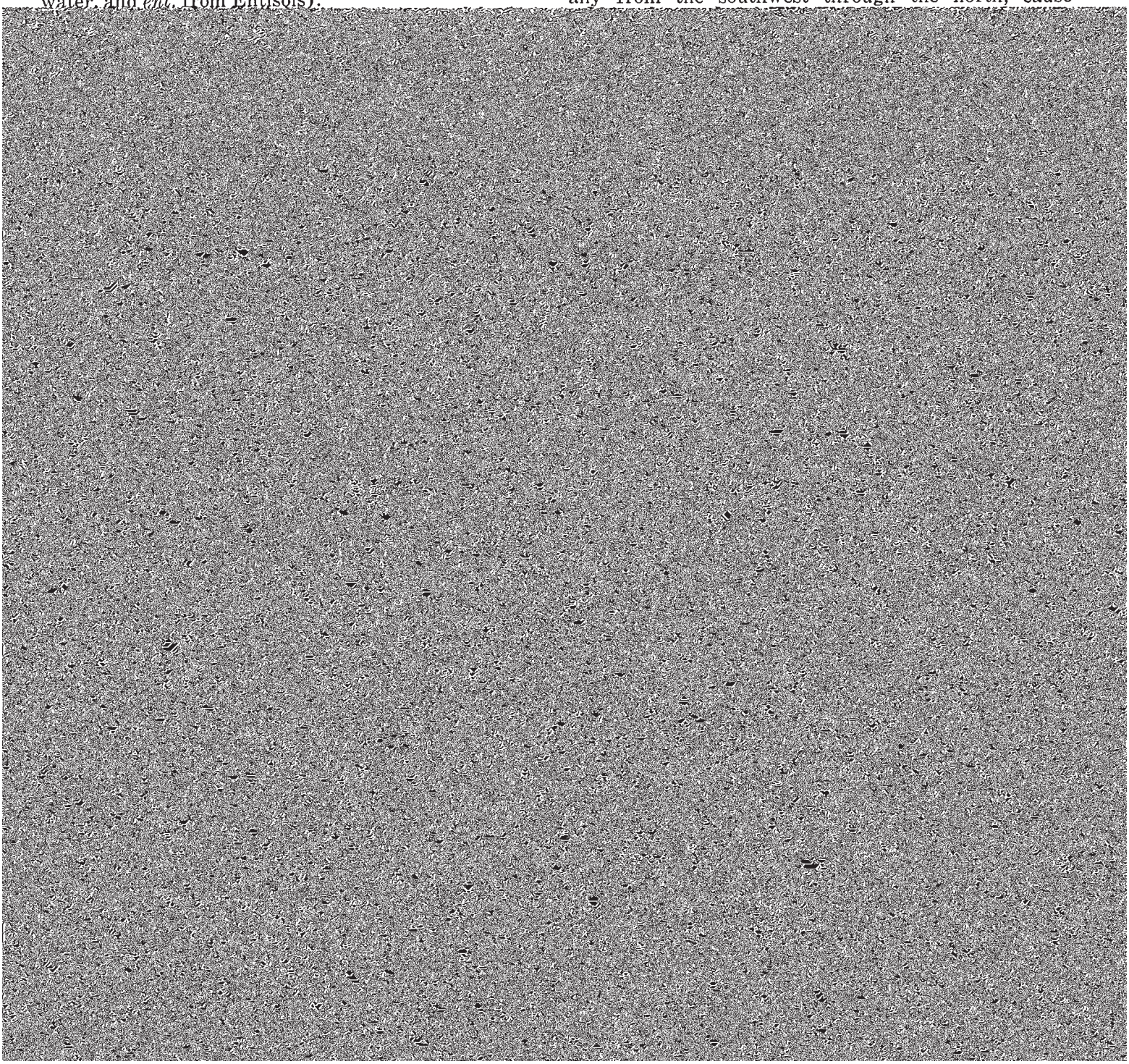
TABLE 7.—*Soil series classified according to the current system of classification*[1]

Series	Family	Subgroup	Order
Acuff	Fine-loamy, mixed, thermic	Aridic Paleustolls	Mollisols.
Amarillo	Fine-loamy, mixed, thermic	Aridic Paleustalfs	Alfisols.
Arvana	Fine-loamy, mixed, thermic	Petrocalcic Paleustalfs	Alfisols.
Berda	Fine-loamy, mixed, thermic	Aridic Ustochrepts	Inceptisols.

