SOIL SURVEY OF

Sumner County, Kansas

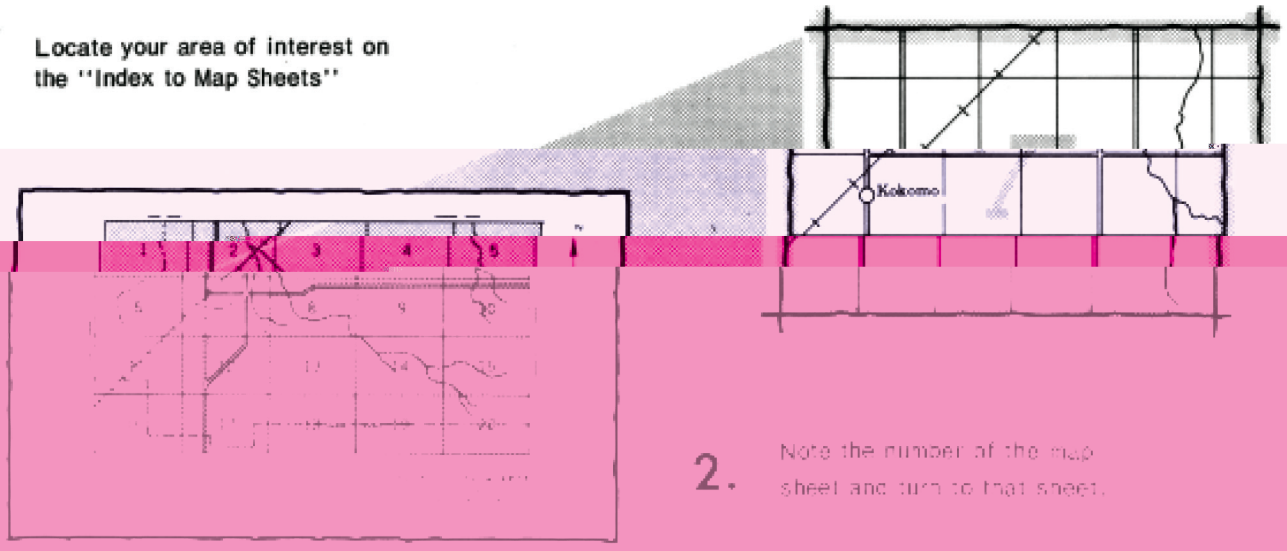
United States Department of Agriculture
Soil Conservation Service

In cooperation with

Kansas Agricultural Experiment Station

HOW TO USE

1. Locate your area of interest on the "Index to Map Sheets"



2. Note the number of the map sheet and turn to that sheet.

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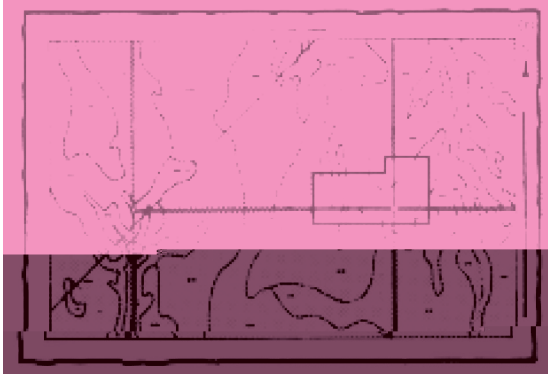
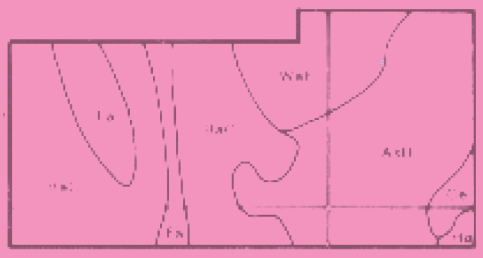
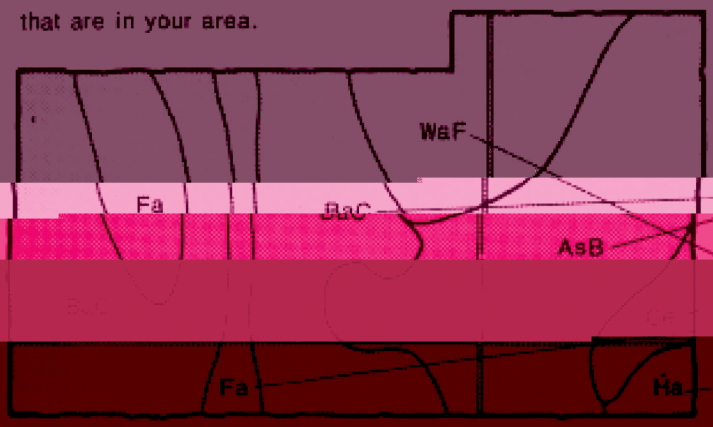




4. List the map unit symbols that are in your area.



Symbols

AsB
BaC
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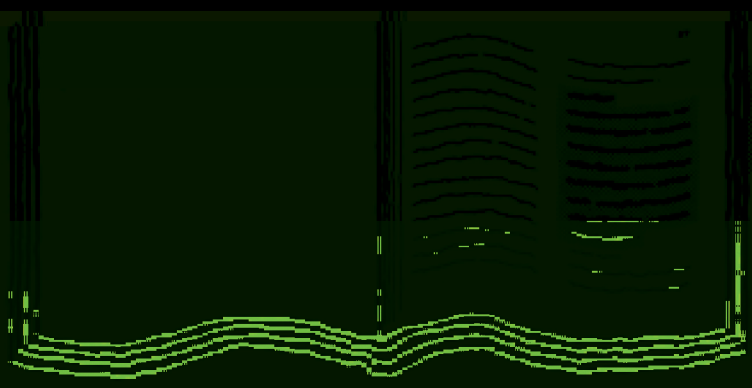
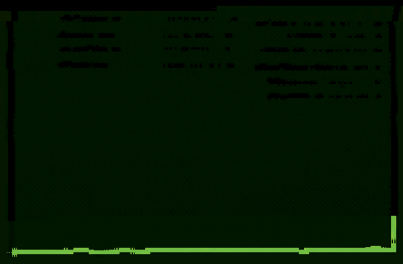
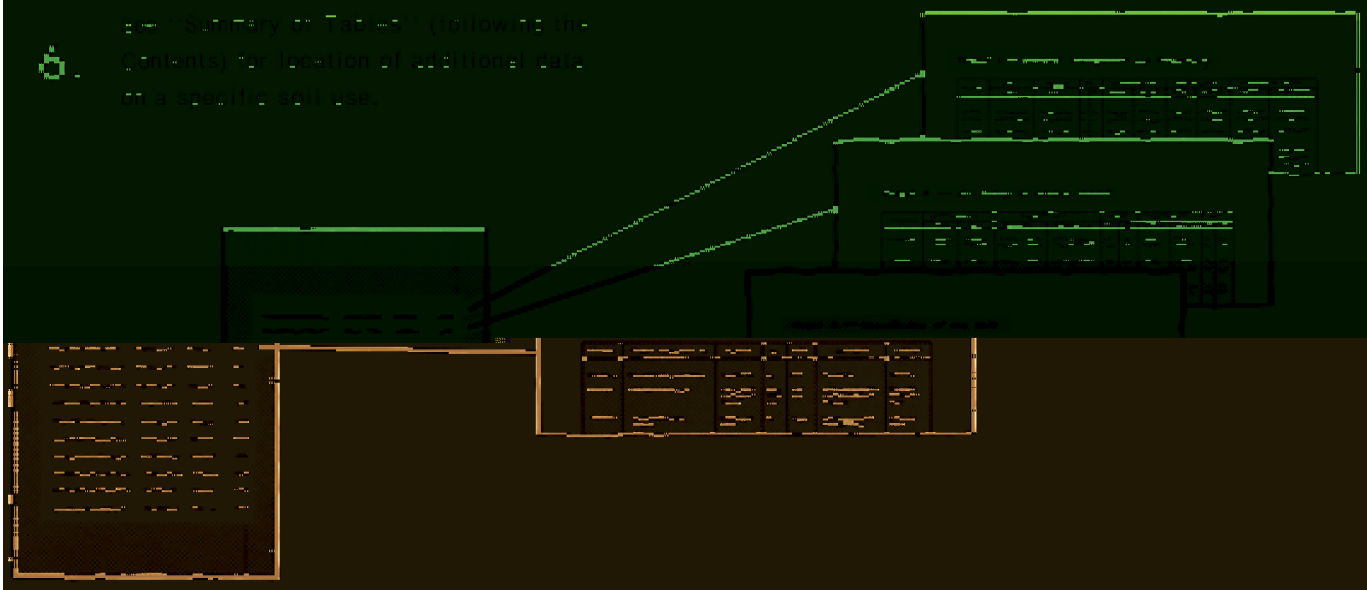
THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.





6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.

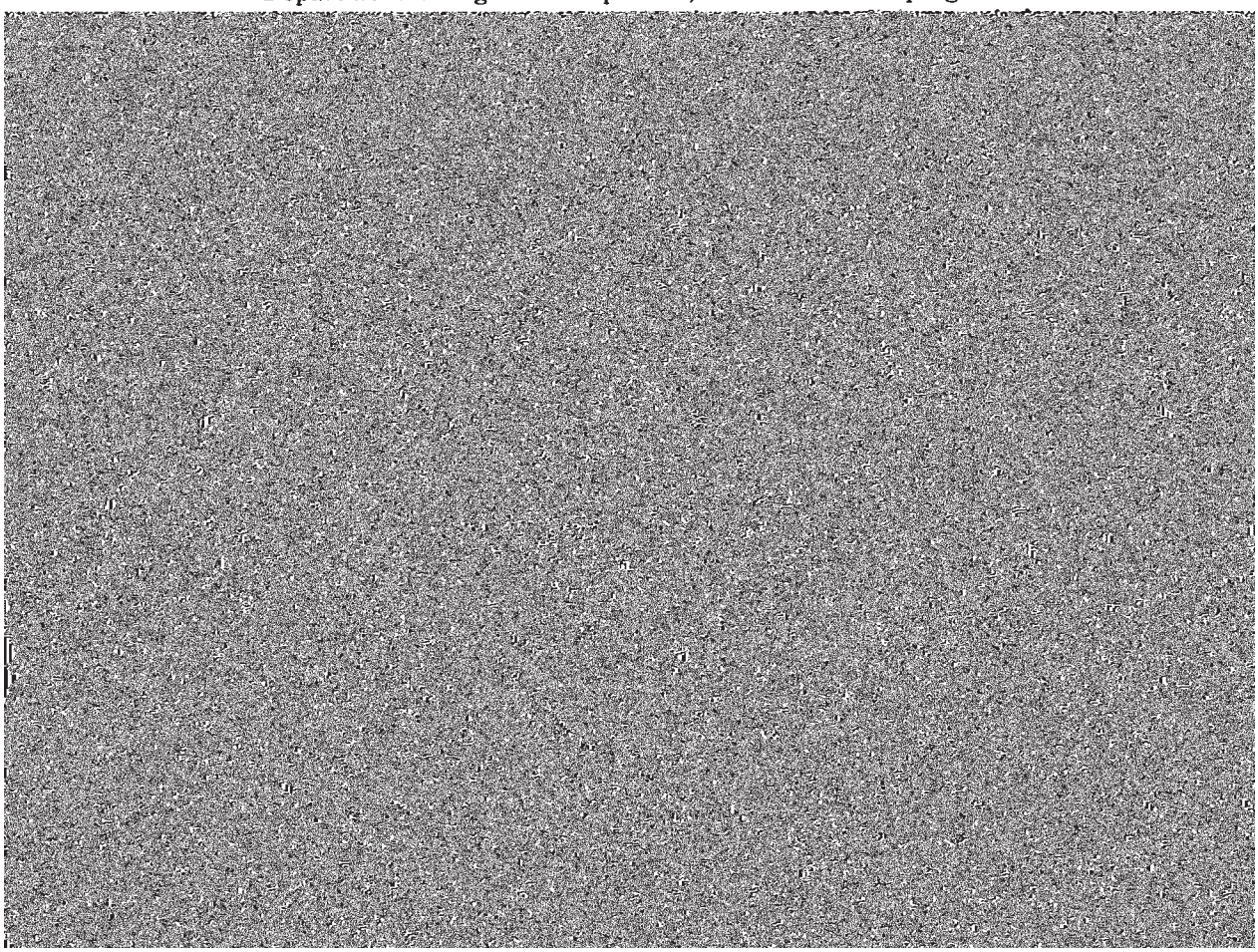


"Contents" for parts of the publication that will meet your specific needs.

Consult

?

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



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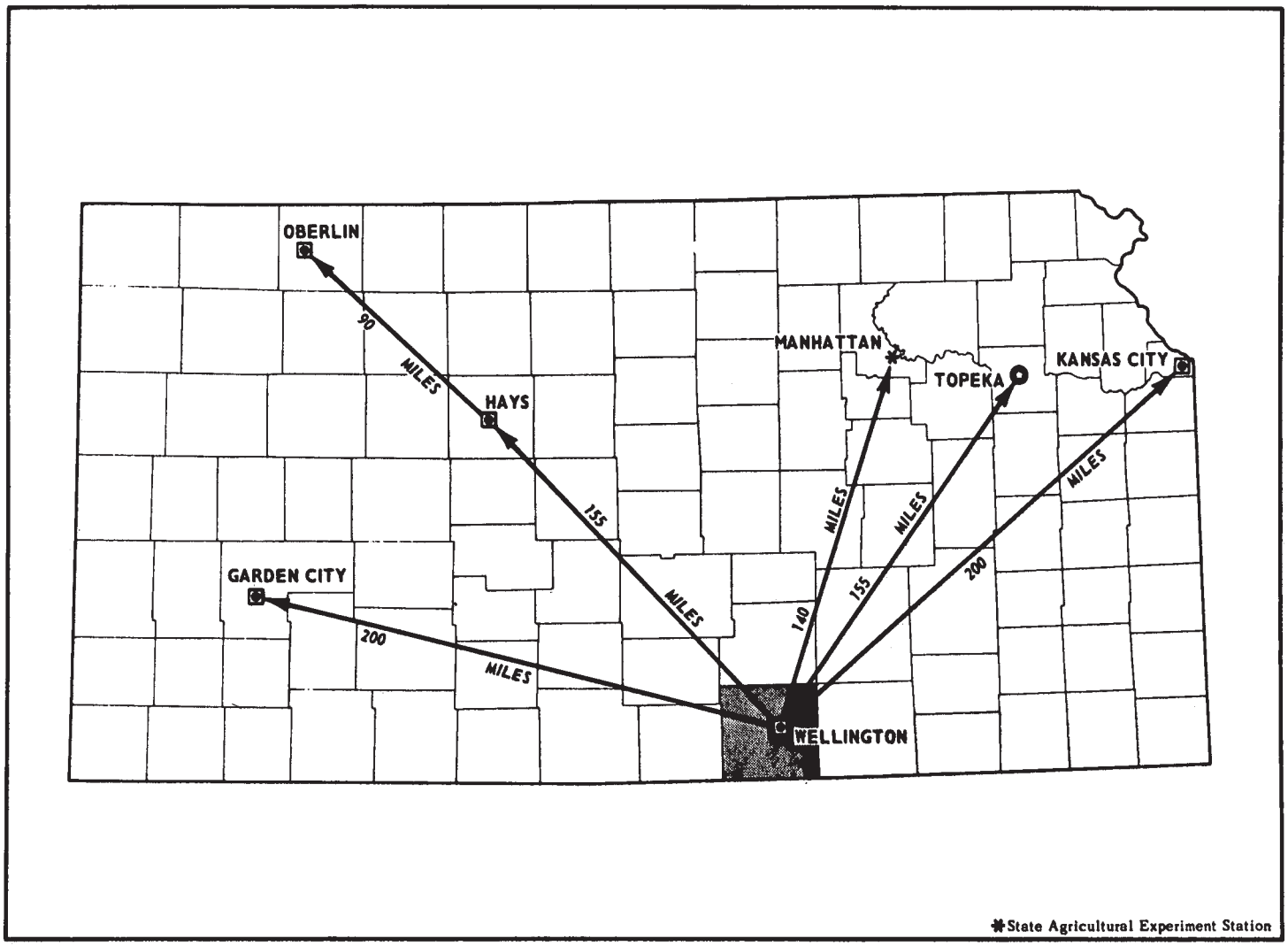
Foreword

The Soil Survey of Sumner County, Kansas, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome these limitations, and the impact that selected land uses will have on the environment.