pans that interfere with growth of roots, movement of water, or both; and those that have thick, dark-colored surface horizons. The features used are the self-mulching properties of clay, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), dark-red and dark-brown colors associated with basic rocks, and the like. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquents (*Hapl,* meaning simple horizons, *aqu* for wetness or water, and *ent,* from Entisols).

rainfall totals decrease significantly during the cold season as frequent cold fronts accompanied by strong northerly winds cut off the supply of moisture from the Gulf of Mexico. The area is subjected to prolonged and severe periods of drought. The most notable of these were the periods from April 1933 through August 1936 and from August 1951 through February 1957, which lasted for 41 months and 67 months, respectively.

Prevailing winds are southerly to southwesterly throughout the year, but northerly winds are frequent in the colder months. Occasionally, strong winds, usually from the southwest through the north, cause



terial of Permian age in Parmer County was reworked in this way, and the resulting sediment is known as the Triassic red beds. The Santa Rosa Sandstone Formation is a part of the Triassic red beds. This formation is a source of some irrigation water that has harmful salts in it.

The uplift of the Rocky Mountains during the Pliocene Epoch was the next important geologic event. Swift streams, flowing from the mountains to the west, cut valleys and canyons through the red beds of Triassic age, and in some places, into the red beds of Permian age. When the mountains reached their maximum height, they began to erode more rapidly. At that time, the climate was extremely wet and rains carried coarse, gravelly material down the slopes and eastward out onto the plains. This material made up the first deposits

History and Settlement

The area that is now Parmer County was originally the hunting grounds of Comanches, Kiowas, Apaches, and other Indians who hunted bison, deer, and antelope. Prairie dog towns spread for miles over the short grassland.

Parmer County was created from the Bexar County Territory in 1876. The county remained under Jack, Oldham, and Wheeler County governments until it was organized in 1907. Parmer County was part of the 3,050,000-acre XIT ranch. It was one of the 10 counties that made up the Capitol Syndicate Land Grant, which built the present Texas State Capitol. The XIT now owns only mineral rights in Parmer County. The last of the land was sold about 1956.

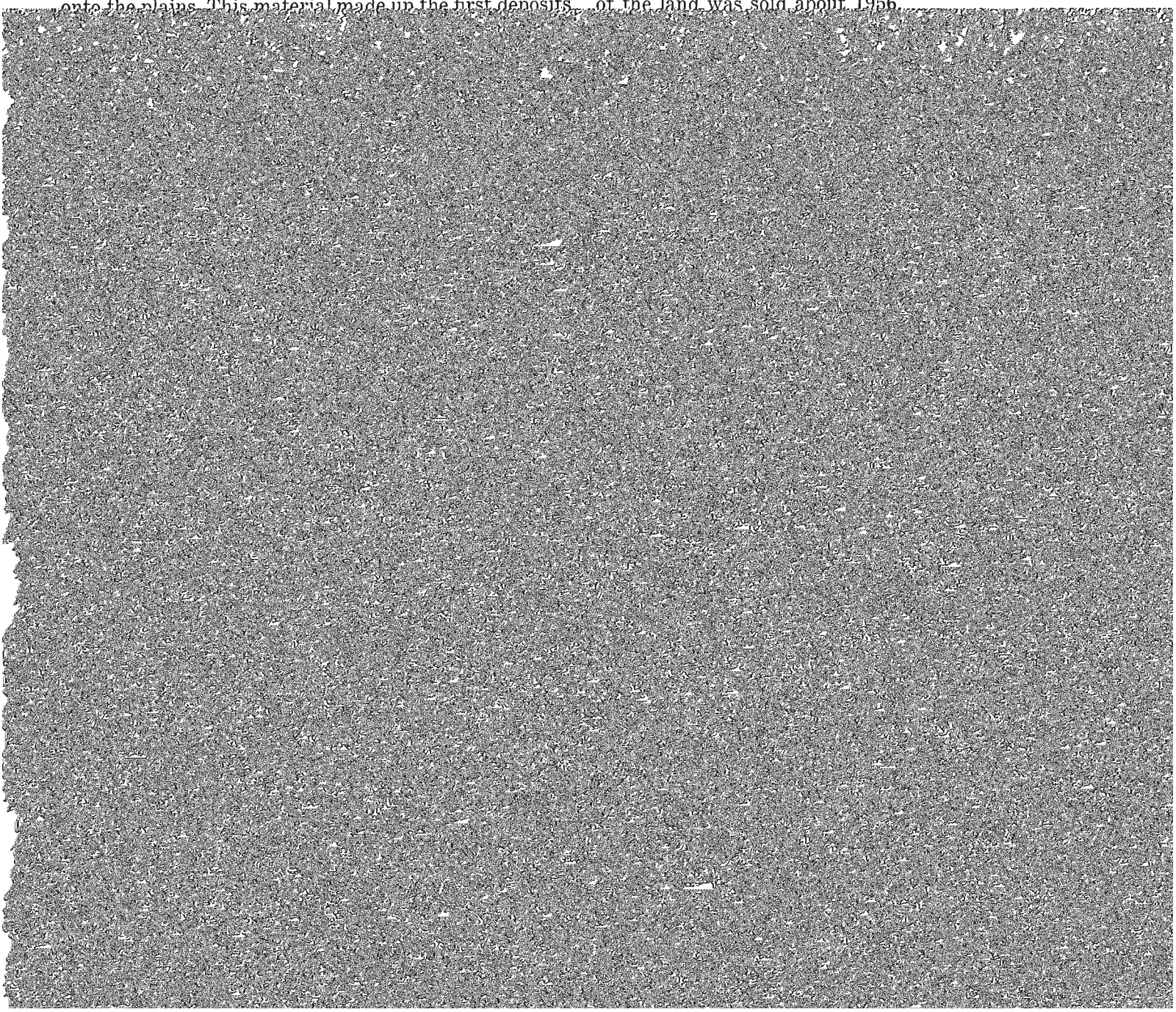


TABLE 8.—*Temperature*

[Data recorded at Friona;

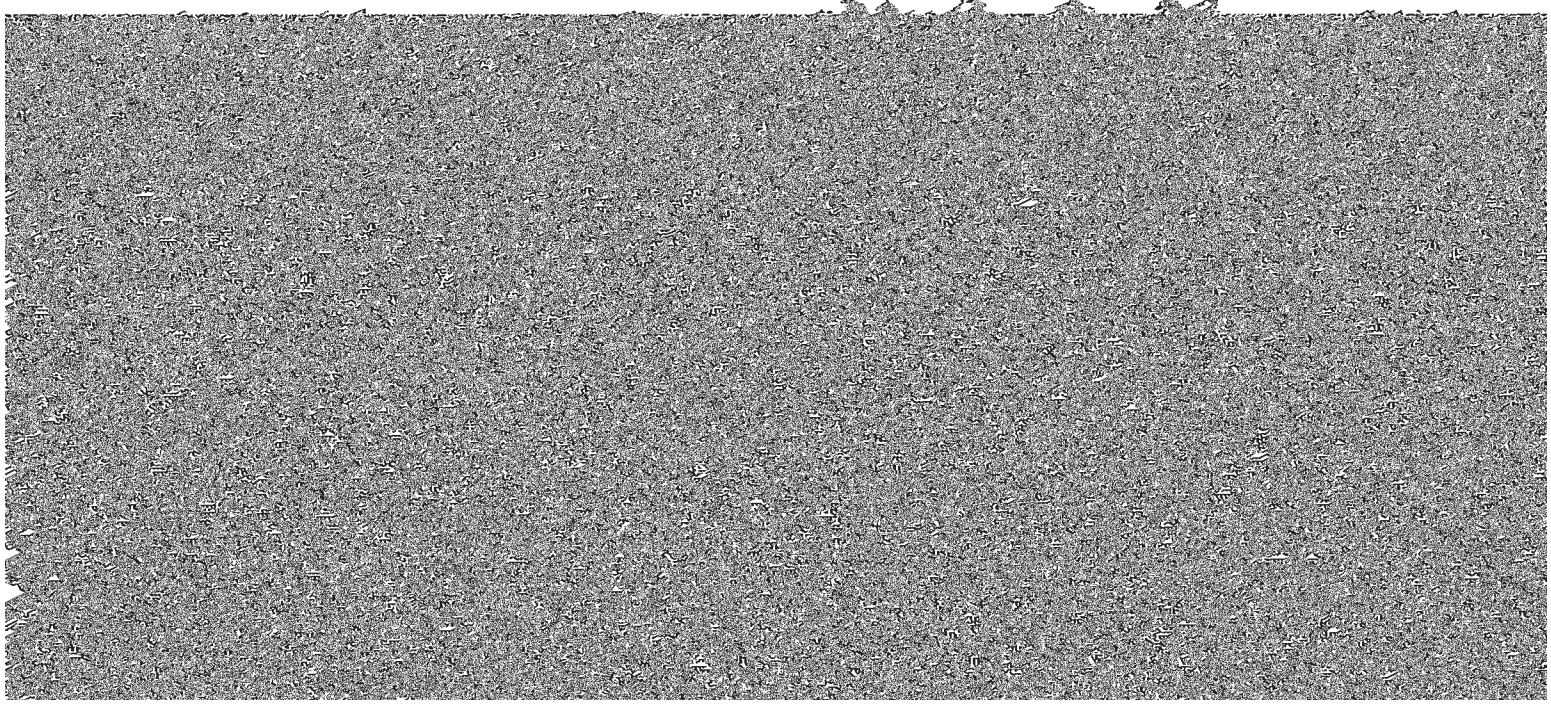
Month	Temperature [1]				Precipitation [2]		
	Average daily maximum	Average monthly maximum	Average daily minimum	Average monthly minimum	Average total	Probability of receiving—	
						0 or trace	0.50 inch or more
	°F	°F	°F	°F	In	Pct	Pct
January	52.5	71.9	21.2	1.0	0.61	3	43
February	53.1	71.9	24.1	9.5	.45	7	32
March	60.3	79.8	30.0	14.0	.56	10	42
April	72.5	86.5	41.4	29.4	1.10	(3)	64
May	80.3	94.5	50.3	36.1	2.80	(3)	92
June	86.3	99.0	58.7	47.9	2.38	1	90
July	91.8	99.1	64.5	57.6	2.55	(3)	90
August	88.6	98.1	61.9	55.8	2.20	(3)	90
September	81.7	93.8	54.7	42.4	1.85	3	79
October	73.4	89.0	42.0	30.4	1.85	4	70
November	62.1	78.8	32.5	19.3	.52	22	40
December	52.9	72.6	23.6	8.1	.63	10	40
Year	71.3	----------	42.1	----------	17.50	----------	----------