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

Many people assume that soils are all more or less alike. They are unaware that great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for



Location of Sumner County in Kansas.

SOIL SURVEY OF SUMNER COUNTY, KANSAS

By Richard W. Fenwick and Ivan W. Ratcliff, Jr., Soil Conservation Service

Fieldwork by Ivan W. Ratcliff, Jr., Soil Conservation Service

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

SUMNER COUNTY is in the south-central part of Kansas. (See map on facing page.) It is 33 miles long and 36 miles wide. The total area is 759,168 acres, or 1,186 square miles. Wellington, the county seat, is near the center of the county.

Farm income in this county comes mainly from the sale of wheat, grain sorghum, alfalfa, and cattle. Farm income is frequently supplemented by work in the aircraft industry at Wichita. Most of the soils are used for dryland farming and range. The range consists mainly of sloping and strongly sloping soils and shallow or moderately deep soils.

General nature of the county

This section provides general information about the climate; physiography, relief, and drainage; and history and development of Sumner County.

Climate

By L. DEAN BARK, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas.

In Sumner County, winters are cold because of frequent incursions of cold, continental air from the polar regions of Canada. Summers are hot, with only occasional interruptions of cooler air from the north. Precipitation is heaviest late in spring and early in summer; most of it comes as late-evening or night-time thunderstorms. Snowfall during winter is usually light, and snow cover is not persistent. Annual precipitation is normally adequate for wheat, the major crop in Sumner County.

Table 1 gives data on temperature and precipitation for Sumner County, as recorded at Wellington for the period 1941 to 1970 (*4*). Table 2 shows probable dates of the first freeze in fall and the last freeze in spring (*3*). Table 3 provides data on length of the growing season.

In winter the average temperature is 36.6 degrees F and the average daily minimum temperature is 25.4 degrees F. The lowest temperature on record, -19 degrees F, occurred at Wellington on January 8, 1913. In summer the average temperature is 79.6 degrees F, and the average daily maximum is 91.9 degrees F. The highest temperature was 120 degrees F, recorded on July 18, 1936.

The annual precipitation is 33.95 inches. Of this, 24.39 inches, or 72 percent, usually falls during the period from April through September, which includes the growing season for most crops. Two years in 10, the April-September rainfall is less than 14.85 inches. The heaviest one-day rainfall during the period of record was 6.52 inches at Wellington on June 21, 1942.

Average annual snowfall is 13.8 inches. The greatest total occurred in the winter of 1948-49, when 38.5 inches of snow was measured. Several winters have passed with only a trace of snow.

An average of 65 percent of the possible sunshine is received annually in Sumner County. In summer and fall sunshine averages 70 to 80 percent of that possible. In January, it is only 50 percent.

The prevailing wind is from the south, but northerly winds are common in winter and early in spring. The normal annual windspeed for nearby Wichita is 12.7 miles per hour. Monthly average windspeed is greatest in March and April.

Duststorms occur occasionally in spring, when strong dry winds blow over unprotected soils. Tornadoes and severe thunderstorms, some with hail, occur occasionally. These storms are local and of short duration, and the pattern of damage is variable and spotty.

Physiography, relief, and drainage

Sumner County is in the Wellington Lowland and the Arkansas River Lowlands of the Central Lowland physiographic province (*5*). Most of the upland soils of the county are on nearly level to moderately sloping plains. The valleys are wide and nearly level except where sand dunes form.

Elevation ranges from 1,490 feet to 1,050 feet above sea level. The highest points in the county are west of

Conway Springs. The lowest points are near Geuda Springs and Drury along the Arkansas and Chikaskia Rivers.

Drainage in the county is generally to the east and south. The northeastern part of the county is drained by the Arkansas and Ninnescah Rivers and their tributaries. Slate Creek and its tributaries drain the northwestern, central, and east-central parts of the county. The Chikaskia River and its main tributaries, Bluff Creek and Fall Creek, drain the west-central and southwestern parts of the county. Shoo Fly Creek and Bitter Creek, which are tributaries of the Chikaskia River, drain the south-central and southeastern parts of the county.

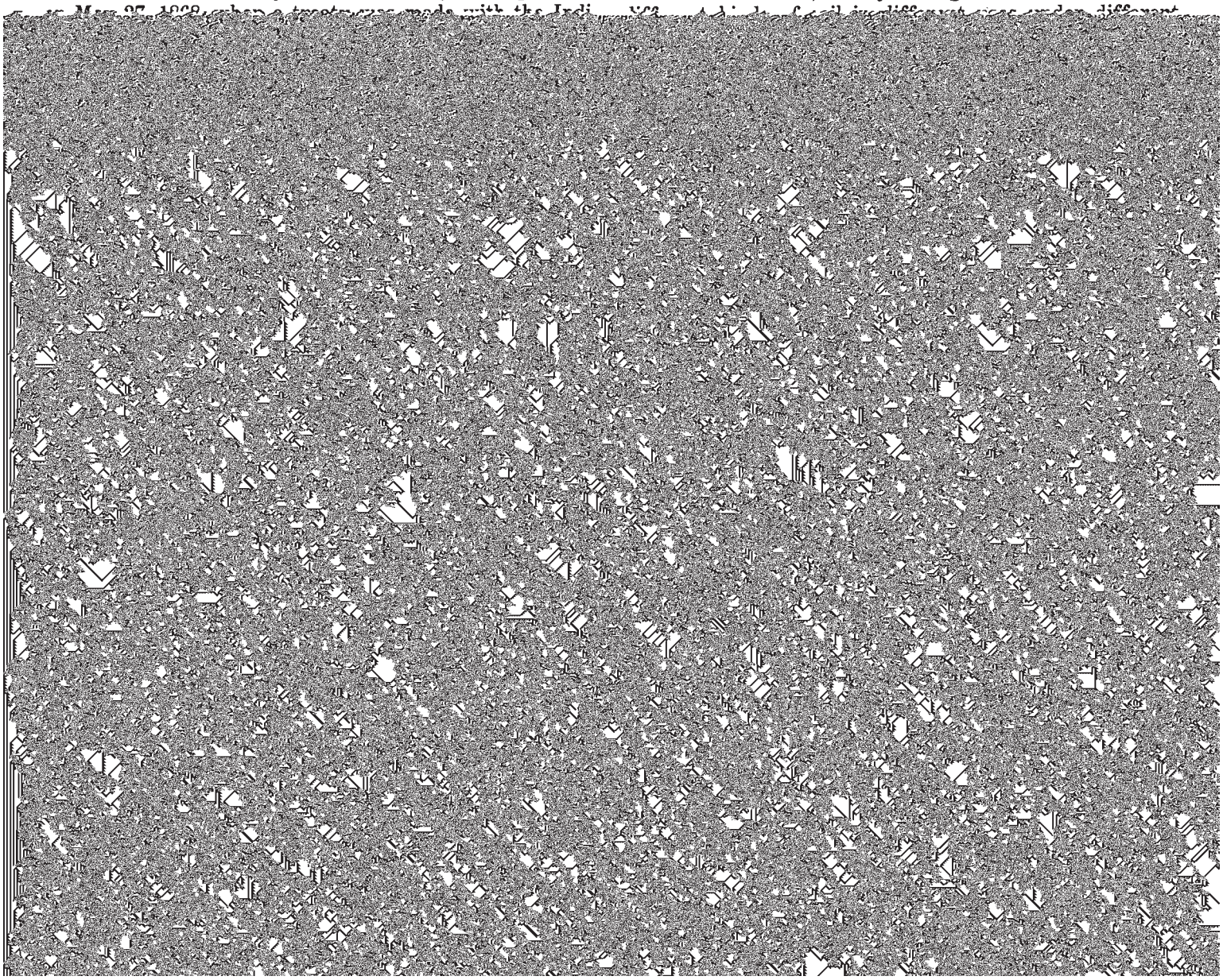
History and development

Sumner County is sloping to gently rolling prairie. The boundaries of the county were defined by the legislature [illegible]

show woodlands, buildings, field borders, roads, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

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

While a soil survey is in progress, samples of soils are taken as needed for laboratory measurements and for engineering tests. The soils are field tested, and interpretations of their behavior are modified as necessary during the course of the survey. New interpretations are added to meet local needs, mainly through field observations of [illegible]



kinds of soil in any one map unit differ from place to place in slope, depth, stoniness, drainage, or other characteristics that affect their management.

1. Bethany-Kirkland-Tabler association

Deep, nearly level and gently sloping, well drained and moderately well drained silt loams and silty clay loams on uplands

This association consists principally of nearly level and gently sloping soils on broad plains. In small areas the slopes are short and occur along intermittent

This association makes up about 7 percent of the county. Farnum soils make up about 31 percent of the association, Vanoss soils make up about 30 percent, and Bethany soils make up about 29 percent. Minor soils make up the remaining 10 percent.

Farnum soils are nearly level to sloping and are on side slopes and broad plains. The surface layer is dark grayish brown loam about 11 inches thick. The subsoil is dark brown, firm clay loam about 29 inches thick. The underlying material is brown sandy clay loam.

Vanoss soils are gently sloping and sloping and are typically on side slopes. In some places they are nearly level

brownish gray, very firm silty clay about 16 inches thick. The underlying material is light gray calcareous shale.

Rosehill soils are moderately deep and gently sloping and sloping. They are on the upper one-half to upper two-thirds of side slopes. Rosehill soils are mostly in the east-

Shellabarger soils are gently sloping and sloping. They are on narrow ridgetops and short side slopes. The surface layer is brown sandy loam about 11 inches thick. The subsoil is reddish brown, friable fine sandy loam and sandy clay loam about 27 inches thick. The underlying

Minor soils in this association are in the Brewer, Lesho, Lincoln, Elandco, Pratt, and Tivoli series. Brewer soils are on low terraces. Lesho, Lincoln, and Elandco soils are on flood plains next to the streams. The Pratt and Tivoli soils occupy sand hills adjacent to the major streams.

Most of this association is in small grains, sorghums, alfalfa, and soybeans. The soils are well suited to alfalfa, and more alfalfa is grown in this association than in any other in the county.

Most crops on soils of this association respond to fertilizer. Lime generally is not required for wheat, sorghum, or soybeans, but it is required in places for alfalfa. Good management is needed for maintaining fertility, tilth, and content of organic matter. The hazard of soil blowing is slight to moderate on the Canadian soils, and practices are needed to control soil blowing. Most soils of this association are occasionally flooded. Floods are usually short and do not cause severe erosion or major damage to growing crops.

6. Elandco-Brewer-Reinach association

Deep, nearly level, well drained and moderately well drained silt loams and silty clay loams on low terraces and flood plains

This association consists of nearly level soils along the major streams in the county.

This association makes up about 8 percent of the county. Elandco soils make up about 50 percent of the association, Brewer soils make up 20 percent, and Reinach soils make up 12 percent. Minor soils make up the remaining 18 percent.

Elandco soils are on flood plains and low terraces throughout the county. The surface layer is very dark grayish brown silty clay loam about 45 inches thick. The underlying material is brown silty clay loam.

Brewer soils are on low terraces and flood plains. These soils are mostly in the eastern half of the county along Slate and Shoo Fly Creeks. The surface layer is very

Most crops on soils of this association respond to fertilizer, good management, and proper tillage. The soils have medium to high fertility. Flooding is rare to frequent. Water erosion and damage to crops may occur during floods. Little can be done on an individual basis to prevent flooding. Major works of improvement, including levee construction and watershed protection by use of large or small water impoundment structures, would diminish the flooding hazard.

Soil maps for detailed planning

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

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

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

Soils that have a similar profile make up a *soil series*. Except for allowable differences in texture of the surface layer or of the underlying substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement in the profile. A soil series

and the pattern and proportion are somewhat similar in all areas. Brewer complex is an example.

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

Most areas of this soil are in wheat, sorghum, and alfalfa. The soil has good potential for crops, rangeland, pasture, and windbreaks.

This soil is well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic matter content. Effective practices for conserving moisture are keeping tillage to a minimum and properly using crop residues. There is little or no erosion hazard.

neutral or mildly alkaline in the upper part and mildly alkaline or moderately alkaline in the lower part. The surface layer is friable and is easily tilled through a fairly wide range in moisture content. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat, sorghum, and alfalfa. The soil has good potential for crops, rangeland, pasture, and windbreaks.

This soil is well suited to small grains, sorghum, and alfalfa. There is a moderate hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Proper use of fertilizer and crop residues helps to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has a high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; and providing drainage outlets and expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the slow permeability. This soil is suitable for bench leveling for flood irrigation if adequate water is available. Capability unit IIe-1; Loamy Upland range site.

Br—Brewer silty clay loam (0 to 2 percent slopes). This is a deep, nearly level, moderately well drained soil in broad areas on low terraces and flood plains. It is rarely flooded.

Typically, the surface layer is very dark gray silty clay loam about 14 inches thick; over most of the area it ranges from about 10 to 15 inches in thickness. The subsoil is very firm silty clay that extends to a depth of more than 60 inches; the upper part is very dark gray, the middle part is very dark grayish brown, and the lower part is dark grayish brown. In about 10 percent of the area the surface layer is silty clay or it is silty clay loam less than 10 inches thick.

Permeability is slow, and available water capacity is high. Runoff is slow, and fertility is medium. The surface layer is slightly acid or neutral. The subsoil is neutral or mildly alkaline in the upper part and neutral to moderately alkaline in the lower part. The surface layer has a moderate shrink-swell potential, and the subsoil has a high shrink-swell potential. The surface layer is friable, but tillage should be performed only under optimum moisture conditions.

Most areas of this soil are farmed. Wheat is the principal crop. Smaller acreages are used for soybeans, sorghum, and alfalfa. This soil has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks.

This soil is well suited to small grains, soybeans, sorghum, and alfalfa. It has a slight hazard of flooding, and crop damage is slight. The hazard of flooding and the slow permeability moderately limit the choice of crops and the time of tillage operations. Tilling when the soil is too wet or too dry causes the soil to be cloddy. Minimum tillage operations performed at optimum moisture conditions and proper use of crop residues help to maintain tilth, content of organic matter, and fertility.

This soil is well suited to rangeland. It receives extra moisture as runoff from nearby higher areas and from flooding. Grazing when the soil is too wet causes surface compaction and poor tilth. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to urban uses such as homes, buildings, and streets and as a source of roadfill because of the flooding hazard and the high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to prevent damage caused by the shrinking and swelling and by flooding. Some treatment methods are using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Areas should be protected from flooding. Sewage lagoons or central sewage systems can be used for waste disposal. Septic tank systems often fail because of the slow permeability. This soil is suitable for leveling for irrigation if adequate drainage is provided. Capability unit I-2; Loamy Lowland range site.

Bs—Brewer complex (0 to 2 percent slopes). This complex consists of deep, nearly level, moderately well drained soils on low terraces and flood plains. These soils are rarely flooded. This complex is 55 to 85 percent Brewer silty clay loam and 15 to 45 percent salt-affected

soils. Individual areas of this mapping unit are small, and they generally occur away from the stream.

Typically, the Brewer soil has a very dark gray silty clay loam surface layer about 14 inches thick; it ranges from 10 to 15 inches in thickness. The subsoil is very firm silty clay that extends to a depth of more than 60 inches; the upper part is very dark gray, the middle part is very dark grayish brown, and the lower part is dark grayish brown. White crystalline materials are in the subsoil in some places.

Typically, the salt-affected soils have a light-colored surface layer 2 to 5 inches thick that forms a crust when dry but puddles after heavy rain; the texture is silty clay loam or clay loam. The subsoil is silty clay that is massive or has weak, blocky structure. In most places the subsoil contains white crystalline salts. The amount and distribution of salts and alkali vary (fig. 5).

Permeability is slow, and available water capacity is high. Runoff is slow. Fertility is medium in the Brewer soil and low in the salt-affected soil. The surface layer has a moderate shrink-swell potential, and the subsoil has a high shink-swell potential.

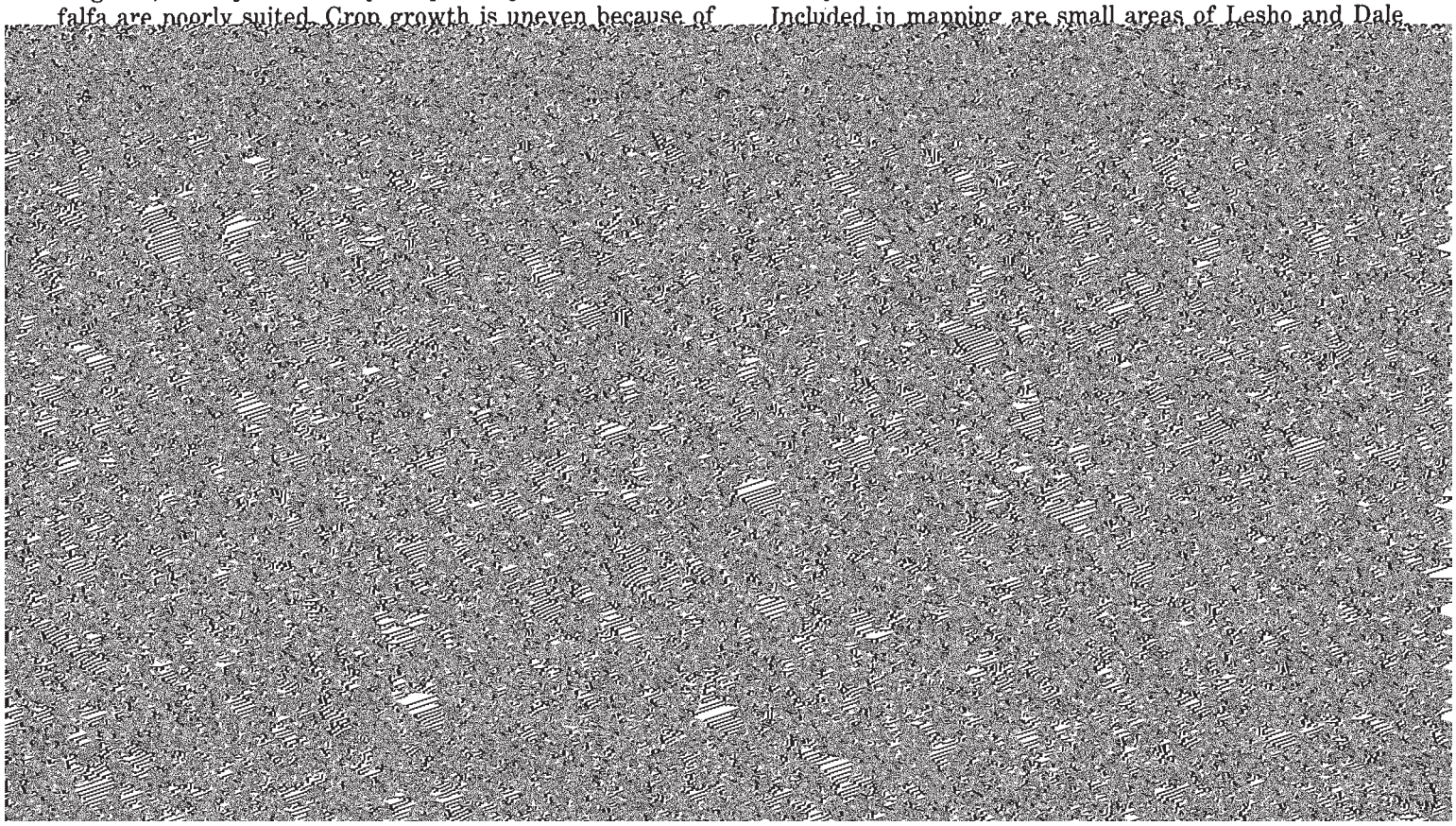
Most of this complex is cultivated. Some formerly cultivated areas are idle. This complex has only poor potential for crops, windbreaks, and most engineering uses. It has only fair potential for rangeland and pasture and good potential for open-land and rangeland wildlife habitat.

Moderately salt-tolerant crops such as barley, grain sorghum, and rye are the principal crops. Wheat and alfalfa are poorly suited. Crop growth is uneven because of potential in the subsoil. If engineering structures are built, they should be placed on the Brewer soil, and they should be designed to withstand the damaging effects of shrinking and swelling and flooding. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel; and providing drainage outlets and expansion joints. The areas should be protected from flooding. The salt-affected soils contain soluble salts in the subsoil that corrode metal. They are also poorly suited for lawns. Septic tank systems often fail because of the slow permeability, but sewage lagoons or a central sewage system can be used for waste disposal. Capability unit IVs-1; Brewer soil in Loamy Lowland range site, salt-affected soils in Saline Lowland range site.

Ca—Canadian sandy loam (0 to 1 percent slopes). This is a deep, nearly level, well drained soil on stream terraces. It is in long, narrow strips along streams, but it is high enough that it is rarely flooded, about once in 5 to 10 years.

Typically, the surface layer is grayish brown sandy loam about 10 inches thick. The subsoil is very friable sandy loam about 30 inches thick; the upper part is pale brown, and the lower part is light yellowish brown. The substratum is reddish yellow loamy fine sand. In some places the soil is redder. In some areas it is more sandy below the surface layer. In some places the surface layer is loamy fine sand 2 to 8 inches thick.

Included in mapping are small areas of Lesho and Dale



stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

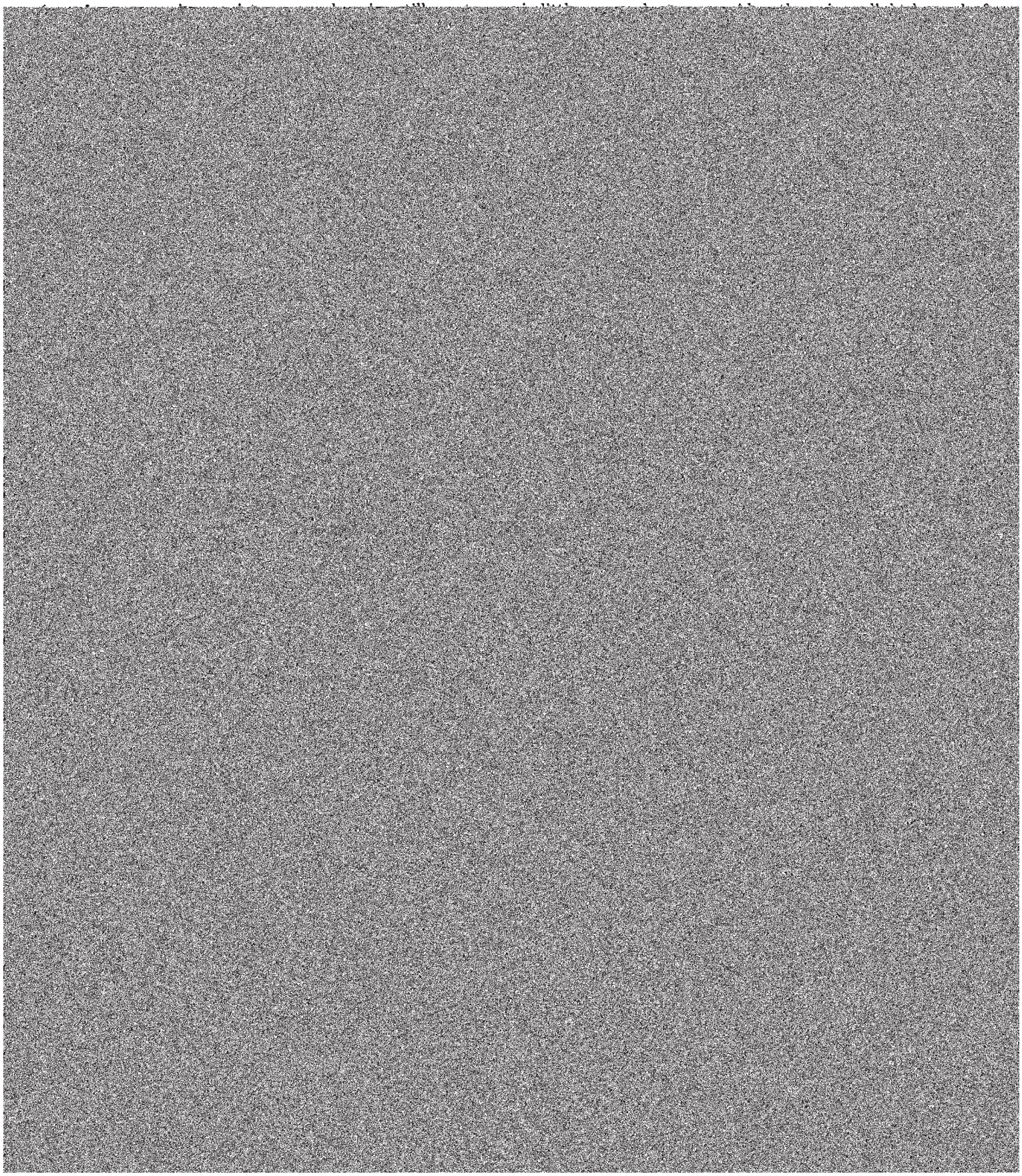
This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the hazard of flooding. It is a good source of topsoil. If this soil is to be used for building sites, the areas should be protected from flooding. It is suitable for leveling for

tion grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

These soils are moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. The main problem is excessive wetness. Survival in low areas where water ponds is likely to be poor. Draining these areas is helpful. Rainfall is likely to be irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

These soils are poorly suited to most urban uses, including building sites, because of the high shrink-swell potential in the subsoil and wetness. If engineering struc-



Most areas of this soil are in wheat, sorghum, soybeans, and alfalfa. This soil has good potential for crops, rangeland, rangeland wildlife habitat, pasture, and windbreaks. It has only fair potential for recreation and fair to poor potential for most engineering uses.

This soil is well suited to small grains, sorghum, soybeans, and alfalfa. The main concerns of management are maintaining fertility, tilth, and content of organic matter. Properly using crop residues and keeping tillage to a minimum help to accomplish these objectives, as well as to conserve moisture. There is little or no erosion hazard. Most areas are rarely flooded, and crop damage is slight.

This soil is well suited to rangeland. It receives extra moisture because of runoff from adjacent upland soils or because of flooding. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the hazard of flooding. If it is to be used for this purpose, the area should be protected from flooding. This soil is suitable for leveling for flood irrigation. Capability unit I-2; Loamy Lowland range site.

This soil is better suited to rangeland than it is to other uses. It receives extra moisture because of runoff from adjacent upland soils and flooding. Frequent flooding and the resulting scouring and deposition make it very difficult to farm. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Fences are hard to maintain because of the frequent flooding. Trees, brush, and weeds tend to invade rangeland on this soil. Proper stocking rates, deferred-rotation grazing, proper placement of salt and water, and control of undesirable vegetation help to keep the grass in good to excellent condition. Sites for ponds are plentiful in areas adjacent to upland soils.

This soil is well suited to windbreaks. Frequent flooding and the resulting scouring and deposition can damage young windbreaks. Older trees catch debris in the floodwaters. This soil receives extra moisture because of runoff from adjacent upland soils and flooding. Despite this, rainfall during part of the growing season is likely to be inadequate for maximum growth of trees, and irrigation helps to promote growth. Windbreaks need to be protected from livestock, fire, and rodents.