[1] For the period 1963–70.

[2] Estimated from long term records at surrounding stations.

Literature Cited

AC soil. A soil that has an A and a C horizon but no B horizon. Commonly such soils are immature, as those developing from



and precipitation

elevation 4,010 feet]

Precipitation [3]—Contd.									
Probability of receiving—Contd.						Average number of days with precipitation of—			Snow and sleet
1 inch or more	2 inches or more	3 inches or more	4 inches or more	5 inches or more	6 inches or more	0.10 inch or more	0.50 inch or more	1 inch or more	Average total
Pct	*Pct*	*Pct*	*Pct*	*Pct*	*Pct*				*Inches*
22	5	1	([3])	([3])	([3])	1	([4])	0	1.4
12	2	([3])	([3])	([3])	([3])	2	([4])	([4])	2.9
24	7	2	([3])	([3])	([3])	2	([4])	([4])	.1
40	16	6	2	([3])	([3])	2	1	([4])	.4
80	54	35	25	15	9	3	1	([4])	0
72	52	30	15	9	7	6	3	1	0
73	45	25	14	7	4	5	2	1	0
74	45	26	13	8	5	4	1	1	0
61	33	20	10	5	4	3	1	([4])	0
70	29	18	8	4	3	2	1	([4])	.1
17	4	([3])	([3])	([3])	([3])	2	([4])	([4])	.7
20	5	1	([3])	([3])	([3])	1	([4])	([4])	1.6
						33	10	3	7.2

[3] Less than 1 percent.

[4] Less than one-half day.

in the soil or of hard, thick beds just beneath the solum, or it may be exposed at the surface by erosion.

Cemented pan. Cemented pan too close to surface.

Chiseling. Tillage of soil with an implement having one or more soil penetrating points that loosen the subsoil and bring *clods* to the surface. A form of emergency tillage to control soil blowing.