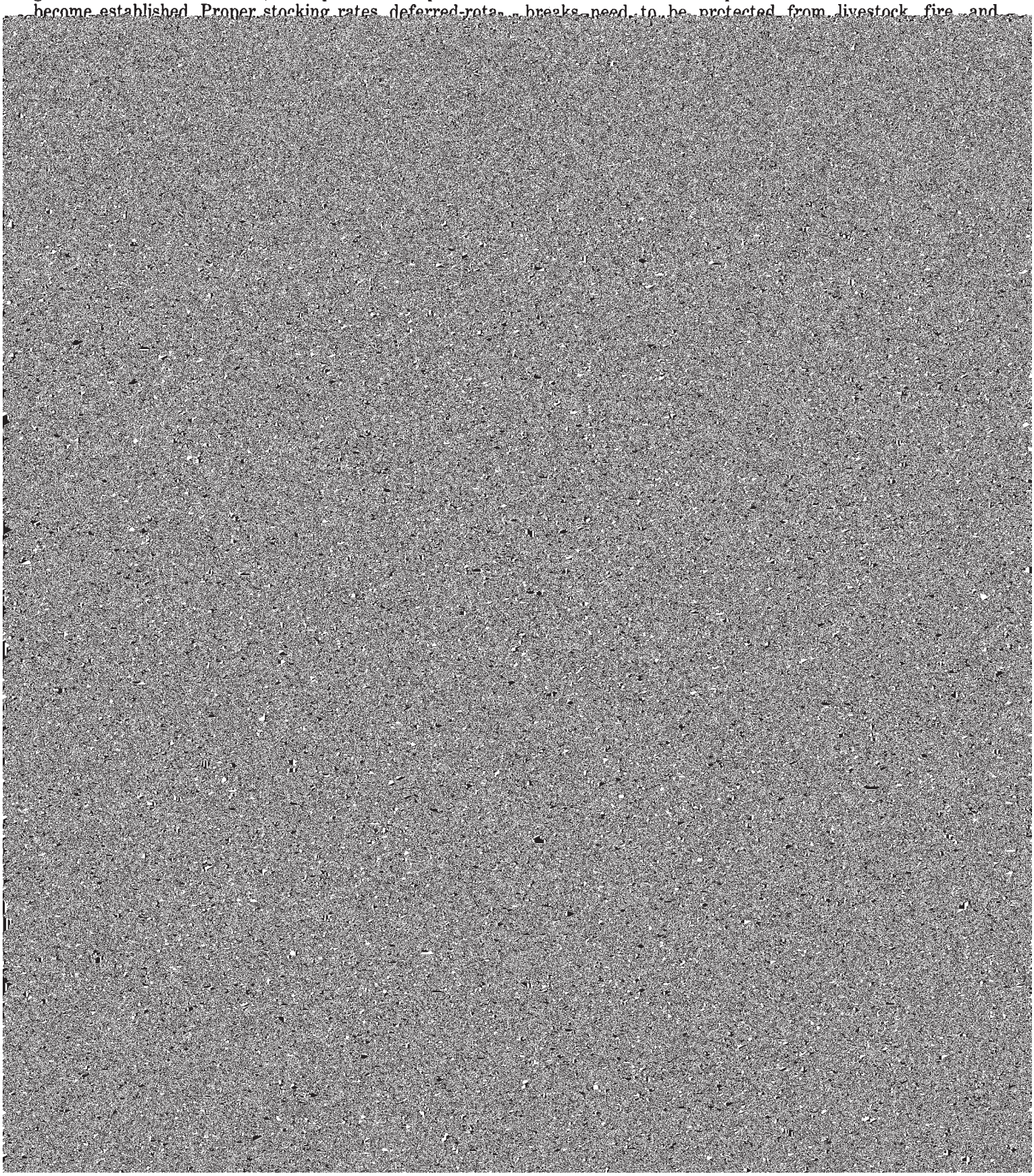
This soil is poorly suited to recreation and most urban uses because of the hazard of flooding. If it is used for these purposes the area should be protected from flooding. This soil is a good source of topsoil. Capability unit Vw-1; Loamy Lowland range site.

Fa—Farnum loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil on uplands. It occupies broad plains.

Typically, the surface layer is dark grayish brown loam about 11 inches thick; it ranges from 8 to 13 inches in thickness. The subsoil is brown to dark brown, firm clay

grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rota-

trol weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and



ble care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigating the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building site development because of the moderate shrink-swell potential in the subsoil. Buildings should be designed to withstand the effects of shrinking and swelling. This soil is a good source of topsoil. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is not well suited to sewage lagoons because of the slope. The slope can be modified according to design, or a central sewage system can be used. Capability unit IIIe-1; Loamy Upland range site.

Fd *Farrum loam, 2 to 6 percent slopes, eroded.* This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces the ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks; however, there is a very severe hazard of water erosion while the windbreaks are being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be pro-

fertility, tilth, and organic matter content. Crops grown on this soil are sometimes damaged by too much moisture during periods of excessive rainfall. Surface drainage is needed in places, and good management of crop residue is needed to keep the surface layer porous and to help prevent crusting. There is little or no erosion hazard.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive grasses to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. Water collects in some low areas during periods of excessive rainfall, and in places trees are damaged in these areas. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees during dry weather promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the high shrink-swell potential of the subsoil. If engineering structures are built on this soil, they should be designed to withstand the effects of shrinking and swelling. Some ways to do this are using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the very slow permeability. Capability unit IIs-1; Clay Upland range site.

Kb—Kirkland silt loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil on uplands on broad side slopes.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick; in most places it ranges from 8 to 14 inches in thickness. The subsoil is very firm clay to a depth of more than 60 inches; the upper part is dark grayish brown, and the next part is brown to dark brown and has a few small calcareous concretions. Below a depth of about 48 inches the subsoil is reddish brown and has a few small calcareous concretions. In some places the surface layer is 14 to 19 inches thick, and in a few places the surface layer is 4 to 7 inches thick.

and fair potential for windbreaks. It has good potential for open-land and rangeland wildlife habitat. It has good to poor potential for recreation and engineering uses.

This soil is moderately well suited to small grains, sorghum, and alfalfa. The clayey subsoil releases moisture slowly. There is a severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Good management of crop residue is needed to keep the surface layer porous and to help prevent crusting.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. There is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the high shrink-swell potential of the subsoil. Engineering structures built on this soil should be designed to withstand the effects of shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete slab driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. Capability unit IIIe-2; Clay Upland range site.

Kc—Kirkland silty clay loam, 1 to 3 percent slopes, eroded. This is a deep, gently sloping, well drained soil on uplands in narrow areas along intermittent drainageways.

Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick; in most places it ranges from 4 to 7 inches in thickness. The original sur-

Permeability is very slow, and available water capacity is moderate. Runoff and fertility are medium. Reaction of the surface layer ranges from medium acid to neutral. The subsoil ranges from neutral to moderately alkaline. The surface layer is friable, but tillage is limited to a narrow range of moisture conditions. The subsoil has a high shrink-swell potential.

Most areas of this soil are in wheat and sorghum. The soil has good potential for rangeland and pasture but only fair potential for crops and windbreaks. It has good potential for open-land and rangeland wildlife habitat. Potential for recreation and engineering uses is fair to poor.

This soil is moderately well suited to small grains and alfalfa and poorly suited to sorghum. The clayey subsoil releases moisture slowly. There is a very severe hazard of water erosion if the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Returning all crop residue to the soil and adding manure help to improve tilth and organic matter content. Including a legume in the rotation is beneficial.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Overgrazing also reduces the ground cover, increasing runoff and erosion. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition and protect the soil.

This soil is moderately well suited to windbreaks. The clayey subsoil releases moisture slowly. There is a very severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. During part of the growing season rainfall is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully so as not to cause water erosion. Cultivation to control weeds must be done carefully so as not to increase erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is poorly suited to building sites because of the high shrink-swell potential in the subsoil. If engineering structures are built on this soil, they should be designed to withstand the effects of shrinking and swelling. Some ways to do this are using adequate reinforcing steel in concrete foundations and backfilling with

Typically, the surface layer is dark grayish brown clay loam about 17 inches thick; the lower part has fine, distinct, brown to dark brown mottles and is calcareous. The next layer is pale brown clay loam about 13 inches thick. It is calcareous and has common, coarse, distinct, brownish yellow mottles. The underlying material is calcareous light yellowish brown loamy fine sand and fine sand. In some areas the soil is well drained and is sandy loam, silt loam, or silty clay loam throughout.

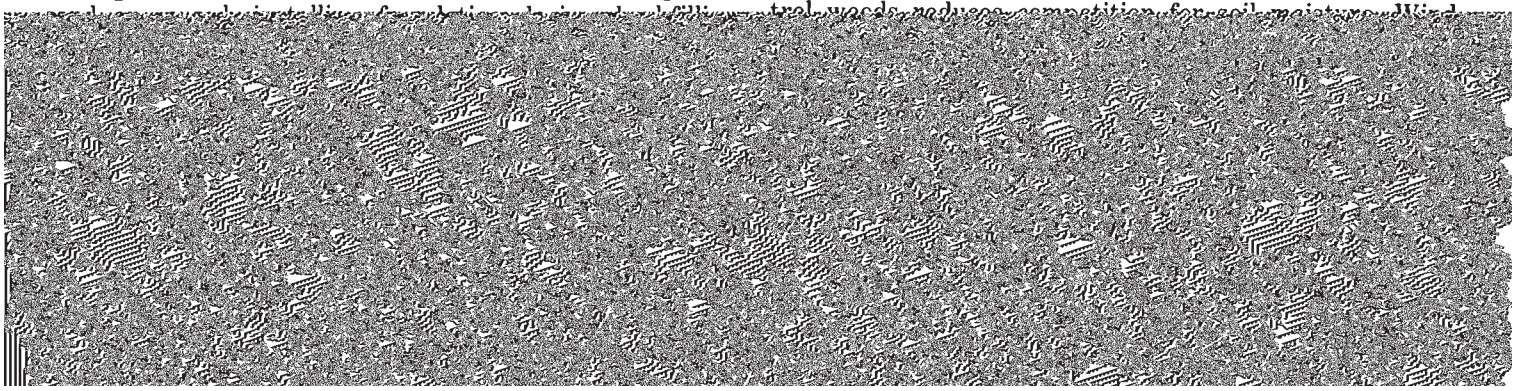
Permeability is moderately slow, and available water capacity is moderate to high. Runoff is slow, and fertility is medium. The surface layer is mildly alkaline or moderately alkaline, and the rest of the soil ranges from mildly alkaline to strongly alkaline. The surface layer is friable and is fairly easily tilled through a fairly wide range in moisture content. The surface layer has moderate shrink-swell potential, and the substratum has low shrink-swell potential. The water table fluctuates between depths of about 2 and 6 feet.

Most areas of this soil are in wheat, sorghum, and soybeans. The soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for woodland and wetland wildlife habitat but only fair potential for open-land wildlife habitat. It has poor potential for recreation and for most engineering uses.

This soil is moderately well suited to small grains, sorghum, soybeans, and alfalfa. Wetness, both from the occasional flooding and from the water table, is a severe limitation. Alfalfa, particularly, grows poorly because of the excess wetness. Little can be done on an individual basis to control wetness. Major works of improvement, such as levees, dams, and a network of drainage ditches would help to control flooding and lower the water table. Proper use of crop residues and a minimum of tillage help to maintain fertility and tilth.

This soil is well suited to rangeland. The water table is within reach of grass roots. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to con-



excesively drained soils on flood plains. These soils are frequently flooded. They are principally along the Arkansas River in strips a few hundred feet wide.

Typically, the surface layer is brown loamy fine sand about 10 inches thick; it ranges from 8 to 15 inches in thickness, and it is mainly loamy fine sand but contains some fine sand, loam, or clay loam strata, usually less than 5 inches thick. The substratum is reddish yellow fine sand that is calcareous and contains strata, 1/2 inch to 5 inches thick, that are darker colored and have finer texture. In some places the profile is noncalcareous above a depth of 40 inches. In some areas the profile is fine sand throughout and is noncalcareous.

Permeability is rapid, and available water capacity is low. Runoff is slow, and fertility is low. The soil is mildly alkaline or moderately alkaline. It has a low shrink-swell potential.

These soils are mostly idle, but they are used for rangeland in some places. The soils have poor potential for crops and windbreaks and only fair potential for rangeland and pasture. They have poor potential for wildlife habitat, recreation, and engineering uses.

Low fertility, low available water capacity, the hazard of soil blowing, and frequent flooding make these soils very difficult to farm.

These soils are better suited to rangeland than to other uses. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Fences are hard to maintain because of the frequent floods. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition. Trees and brush have a tendency to invade rangeland.

These soils are poorly suited to recreation and urban uses because of the hazard of flooding. If the soils are used for building sites, areas should be protected from flooding. These soils are a fair source of sand. Capability unit Vw-1; Sandy Lowland range site.

Ma—Milan loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil on uplands. It is mainly on ridges in relatively narrow strips but a few areas are wide range of moisture content. The subsoil has moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for crops, rangeland, pasture, and windbreaks. It has good potential for open-land wildlife habitat but only fair potential for rangeland wildlife habitat. Potential for recreation and for most engineering uses is good to fair.

This soil is well suited to small grains, sorghum, and alfalfa. The main concerns of management are maintaining fertility, tilth, and organic matter content. Effective practices for conserving moisture are keeping tillage to a minimum and properly using crop residues. There is little or no erosion hazard.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites because of the moderate shrink-swell potential in the subsoil. Buildings should be designed to withstand the effects of shrinking and swelling. This soil is a fair source of topsoil. Sewage lagoons or a central sewage system can be used for waste disposal. Septic tank systems are subject to failure because of the moderately slow permeability. This soil is suitable for leveling for irrigation if adequate water is available. Capability unit I-1; Loamy Upland range site.

Mb—Milan loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil on uplands. It occupies broad side slopes.

Typically, the surface layer is dark grayish brown loam

Most areas of this soil are in wheat and sorghum. This has good potential for open-land wildlife habitat but only

acid. The subsoil ranges from medium acid to neutral. The surface layer is friable and fairly easily tilled through a fairly wide range in moisture content. The subsoil has a moderate shrink-swell potential.

Most areas of this soil are in wheat and sorghum. This soil has good potential for rangeland and pasture but only

of these included soils are generally 2 acres or less in size. The Kirkland and Renfrow soils are 40 or more inches deep over shale. The Rosehill soils are 20 to 40 inches deep over shale.

Permeability is very slow, and runoff is rapid. Available water capacity is very low. Tilth is poor, and the surface

gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of 20 inches. In places this soil is reddish brown throughout.

Included with this soil in mapping are small intermingled areas of Renfrow and Rosehill soils. The Renfrow soils are more than 40 inches deep over bedrock. Rosehill soils are 20 to 40 inches deep over bedrock. Also included in this mapping unit are small areas, generally an acre or less in size, of shale outcrops, and small areas of soils that are less than 10 inches deep over bedrock. Included areas make up about 35 percent of this mapping unit.

This soil has very slow permeability. Runoff is rapid. Available water capacity is very low. This soil has a high shrink-swell potential. Depth to shale bedrock ranges from 10 to 20 inches. Natural fertility is low. The surface layer is mildly alkaline, and the underlying material is moderately alkaline.

Most areas of this soil are used for rangeland. This soil has poor potential for cultivated crops and for most urban and engineering uses.