Chlorosis. A yellowing between veins on upper foliage that results from chlorophyll deficiency. Many factors, including heredity, cause chlorosis.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand,

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

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeable layer in or immediately beneath the solum. They have uniform color in the A and upper B horizons and have mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

[illegible] and are light

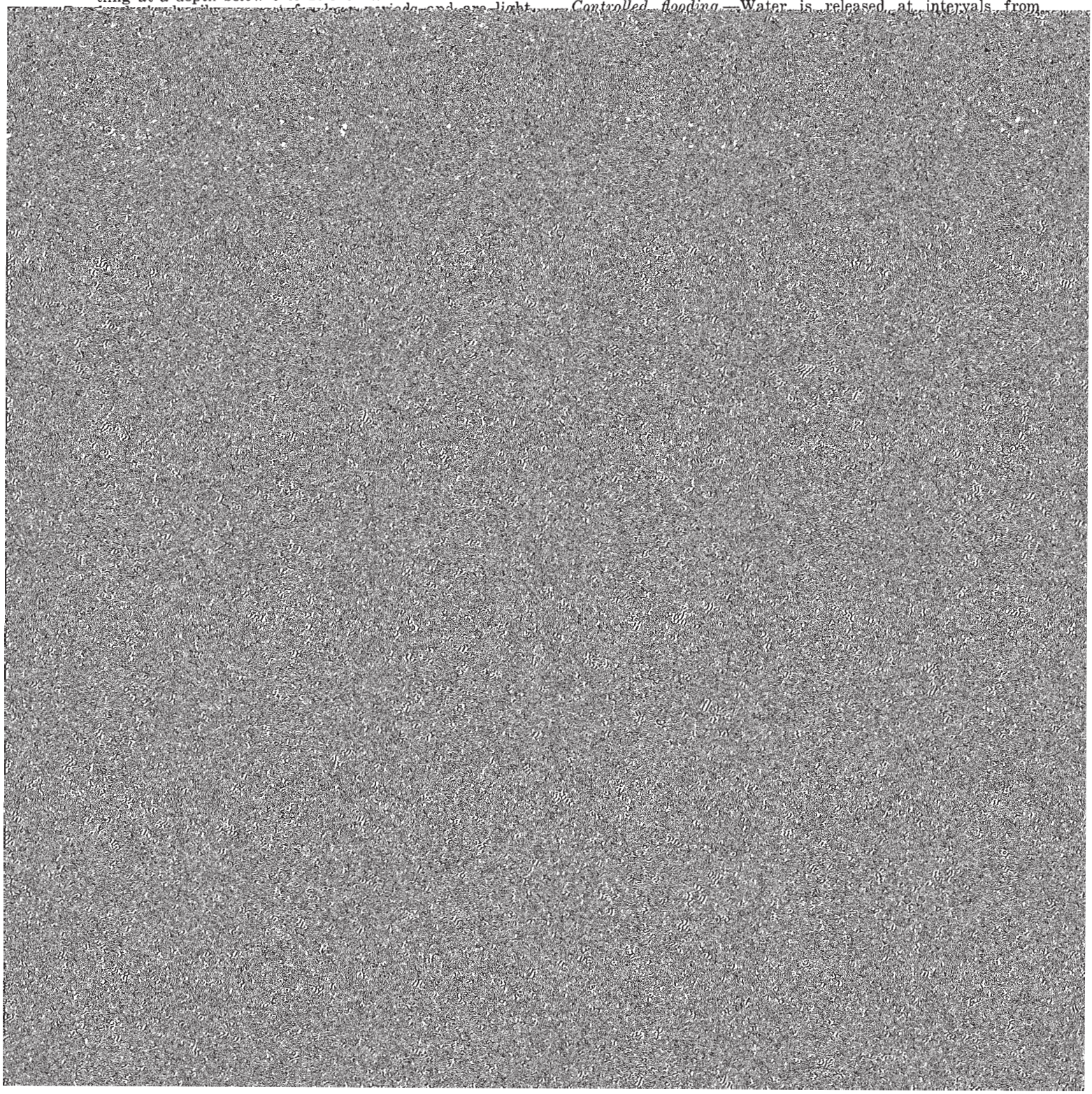
If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

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 relatively level plots surrounded by levees or dikes.