This unit is better suited to rangeland than to other

ley floors. Areas of the soils are so intricately mixed, or so small in size, that it is not practical to separate them in mapping.

Typically, the Owens soils have a dark grayish brown clay loam surface layer about 4 inches thick. The subsoil is light brownish gray, very firm silty clay. Bedrock of mixed clayey shale and limestone is at a depth of about 20 inches. In many places these soils are reddish brown throughout.

Typically, the Elandco soils have a very dark grayish brown silty clay loam surface layer about 45 inches thick. The underlying material is brown silty clay loam.

Included with these soils in mapping and making up about 5 percent of the unit are small areas of Shale outcrops. These Shale outcrops are on the steeper points and breaks of the side slopes.

The Owens soils have very slow permeability and rapid runoff. The Elandco soils have moderate permeability and slow runoff. Available water capacity is very low in the Owens soils and high in the Elandco soils. The Owens soils have high shrink-swell potential, and the Elandco

and swelling. The Elandco soils should be protected from flooding. Capability unit VIe-2; Owens soil in Clay Upland range site, and Elandco soil in Loamy Lowland range site.

Or—Owens-Renfrow complex, 2 to 6 percent slopes, eroded. This complex consists of gently sloping to sloping, well drained soils on irregularly shaped side slopes of

cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing reduce the plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing

low available water capacity and rapid runoff. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. Under these conditions the taller, more desirable grasses are replaced by less productive short grasses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

The Owens soil is poorly suited to windbreaks. The shallow depth of soil material over shale restricts or prohibits growth of tree roots.

The Owens soil is severely limited for most urban and engineering uses because it is very slowly permeable, has a high shrink-swell potential, has bedrock within 20 inches of the surface, and is strongly sloping to steep. Extensive land shaping is necessary if this soil is used for building sites. Buildings should be designed to prevent damage caused by shrinking and swelling. Capability unit VIIs-1; Owens soil in Clay Upland range site, and Shale outcrop not assigned to a range site.

Pa—Pond Creek silt loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil in broad areas on uplands. Some narrow areas are on the tops of ridges.

Typically, the surface layer is dark brown silt loam about 13 inches thick. The upper part of the subsoil is dark brown, friable light silty clay loam; the next part is dark brown, firm clay loam; and the lower part is reddish brown, friable light clay loam. A few small lime concretions are in the subsoil. The underlying material is reddish brown silty clay loam. In some places the subsoil is more clayey.

Included with this soil in mapping are small intermingled areas of Kirkland and Tabler soils. The Kirkland soils have a more clayey subsoil. Tabler soils have a subsoil that is more clayey and is grayer than the one in this Pond soil. These included soils have similar slopes and are in similar positions. They make up about 5 percent of the unit.

Permeability is moderately slow, and runoff is slow. Available water capacity is very high. The surface layer is friable and easily tilled. Natural fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil ranges from slightly acid to moderately alkaline. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are cultivated. This soil has good potential for all crops commonly grown in the county and for range, pasture, and windbreaks. It has poor to fair potential for most urban, engineering, and recreational uses.

This soil is well suited to all crops commonly grown in the county. There are few or no hazards when this unit is used for cultivated crops. Proper use of fertilizer and crop residue management help to maintain fertility, organic matter content, and tilth.

This soil is well suited to rangeland. Overgrazing reduces the vigor and growth of the tall, palatable grasses and allows shorter, less productive species to become established. Proper stocking rates, deferred-rotation grazing, and proper placement of salt and water help to keep the grass in good to excellent condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments. Dwellings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. These soils have severe limitations for septic tank absorption fields because of the moderately slow permeability; however, there are only slight limitations for construction of sewage lagoons. Increasing the size of the absorption area of septic tank filter fields helps to overcome the limitation of moderately slow permeability. Capability unit I-1; Loamy Upland range site.

Pb—Pond Creek silt loam, 1 to 3 percent slopes. This is a deep, gently sloping, well drained soil in broad areas on smooth uplands. In some places the soil is gently sloping on short side slopes. Areas of this soil are irregular in shape and range from about 50 acres to several hundred acres in size.

Typically, the surface layer is dark brown silt loam about 13 inches thick. The upper part of the subsoil is dark brown, friable light silty clay loam; the next part is dark brown, firm clay loam; and the lower part is reddish brown, friable light clay loam. A few small lime concretions are in the subsoil. The underlying material is reddish brown silty clay loam. In some places the subsoil is more clayey than is indicated in the typical profile.

Included with this soil in mapping are small intermingled areas of Milan soils that have more sand in the subsoil. These included soils have similar slopes and are in similar positions, and they make up about 5 percent of the unit.

Permeability is moderately slow, and runoff is medium. Available water capacity is very high. Natural fertility is high. The surface layer ranges from medium acid to neutral, and the subsoil ranges from slightly acid to moderately alkaline. The surface layer is friable and easily tilled. The shrink-swell potential of the subsoil is moderate.

Most areas of this soil are cultivated. A small acreage is used for rangeland. This soil has good potential for all crops commonly grown in the county and for rangeland, pasture, and hay. It has poor to fair potential for most urban, engineering, and recreational uses.

This soil is well suited to all crops commonly grown in the county. These soils are easily tilled, but maintenance of tilth and fertility is required. Soils in this unit have a

moderate erosion hazard. Terraces and contour farming help to control erosion. Proper management of crop residues and use of fertilizer help to maintain fertility, organic matter content, and tilth.

Range management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks. The clayey subsoil releases moisture slowly. Young trees need considerable care if they are to grow well. Rainfall is likely to be limited and irregular, and irrigating the trees promotes growth. Cultivating young windbreaks to control weeds reduces competition for soil moisture. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments. Dwellings should be designed and constructed to prevent structural damage caused by shrinking and swelling of the soil. This soil has severe limitations for septic tank absorption fields because of the moderately slow permeability. There are moderate limitations for construction of sewage lagoons because of slope. Increasing the size of the absorption area of septic tank filter fields helps to overcome the limitation of moderately slow permeability. Capability unit IIe-1; Loamy Upland range site.

Pc—Pond Creek silt loam, 3 to 6 percent slopes. This is a deep, closing, well drained soil on short, convex

This soil is well suited to all crops commonly grown in the county. If the soil is cultivated and not protected, the hazard of water erosion is severe. Control of erosion and maintenance of tilth and fertility are the main concerns of management. Terraces and contour farming are needed to help to control erosion. Proper management of crop residues and use of fertilizer help to maintain fertility, organic matter content, and tilth.

Rangeland management that maintains an adequate plant cover and ground mulch helps to prevent excessive soil losses. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and the soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil has moderate limitations for building sites and recreational developments because of the shrink-swell potential, moderately slow permeability, and slope. There are severe limitations for septic tank absorption fields

Typically, the surface layer is about 12 inches thick; the upper part is dark reddish gray clay loam, and the lower part is reddish brown clay loam. The subsoil is reddish brown and red, very firm clay more than 50 inches thick; in most places this layer contains fragments of shale in the lower part. Red and gray shale is at a depth of more than 60 inches. In about 30 percent of the area the depth to shale ranges from 20 to 60 inches. In other places the soil is grayer in color throughout.

Included with this unit in mapping are small intermingled areas of Owens soils. The Owens soils are 10 to 20 inches deep over shale bedrock. Also included are soils that are less than 10 inches deep over bedrock. These included soils have similar slopes and are in similar positions, and they make up about 25 percent of the acreage.

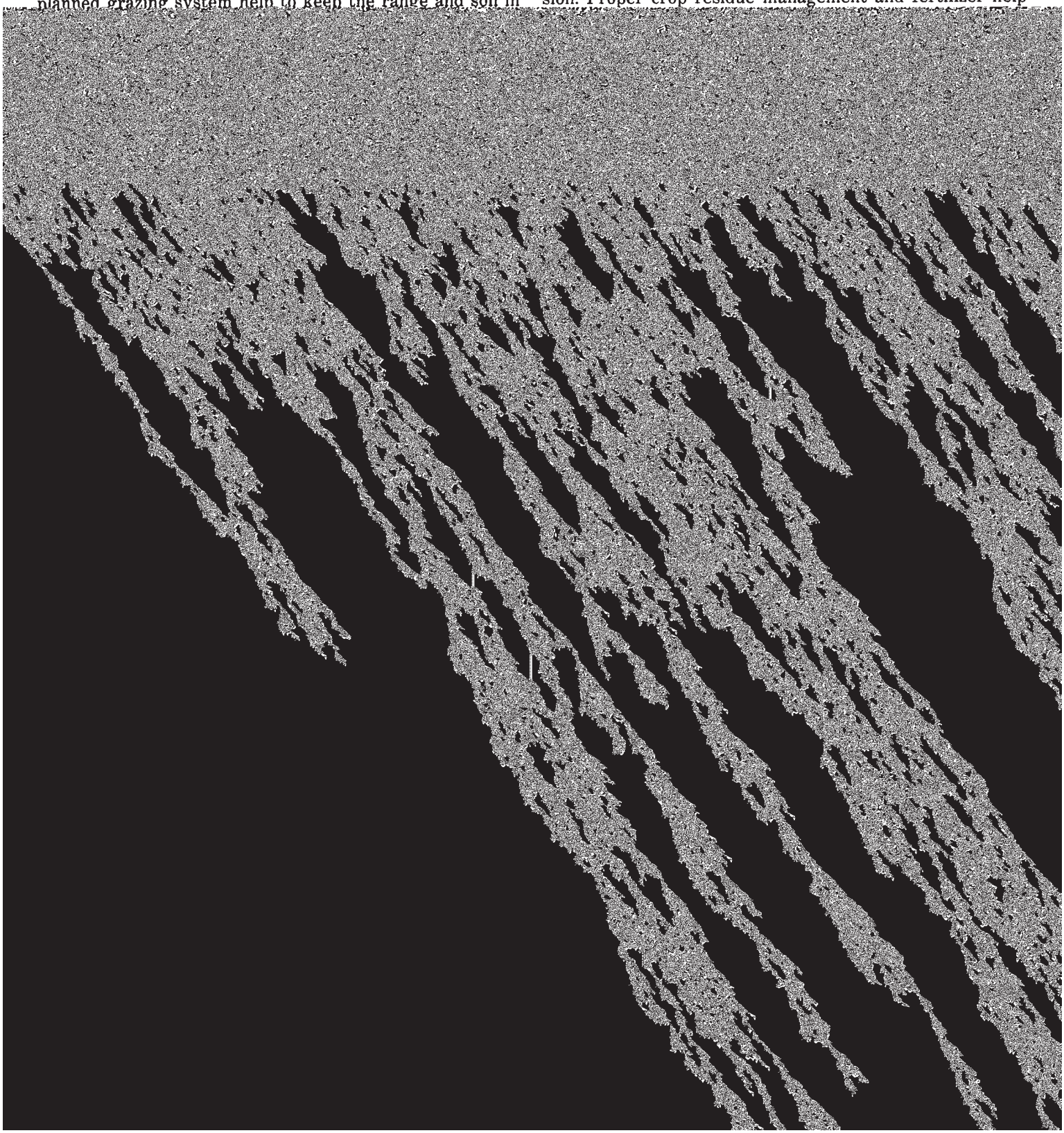
The soils are very slowly permeable. Runoff is medium. Available water capacity is low to moderate. Tilth is poor; clods form and structure is destroyed if the soils are worked when too wet or too dry. Natural fertility is

These soils are poorly suited to use as building sites because of the high shrink-swell potential and very slow permeability. Structures should be designed to prevent damage caused by shrinking and swelling. This can be done by using adequate reinforcing steel in concrete foundations and backfilling with sand or gravel; installing foundation drains; backfilling under concrete driveways, sidewalks, and local roads and streets with sand or gravel and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tanks often fail because of the very slow permeability. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in bare areas. Capability unit IIIe-2; Clay Upland range site.

Ro—Rosehill clay loam, 1 to 3 percent slopes. This is a moderately deep, gently sloping, well drained soil on upland side slopes. Individual areas are irregular in shape and range from about 20 acres to several hundred acres

reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover and cause deterioration of the plant community. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in

Erosion is a severe hazard when these soils are cultivated and not protected. The main concerns of management are controlling erosion, conserving moisture, and maintaining tilth. Terraces and contour farming help to control erosion. Proper crop residue management and fertilizer help



Included with this soil in mapping are small intermingled areas of Owens soils and shale outcrops. The Owens soils have shale bedrock at a depth of less than 20 inches. They have similar slopes and are in similar positions. Shale outcrops are on some of the steeper points and breaks. These included areas make up about 5 percent of the acreage.

This soil has very slow permeability and medium runoff. Available water capacity is low. Tilth is poor, and the surface tends to crust and puddle. Natural fertility is medium, and reaction ranges from neutral to moderately alkaline throughout the soil. The shrink-swell potential is high. Depth to shale bedrock ranges from 20 to 40 inches.

Most areas of this soil are cultivated. This soil has fair to poor potential for cultivated crops. The potential for rangeland, pasture, hay, and wildlife habitat is good to fair. The soil has only poor potential for most urban and engineering uses.

This soil is poorly suited to most commonly grown cultivated crops because of the severe hazard of continued erosion and the low available water capacity. The main concerns of management are controlling erosion, conserving moisture, and maintaining tilth. Terracing, contour farming, minimum tillage, carefully selected cropping systems, and fertilizer help to reduce runoff, conserve moisture, maintain fertility, organic matter content, and tilth, and control further erosion.

and providing drainage outlets; and including expansion joints. Sewage lagoons or a central sewage system should be used for waste disposal. Septic tank systems often fail because of the very slow permeability. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover needs to be established quickly in denuded areas. Capability unit IVe-4; Clay Upland range site.

Sa—Shellabarger sandy loam, 1 to 3 percent slopes. This is a deep, well drained, gently sloping soil on long and short side slopes. Individual areas of this soil are irregular in shape and range from about 20 acres to several hundred acres in size.

Typically, the surface layer is brown sandy loam about 11 inches thick. The upper part of the subsoil is reddish brown, friable fine sandy loam, and the lower part is reddish brown, friable sandy clay loam. The underlying material is yellowish red heavy sandy loam. In some places the subsoil contains more clay than is indicated for the typical profile. In other places the subsoil is dark brown and also contains more clay.

Included with this soil in mapping are small intermingled areas of Pratt and Carwile soils. Carwile soils are in nearby depressions, are somewhat poorly drained, and have a more clayey subsoil. Pratt soils have more sand in the subsoil, and have similar slopes and are in similar positions. In some places there are inclusions of soils that

This soil is well suited to windbreaks; however, there is a hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is suitable for building sites and for onsite waste disposal if proper design and installation procedures are used. Seepage from sewage lagoons can be prevented by special treatment to seal the bottom of the lagoon. If the soil is used as a construction site, development of the site should be on the contour wherever possible. Removal of vegetation should be held to a minimum, and temporary plant cover should be established quickly in denuded areas. Capability unit IIe-2; Sandy range site.