Controlled flooding.—Water is released at intervals from



pressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0

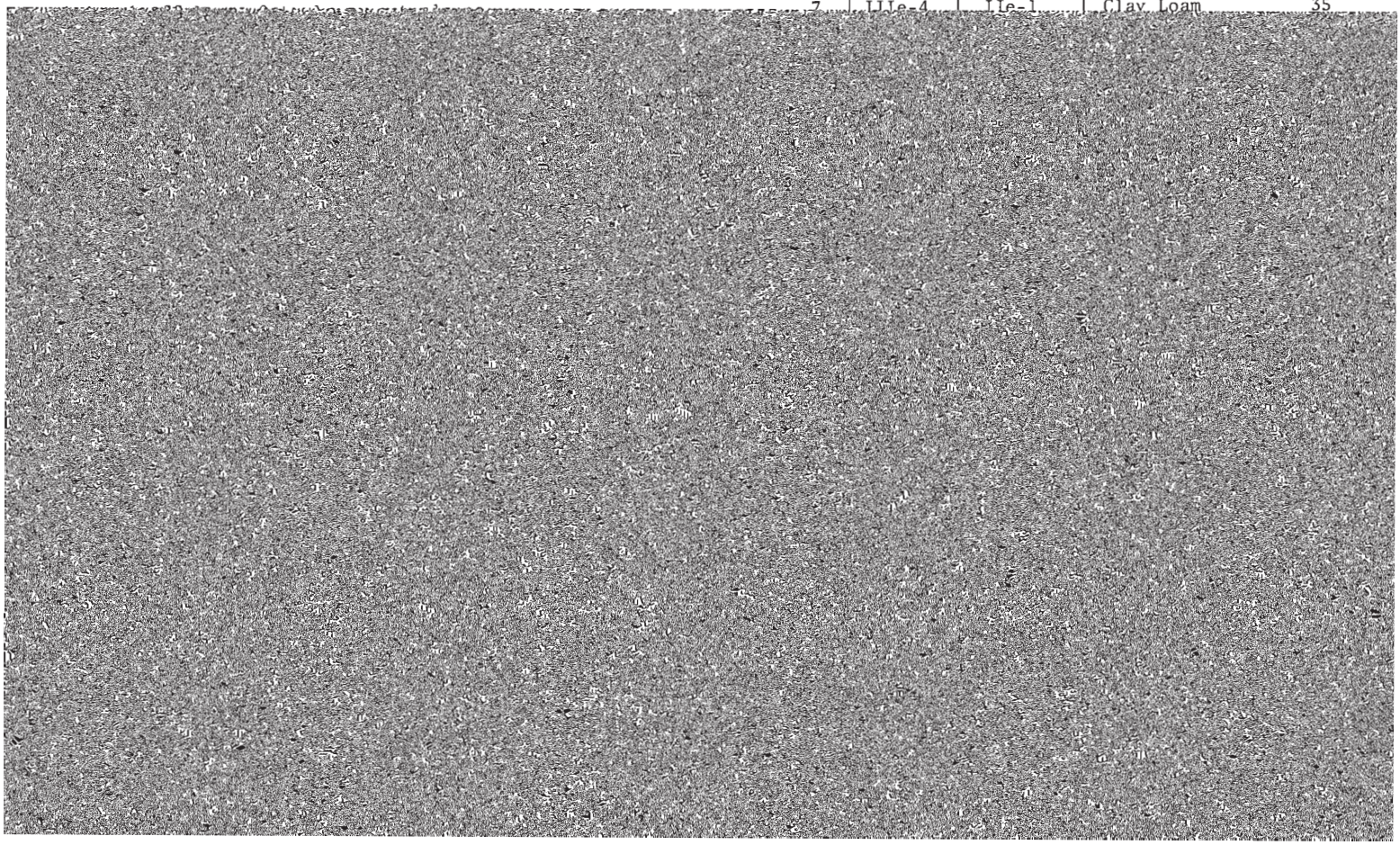
and other plant and animal life characteristic of the soil are largely confined to the solum.

Structure, soil. The arrangements of primary soil particles into compound particles or clusters that are separated from adjoining aggregates and have properties unlike those of an equal mass of unaggregated primary soil particles. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grain* (each grain by itself, as in dune sand) or

GUIDE TO MAPPING UNITS

For complete information about a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. In referring to a capability unit, a range site, wildlife rating, or recreational development, read the introduction to the section it is in for general information about its management. Dashes in a column mean that the mapping unit was not placed in that particular grouping.

Map symbol	Mapping unit	Page	Capability unit		Range site	
			Dryland	Irrigated		
			Symbol	Symbol	Name	Page
		7	IIIe-4	IIe-1	Clay Loam	35



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