Sb—Shellabarger sandy loam, 3 to 6 percent slopes. This is a deep, well-drained, sloping soil on long and short

This unit is also well suited to rangeland, but the hazard of erosion is a major concern. Maintaining adequate plant cover and ground mulch helps to prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and overgrazing the range reduce the protective plant cover. Proper stocking rates, uniform grazing distribution, timely deferment of grazing, and a planned grazing system help to keep the range and soil in good condition.

This soil is well suited to windbreaks; however, there is a severe hazard of water erosion while the windbreak is being established. Planting the rows of trees on the contour helps to control erosion. Young trees need considerable care if they are to grow well. Rainfall during part of the growing season is likely to be inadequate for maximum growth. Irrigation of the trees needs to be done carefully to avoid water erosion. Cultivation to control weeds must be done carefully to prevent increased erosion. Windbreaks need to be protected from livestock, fire, and rodents.

This soil is suitable for building sites and for onsite waste disposal if proper design and installation

moderate to severe hazard of soil blowing in spring and fall. The main concerns of management are controlling erosion and maintaining fertility and tilth. Terraces and contour farming help to control water erosion. Strip-cropping, crop residue management, and fertilizer help to conserve moisture and maintain organic matter content.

Most areas of this soil are cultivated. This soil has good potential for most crops grown in the county and for range, pasture, hay, and wildlife habitat. It has poor potential for most urban and engineering uses.

This soil is well suited to most crops commonly grown

This soil is better suited to rangeland than to other uses. Major concerns of range management are the

Va—Vanoss silt loam, 0 to 1 percent slopes. This is a deep, nearly level, well drained soil that is typically on

Included with this soil in mapping are small intermingled areas of Milan soils. These soils have more sand in the subsoil. They have similar slopes and are in similar positions, and they make up about 5 percent of the mapping unit.

This soil has moderate permeability. Runoff is medium. Available water capacity is high. The surface is friable and easily tilled. Natural fertility is high, and reaction is slightly acid to neutral. The shrink-swell potential is moderate.

Most areas of this soil are cultivated. A small acreage is used for rangeland. This soil has good potential for crops, rangeland, pasture, hay, windbreaks, and wildlife habitat. It has only fair potential for most urban and engineering uses.

This soil is well suited to all crops commonly grown in the county. These soils are easily tilled, but maintenance of tilth and fertility is required. There is a moderate hazard of water erosion when the soil is cultivated and not protected. Terraces and contour farming help to control erosion. Minimum tillage, carefully selected cropping

Included with this soil in mapping are small intermingled areas of Milan soils. The Milan soils have more sand in the subsoil than this Vanoss soil. They have similar slopes and are in similar positions, and they make up about 5 percent of the mapping unit.

This soil has moderate permeability. Runoff is medium. Available water capacity is high. The surface layer is friable and easily tilled. Natural fertility is high, and reaction is slightly acid to neutral. The shrink-swell potential is moderate.

Most areas of this soil are cultivated. This soil has good potential for crops, range, pasture, hay, windbreaks, and wildlife habitat. It has fair potential for most urban and engineering uses.

This soil is suited to most crops commonly grown in the county. There is a severe hazard of water erosion when the soil is cultivated and not protected. The main concerns of management are controlling erosion and maintaining tilth and fertility. Terraces and contour farming are needed to help to control erosion. Minimum tillage, carefully selected cropping systems, and fertilizer help to

This soil has very slow permeability. Runoff is slow. The available water capacity is moderate. Tilth is poor, and the surface has a tendency to crust and puddle. Natural fertility is medium. The surface layer ranges from medium acid to neutral, and the subsoil is neutral to moderately alkaline. The subsoil has a high shrink-swell potential.

Most areas of this soil are cultivated. This soil has good potential for crops, rangeland, pasture, hay, windbreaks, and wildlife habitat. The potential for most urban and engineering uses is poor.

This soil is suited to most crops commonly grown in the county. Surface drainage is needed in some places. During wet periods, water is sometimes ponded on the surface and remains for several days. Planting and harvesting are often delayed, and crops sometimes drown. The main concerns of management are maintaining tilth, organic matter content, and fertility. Tilling when moisture conditions are most favorable helps to keep the soil in good tilth. Minimum tillage, carefully selected cropping systems, and fertilizer help to maintain organic matter content, fertility, and tilth.

This soil is well suited to rangeland. Overgrazing or

is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in uses of the land.

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

Information in this section is useful in planning use and management of soils for crops and pasture, rangeland, and woodland, and as sites for buildings, highways and other transportation systems, sanitary facilities, parks and other recreation facilities, and wildlife habitat. From the data presented, the potential of each soil for specified land uses can be determined, soil limitations to these land uses can be identified, and costly failures in houses and

This section provides information about the overall agricultural potential and needed practices in the survey area for those in the agribusiness sector—equipment dealers, fertilizer companies, processing companies, planners, conservationists, and others. For each kind of soil, information about management is presented in the section, "Soil maps for detailed planning." This information should be referred to when planning management systems for individual fields or farms.

Approximately 550,000 acres in Sumner County was used for crops and pasture in 1967, according to the Conservation Needs Inventory. The 1973 Kansas Farm Facts shows 407,000 acres in close grown crops, mainly wheat. Sumner County has been the leading wheat producing county in Kansas each of the last 10 years. Other crops produced were 44,000 acres of sorghum, 9,000 acres of soybeans, and 22,000 acres of alfalfa. In 1967, 70,000 acres was in summer fallow.

The acreage of wheat has increased over the past 10 years, while the acreage of grain sorghum has declined. Also, in recent years the acreage of summer fallow has dropped considerably. The acreage of alfalfa has remained constant over several years. Sumner County ranks high in the State in barley production, but the crop amounts to only 14,000 acres.

Only 2,000 acres was in tame pasture in 1967, but tame pasture has increased in the last 2 or 3 years.

The potential of the soils in Sumner County for increased production of food and fiber is good. A large portion of this increase will come from the crop production on the approximately 70,000 acres that has been in summer fallow. Food production could also be increased by extending the latest crop production technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

There was an increase of only 200 acres of urban and built-up land in the county from 1958 to 1967.

Soil erosion is the major problem on about 50 percent of the cropland in Sumner County. If slope is more than 1 percent, erosion is a hazard. Bethany, Farnum, Milan, and Kirkland are the principal soils used for crops in the county.

Loss of the surface layer through erosion is damaging for two reasons: first, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer, and second, soil erosion on farmland results in sediment entering streams. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as the Bethany, Kirkland, Renfrow, and Tabler. Control of erosion minimizes the pollution of streams by sediment and improves quality of water for municipal use, for recreation, and for fish and wildlife.

In many sloping fields, preparing a good seedbed and tilling are difficult on clayey spots because the original friable surface layer has been eroded away. Such spots are common in areas of moderately eroded Kirkland soils.

Erosion control practices provide protective surface cover, reduce runoff, and increase infiltration. A cropping system that keeps a plant cover on the soil for extended periods can hold soil erosion losses to amounts that will not reduce the productive capacity of the soils. On livestock farms, which require pasture and hay, the legume and grass forage crops in the cropping system reduce erosion on sloping land and also provide nitrogen and improve tilth for the following crop.

Terracing and contour tillage are not practical on some soils, because slopes are short and irregular and the surface layer is coarse textured and moderately coarse textured. On these soils, cropping systems that provide substantial plant cover are required to control soil blowing and water erosion. Leaving crop residues on the surface either by minimum tillage or by stubble mulching helps to increase infiltration and reduce the hazards of runoff and water erosion. The extra cover is essential to help prevent soil blowing during periods of crop production. Minimum tillage for sorghum and other row crops is becoming more common in Sumner County. It is effective in reducing erosion on sloping land and can be adapted to most soils in the survey area.

Terraces and diversions reduce the length of slopes and reduce runoff and erosion. They are most practical on **deep, well drained soils that have uniform, regular slopes. This includes practically all soils except the coarse textured and moderately coarse textured soils.**

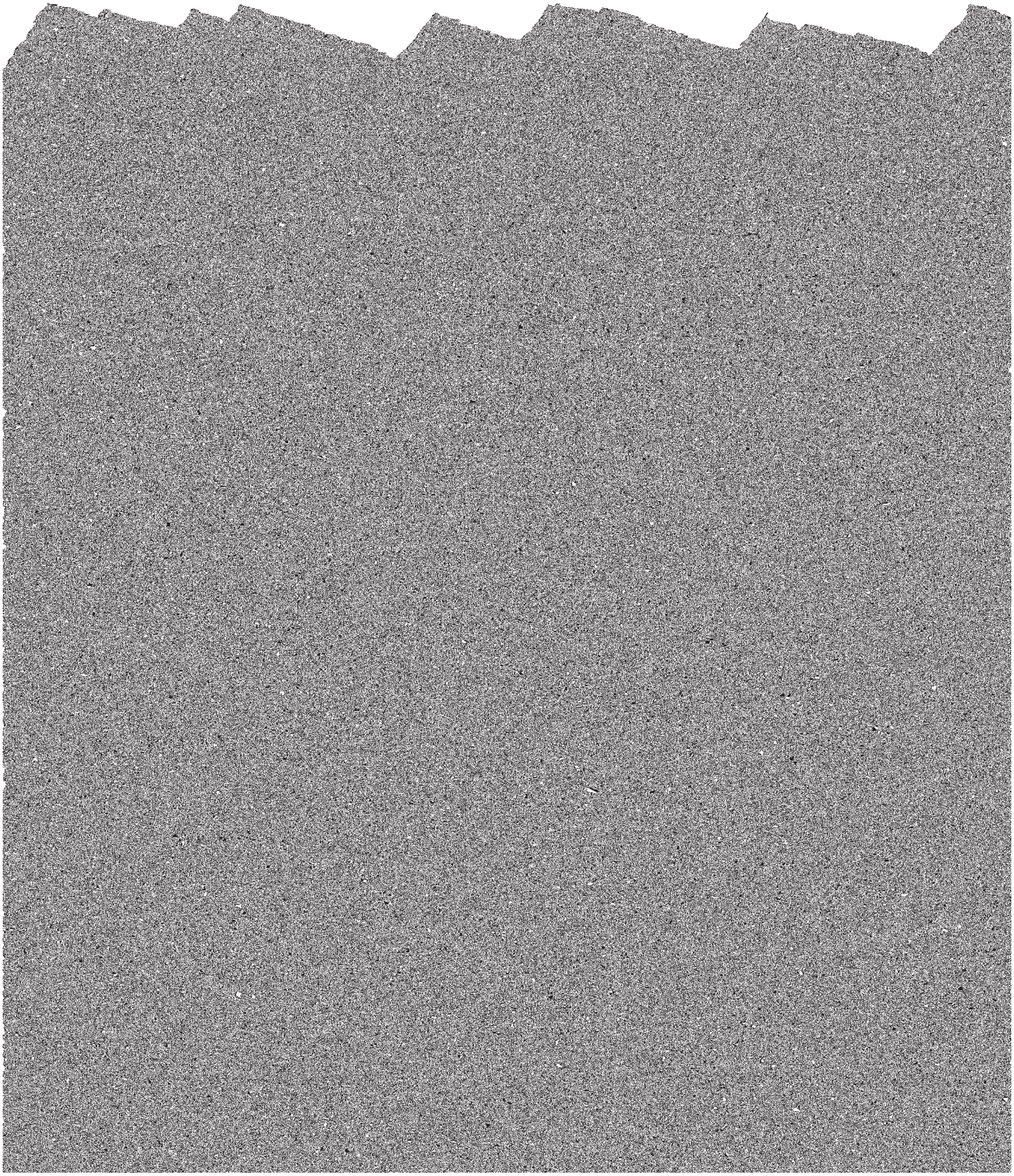
Contour tillage is rarely used by itself but is a companion practice along with terraces. Contouring is best suited to soils with smooth, uniform slopes where terracing is applicable.

Soil blowing is a hazard on the coarse textured and moderately coarse textured Canadian, Carwile, Shellabarger, and Pratt soils. Soil blowing can damage these soils if they are bare of vegetation or surface mulch. Maintaining plant cover, surface mulch, or a rough surface through proper tillage minimizes soil blowing on these soils.

Information for the design of erosion control practices for each kind of soil is contained in the Field Office Technical Guide, which is available in local offices of the Soil Conservation Service.

Soil drainage is needed on less than 1 percent of the acreage used for crops and pasture in the survey area. Soils like the Waurika and Carwile are somewhat poorly drained and very slowly permeable; crops on these soils are likely to be damaged in some years. Shallow open drains connecting one pothole with another will help to improve drainage on these soils.

Soil fertility is naturally low on Owens soil but is medium or high on the remaining arable soils in the county. The soils range from medium acid to mildly alkaline in reaction. Soils such as Bethany, Corbin, Crisfield, Kirkland, Milan, Elandco, Shellabarger, Vanoss, and Waurika soils may be medium acid and need an application of ground limestone to raise the reaction (pH) sufficiently for good growth of alfalfa and other crops that grow well only on nearly neutral soils. On all soils additions of lime and fertilizer should be based on the results of soil tests,



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

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

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

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

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

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

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is too cold or too dry.

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

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, I-1 or IIw-1. The capability units is identified in the description of each soil map unit in the section "Soil maps for detailed planning."

Rangeland

ARNOLD G. MENDENHALL, range conservationist, Soil Conservation Service, assisted in preparing this section.

Rangeland is land on which the natural, or climax, vegetation is composed principally of native grasses, grasslike plants, forbs, and shrubs which are valuable for grazing by livestock. Range management is the wise use of rangelands to produce forage for livestock and to provide habitat for wildlife, clean water, recreation, esthetic values, and related uses.

In Sumner County, livestock and livestock products account for about 28 percent of the agricultural income. The number of beef cows that calved in the county ranged from 24,000 to 27,000 in a recent 3-year period (*6*, *7*).

Most livestock forage is produced on rangeland. Supplemental feed comes from crops and their byproducts. Rangeland makes up about 20 percent of the county, or about 146,000 acres.

The rangeland in Sumner County varies considerably in the kinds and amounts of native plants produced. The range managers or operators need to know the capabilities of different kinds of rangeland before they can manage it properly.

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

Table 6 shows, for each kind of soil, the name of the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the expected percentage of each species in the composition of the potential natural plant community. Soils not listed cannot support a natural plant community of predominately grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. The following are explanations of column headings in table 6.

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

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

Dry weight refers to the total air-dry vegetation produced per acre each year by the potential natural plant community. Vegetation that is highly palatable to livestock and vegetation that is unpalatable are included. Some of the vegetation can also be grazed extensively by wildlife. Plant species that have special value for livestock forage are mentioned in the description of each soil mapping unit.

Common plant names of grasses, grasslike plants, forbs, and shrubs that make up most of the potential natural plant community on each soil are listed. Under *Composition*, the expected proportion of each species is

presented as the percentage, in air-dry weight, of the total annual production of herbaceous and woody plants. Because only major species are listed, percentages do not necessarily total 100. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluaton of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the maximum production of vegeta-

Engineering

CLIFTON E. DEAL, civil engineer, Soil Conservation Service, assisted in preparation of this section.

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

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

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope,

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

The information is presented mainly in tables. Table 8 shows, for each kind of soil, the degree and kind of limitations for building site development; table 9, for sanitary facilities; and table 11, for water management. Table 10 shows the suitability of each kind of soil as a source of construction materials.

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

Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation. Requirements for protecting built-up areas from flooding can be obtained from the State Division of Water Resources.

Local roads and streets referred to in table 8 have an

limitations are minor and easily overcome; if *moderate*, soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe*, soil properties or site features are so unfavorable or difficult to overcome that

Sanitary landfill is solid waste (refuse) and soil material that is placed in successive layers either in excavated trenches or on the surface of the soil. The waste is spread, compacted, and covered daily with thin layers of soil. Landfill areas are subject to heavy vehicular traffic.

row areas. These factors include slope, erodibility, and potential for plant growth.

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

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

The ratings apply to the soil material between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 14 provide specific information about the nature of each horizon. This information can help determine the suitability of each horizon for roadfill.

Soils rated *good* are coarse grained. They have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as moderate shrink-swell potential, moderately steep slopes, wetness, or many stones. If the [illegible]

to support plantlife. Also considered is the damage that can result at the area from which the topsoil is taken.

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

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

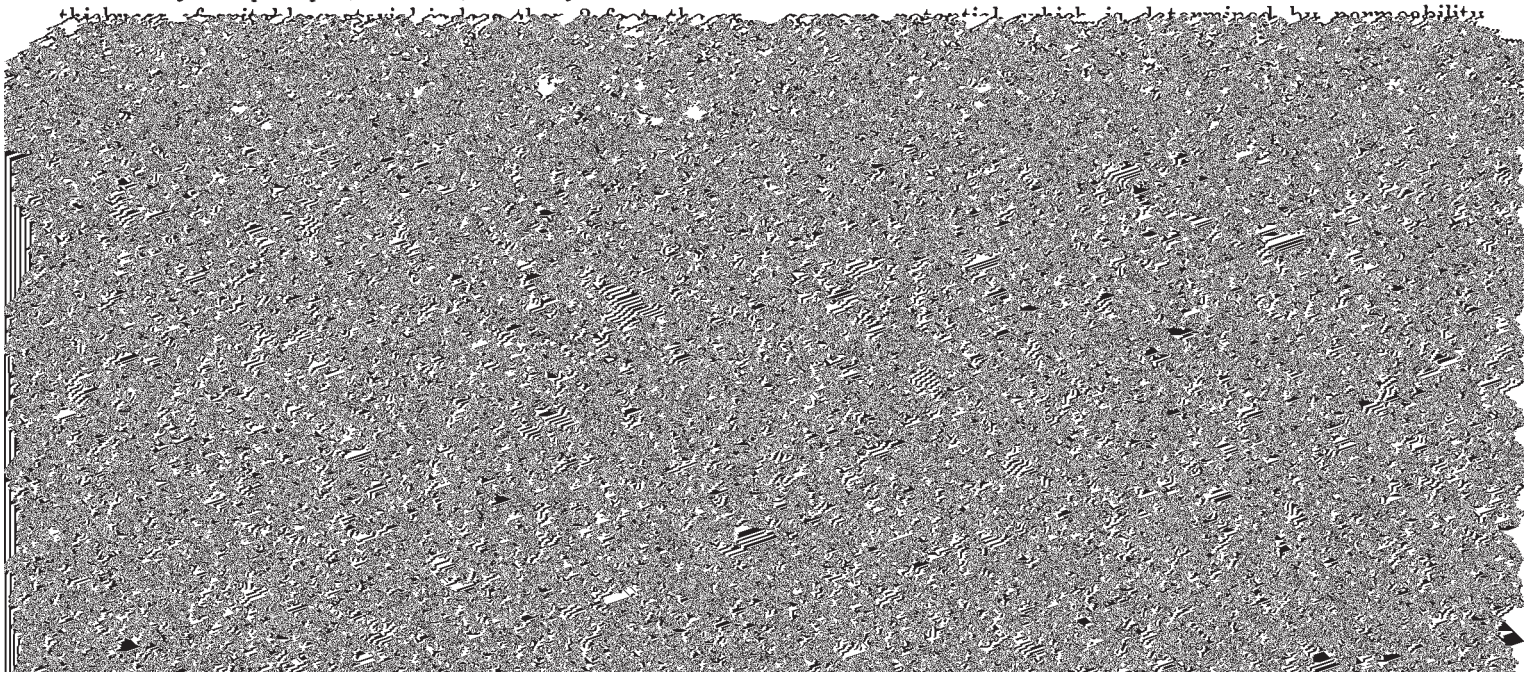
Soils rated *poor* are very sandy soils and very firm clayey soils; soils with suitable layers less than 8 inches thick; soils having large amounts of gravel, stones, or soluble salt; steep soils; and poorly drained soils.

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

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 11 the degree of soil limitation and soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have a low [illegible]



Terraces and diversions are embankments or a com- or boulders can greatly increase the cost of constructing

places. Moderately intensive management is required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

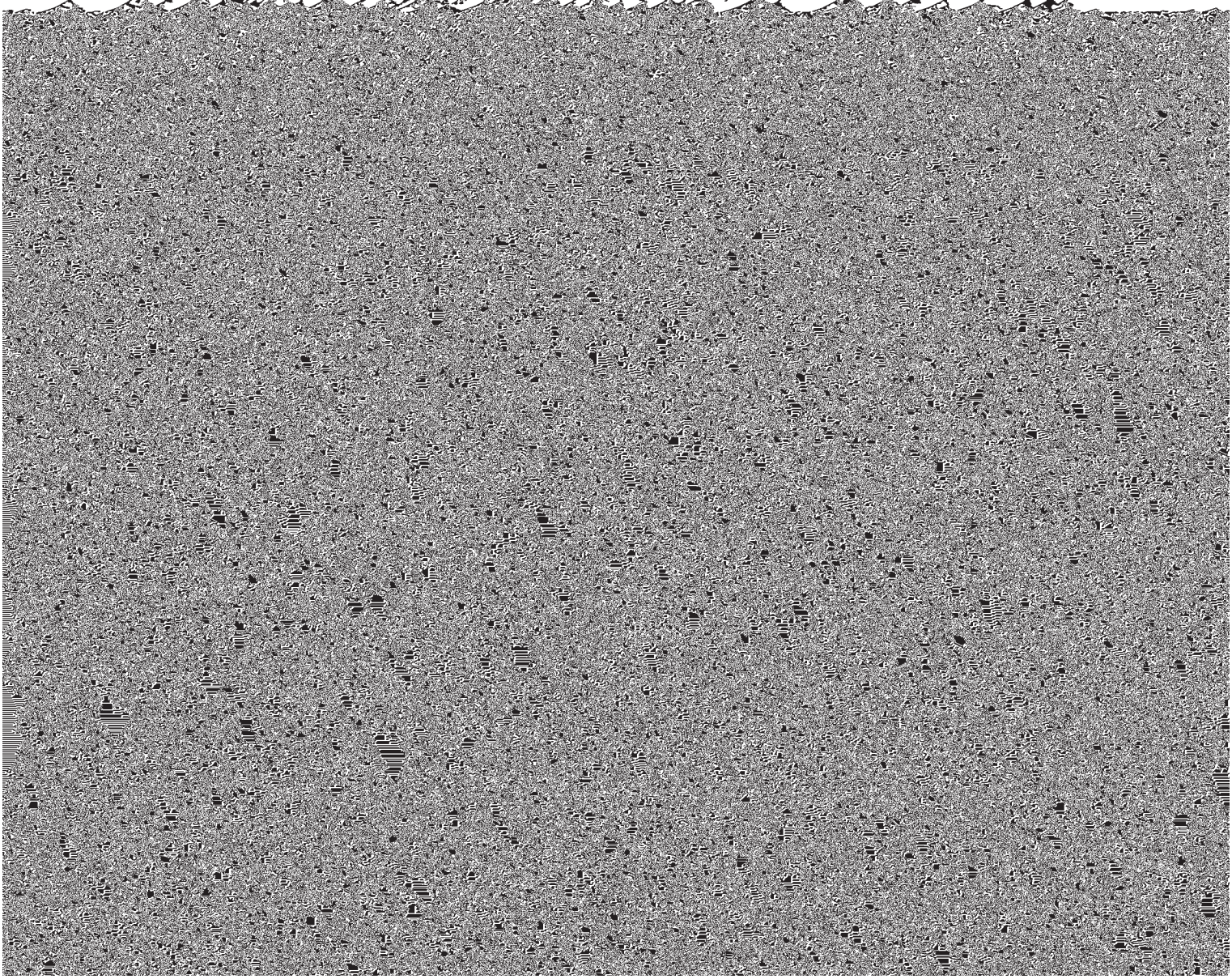
The elements of wildlife habitat are briefly described in the following paragraphs.

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

vide cover and shade for some species of wildlife. Examples are mountainmahogany, bitterbrush, snowberry, and big sagebrush. Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, wild millet, wildrice, saltgrass, and cordgrass and rushes, sedges, and reeds. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of water that have an average depth of less than 5 feet and that are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in



Soil properties

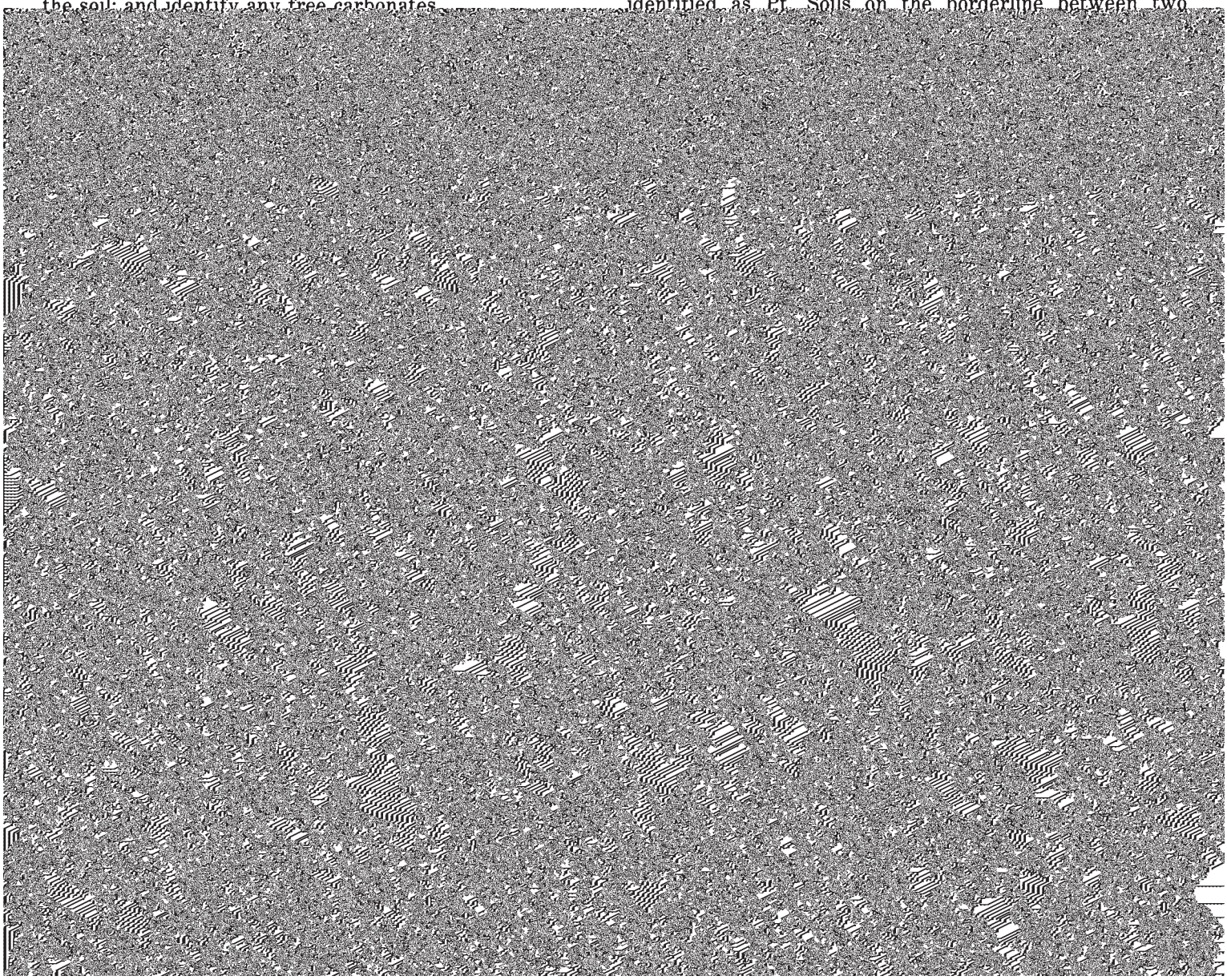
Extensive data about soil properties are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of selected soil samples from typical profiles.

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

coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (AASHTO) (*1*). In table 14 soils in the survey area are classified according to both systems.

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



making general predictions of soil behavior. Range in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted in table 14.

Physical and chemical properties

Table 15 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on field observations and on test data for these and similar soils.

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

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

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

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific

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

al. These soils have a very slow rate of water transmission.

Flooding is the temporary covering of soil with water

Test data

Table 17 contains engineering test data for some of the major soil series in Sumner County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Compaction (or moisture-density) data are important in earthwork. If the soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted

argillic horizon. Kirkland and Tabler soils have a more abrupt texture change between the A and B horizons. Tabler soils also have a less brown Bt horizon. Pond Creek soils have a fine-silty control section. Waurika soils have an A2 horizon.

Typical pedon of Bethany silt loam, 1 to 3 percent slopes, 1,300 feet north and 150 feet east of the southwest corner of section 32, T. 32 S., R. 2 E.:

A1—0 to 8 inches; dark grayish brown (10YR 4/2) heavy silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, friable; slightly acid; gradual boundary.

A3—8 to 17 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; strong fine granular structure; slightly hard, friable; neutral; gradual boundary.

B3—50 to 60 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak coarse blocky structure; very hard, very firm; moderately alkaline.

The solum ranges from 50 to 60 inches in thickness. The mollic

A1—0 to 10 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, friable; slightly acid; clear boundary.

B2t—10 to 39 inches; light brownish gray (10YR 6/2) clay, dark grayish brown (10YR 4/2) moist; common medium distinct strong brown

Crisfield soils are similar to Canadian soils and are commonly adjacent to Lincoln and Pratt soils on the landscape. Canadian soils do not have hue of 5YR in the B horizon. Lincoln and Pratt soils lack a mollic epipedon and

loam. Reaction ranges from slightly acid to moderately alkaline. The C horizon has hue of 10YR to 5YR, value of 4 to 6, and chroma of 3 to 6. It is silty clay loam, silt loam, or loam. Reaction is neutral to moderately alkaline.

The solum ranges from 32 inches to more than 60 inches. The mollic epipedon is more than 20 inches thick and extends into the argillic horizon in most pedons.

The A horizon has hue of 7.5YR or 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. Reaction is slightly acid or neutral. The B horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 4. It is clay loam that is less than 35 percent clay. Reaction is neutral or mildly alkaline. The C horizon has hue of 5YR to 10YR, value of 4 to 6, and chroma of 3 to 5. It is clay loam or sandy clay loam. Reaction is neutral or mildly alkaline.

Kirkland series

The Kirkland series consists of deep, well drained, very slowly permeable soils on uplands. These soils formed in old alluvium. Slope ranges from 0 to 3 percent.

Kirkland soils are similar to Bethany, Renfrow, Tabler, and Waurika soils and are commonly adjacent to Bethany, Corbin, Tabler, and Waurika soils on the landscape. Bethany, Corbin, and Tabler soils lack an abrupt texture

Ap—0 to 10 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; very weak fine granular structure; soft, friable; mildly alkaline; clear boundary.

A12—10 to 17 inches; dark grayish brown (10YR 4/2) light clay loam, very dark grayish brown (10YR 3/2) moist; common fine distinct mottles of dark brown (7.5YR 4/4) and grayish brown (10YR 5/2) moist; moderate medium granular structure; slightly hard, friable; slight effervescence; moderately alkaline; gradual boundary.

C—17 to 30 inches; pale brown (10YR 6/3) clay loam, brown (10YR 5/3) moist; common coarse distinct mottles of brownish yellow (10YR 6/6); weak fine subangular blocky structure; soft, friable; strong effervescence; moderately alkaline; gradual boundary.

IIC—30 to 60 inches; light yellowish brown (10YR 6/4) loamy fine sand and fine sand, yellowish brown (10YR 5/4) moist; single grained; strong effervescence; moderately alkaline.

The solum and the mollic epipedon range from 10 to 20 inches in thickness. Depth to the IIC horizon ranges from 20 to 40 inches.

The A horizon has hue of 10YR, value of 3 to 5, and chroma of 2 or 3. It is dominantly clay loam but ranges to loam and silty clay loam. Reaction is mildly alkaline or moderately alkaline. The C horizon has hue of

the landscape. Farnum soils have a mollic epipedon more than 20 inches thick and have less red hue. Shellabarger soils have coarser texture. Vanoss soils have fine-silty texture.

Typical pedon of Milan loam, 1 to 3 percent slopes, 2,000 feet south and 200 feet west of the southeast corner

The A horizon has a hue of 5YR to 2.5Y, value of 4 to 6 (2 to 4 moist), and chroma of 2 to 4. It is dominantly clay loam but ranges to clay and silty clay. The B2 horizon has hue of 5YR to 2.5Y, value of 4 to 7 (3 to 6 moist), and chroma of 2 to 6. It is silty clay, clay, or clay loam and ranges from 35 to 50 percent clay. The C horizon has hue of 5YR to 5Y, value of 4 to 8, and chroma of 2 to 6. It is shaly clay, clayey shale, or weakly consolidated shale. Thin layers of fractured

orgillic horizon. Typical pedon of Pratt loamy fine sand, undulating, 400 feet north and 1,600 feet east of the southwest corner of section 17, T. 32 S., R. 4 W.:

A1—0 to 14 inches; pinkish gray (7.5YR 6/2) loamy fine sand, brown (7.5YR 4/2) moist; very weak fine granular structure; soft, very friable; slightly acid; diffuse boundary.

B2t—14 to 38 inches; brown (7.5YR 5/4) loamy fine sand, dark brown (7.5YR 4/4) moist; weak fine granular structure; soft, very friable; slightly acid; gradual boundary.

C—38 to 60 inches; strong brown (7.5YR 5/6) fine sand, strong brown (7.5YR 4/6) moist; structureless (single grained); loose; very friable; neutral.

The solum ranges from 24 to 50 inches in thickness. Reaction is slightly acid or neutral throughout.

The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 or 3. It is dominantly loamy fine sand but ranges to sand or fine sand. The B2 horizon has hue of 7.5YR or 10YR, value of 4 to 6 (4 or 5 moist), and chroma of 2 to 4. It is loamy sand or loamy fine sand and has 3 to 9 percent more clay than the A horizon. The C horizon has hue of 7.5YR or 10YR, value of 4 to 7 (3 to 6 moist), and chroma of 3 to 6. It is loamy fine sand, loamy sand, or sand.

Reinach series

The Reinach series consists of deep, well drained, moderately permeable soils on low terraces and flood plains. These soils formed in silty alluvium. Slope ranges from 0 to 1 percent.

Reinach soils are similar to Dale and Elandco soils and are commonly adjacent to Dale, Elandco, and Vanoss soils on the landscape. Dale soils are more clayey than Reinach soils. Elandco soils are more clayey than Reinach soils and are stratified and Vanoss soils are more clayey and are on uplands.

Typical pedon of Reinach silt loam in an area of Dale and Reinach silt loams 1,500 feet north and 150 feet east of the southwest corner of section 12, T. 35 S., R. 4 W.:

A1—0 to 13 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; weak fine granular structure; soft, friable; slightly acid; gradual boundary.

B2—13 to 30 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; neutral; gradual boundary.

C—30 to 60 inches; light brown (7.5YR 6/4) silt loam, brown (7.5YR 4/4) moist; massive; soft, friable; moderately alkaline; calcareous.

The solum ranges from 20 inches to more than 60 inches in thickness. The mollic epipedon is more than 20 inches thick and extends into the B horizon in most pedons.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. Reaction is slightly acid or neutral. The B2 horizon has hue of 7.5YR, value of 4 or 5 (2 to 4 moist), and chroma of 2 to 4. It is silt loam that is less than 18 percent clay. Reaction ranges from neutral to moderately alkaline. The C horizon has hue of 5YR or 7.5YR, value of 4 to 7, and chroma of 3 to 6. Reaction is mildly alkaline or moderately alkaline. Texture ranges from fine sandy loam to clay loam below a depth of 40 inches in some pedons.

Renfrow series

The Renfrow series consists of deep, well drained, very slowly permeable soils on uplands. These soils formed in material weathered from clayey shale. Slope ranges from 1 to 6 percent.

Renfrow soils are similar to Kirkland, Owens, and Rosehill soils and are commonly adjacent to Owens and Rosehill soils on the landscape. Kirkland soils have a mollic epipedon more than 20 inches thick. Owens soils are shallow over shale. In Rosehill soils, depth of shale is 20 to 40 inches; Rosehill soils have less red hue than Renfrow soils.

Typical pedon of Renfrow clay loam in an area of Renfrow complex, 1 to 3 percent slopes, 2,600 feet west and 300 feet north of the southeast corner of section 15, T. 31 S., R. 3 W.:

Ap—0 to 6 inches; dark reddish gray (5YR 4/2) clay loam, dark reddish brown (5YR 3/2) moist; moderate medium granular structure; hard, friable; slightly acid; clear boundary.

A12—6 to 12 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; strong fine subangular blocky structure and coarse granular; hard, firm; slightly acid; abrupt boundary.

B21t—12 to 27 inches; reddish brown (5YR 5/4) clay, reddish brown (5YR 4/4) moist; moderate medium and coarse blocky structure; very hard, very firm; neutral; few small calcium carbonate concretions; gradual boundary.

B22t—27 to 48 inches; reddish brown (2.5YR 4/4) clay, dark reddish brown (2.5YR 3/4) moist, moderate coarse blocky structure; extremely hard, very firm; mildly alkaline; gradual boundary.

B3—48 to 62 inches; red (2.5YR 5/6) clay, red (2.5YR 4/6) moist; part of the matrix is light reddish brown (2.5YR 6/4), reddish brown (2.5YR 5/4) moist; weak fine blocky structure; extremely hard, very firm; mildly alkaline; calcareous.

The solum is more than 60 inches thick. The mollic epipedon ranges from 8 to 12 inches in thickness. Reaction ranges from slightly acid to moderately alkaline throughout.

The A horizon has hue of 5YR to 10YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is dominantly clay loam but ranges to silt loam and silty clay loam. The B2t horizon has hue of 2.5YR or 5YR, value of 4 or 5 (3 or 4 moist), and chroma of 4 to 6. It is dominantly clay that is 40 to 50 percent clay, but silty clay, silty clay loam, and clay loam that are 35 to 60 percent clay are also included. The B3 horizon has hue of 2.5YR or 5YR, value of 4 to 6, and chroma of 4 to 8. Texture is similar to that of the B2t horizon.

Rosehill series

The Rosehill series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in material weathered from clayey shale. Slope ranges from 1 to 6 percent.

Rosehill soils are similar to Owens and Renfrow soils and are commonly adjacent to Owens and Renfrow soils on the landscape. Owens soils have shale at a depth of less than 20 inches. Renfrow soils lack shale above a depth of 40 inches.

Typical pedon of Rosehill clay loam, 3 to 6 percent slopes, 2,250 feet west and 50 feet south of the northeast corner of section 11, T. 35 S., R. 1 E.:

A1—0 to 10 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; weak medium granular structure; slightly hard, firm; many roots; neutral; clear boundary.

AC—10 to 29 inches; light olive brown (2.5Y 5/3) clay, olive brown (2.5Y 4/3) moist; moderate medium blocky structure; very hard, very firm; few roots; neutral; few small hard calcareous concretions; clear boundary.

C1—29 to 40 inches; light olive brown (2.5Y 5/4) clay, common fine shale fragments, olive brown (2.5Y 4/4) moist; many distinct fine yellowish brown mottles; massive; extremely hard, very firm; moderately alkaline; calcareous; diffuse boundary.

C2—40 to 48 inches; olive brown soft clayey shale with seams of limestone.

The solum ranges from 20 to 40 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 10YR or 2.5Y, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is clay loam or silty clay loam. Reaction is

and B horizons and have redder hue in the argillic horizon. Kirkland soils have an abrupt texture change between the A and B horizons and have redder hue in the B and C horizons. Waurika soils have an A2 horizon.

Typical pedon of Tabler silty clay loam 1,300 feet north

Typical pedon of Vanoss silt loam, 1 to 3 percent slopes, 1,300 feet west and 60 feet north of the southeast corner of section 31, T. 31 S., R. 2 E.:

A1—0 to 16 inches; brown (7.5YR 4/2) silt loam, dark brown (7.5YR 3/2) moist; moderate medium and fine granular structure; soft, friable; medium acid; gradual boundary.

B2t—16 to 40 inches; brown (7.5YR 5/4) clay loam, dark brown (7.5YR 4/4) moist; moderate medium subangular blocky structure; slightly hard, friable; slightly acid; diffuse boundary.

B3—40 to 60 inches; strong brown (7.5YR 5/6) clay loam, strong brown (7.5YR 4/6) moist; very weak fine subangular blocky structure; slightly hard, friable; neutral.

The solum ranges from 40 inches to more than 60 inches in thickness. The mollic epipedon ranges from 10 to 20 inches in thickness.

The A horizon has hue of 7.5YR or 10YR, value of 4 or 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly silt loam but ranges to loam. Reaction is slightly acid or medium acid. The B2t horizon has hue of 7.5YR or 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 5. It is clay loam or silty clay loam and averages between 27 and 35 percent clay. The B3 horizon has hue of 7.5YR or 10YR, value of 4 to 7, and chroma of 3 to 8. It is dominantly clay loam but ranges to loam and silt loam. Reaction is slightly acid or neutral.

Waurika series

The Waurika series consists of deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in old alluvium and loess. Slope ranges from 0 to 1 percent.

Waurika soils are similar to Kirkland and Tabler soils and are commonly adjacent to Bethany, Kirkland, and Ta-

Classification

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Readers interested in further details about the system should refer to the latest literature available (*8*, *10*).

The system of classification has six categories. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. In this system the classification is based on the different soil properties that can be observed in the field or those that can be inferred either from other properties that are observable in the field or from the combined data of soil science and other disciplines. The properties selected for the higher categories are the result of soil genesis or of factors that affect soil genesis. In table 18, the soils of the survey area are classified according to the system. Categories of the system are discussed in the following paragraphs.

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

SUBORDER. Each order is divided into suborders based primarily on properties that influence soil genesis and are important to plant growth or that are selected to reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the

perature regime, thickness of the soil penetrable by roots, consistence, moisture equivalent, soil slope, and permanent cracks. A family name consists of the name of a subgroup and a series of adjectives. The adjectives are the class names for the soil properties used as family differentiae. An example is fine, mixed, thermic, Typic Argiaquolls.

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

Formation of the soils

In this section, the processes of soil formation are discussed and related to the soils in the survey area.

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic forces. The characteristics of the soil at any given point are determined by the five factors of soil formation. These factors are the physical and mineralogical composition of the parent material; the climate under which the soil

Parent material

The soils of Sumner County formed in at least five different parent materials. The parent materials are eolian sands, outwash sediments, loess, alluvium, and Permian shales.

Soils that formed in wind deposited (eolian) sands are principally along the Ninnescah, Arkansas, and Chikaskia Rivers. The principal soils that formed in these materials are in the Pratt and Tivoli series.

Outwash sediment from Pleistocene deposits of Nebraskan age are poorly sorted sands, silt, and clays. The principal soils that formed in these materials are soils of the Farnum, Milan, and Shellabarger series.

Loessal deposits are silty materials carried by wind. In most of the county there is only a thin layer of loess on the surface of soils that formed in other parent materials. The principal soils that have a surface layer of loessal origin are the Bethany, Corbin, Kirkland, Tabler, Waurika, and Vanoss.

Alluvium of variable texture is deposited on terraces and flood plains of streams throughout the county. The principal soils forming in this material are the Brewer, Dale, Canadian, and Reinach. Textures of the soils are the same as textures of the materials transported and deposited by the streams. Generally the materials on flood plains and terraces of the Arkansas, Chikaskia, and Ninnescah Rivers are coarse sand and gravel in the sub-

high winds. The finer textured soils may retain more of their moisture and be less subject to blowing. The sandy soils that are subject to soil blowing may soon completely lose the surface layer. Soils that have not been eroded by wind action may have received accumulations of soil material from the wind.

Plant and animal life

Plants and animals are soil-forming factors. Plants decay and add organic matter to the soil. Burrowing animals mix the soil material. Micro-organisms aid in the breakdown of plants to soil humus.

Relief

Slope or general topography influences soil development because it controls runoff and resultant erosion, vegetation, and, to a lesser extent, temperature. If the soil is steep and not permeable enough to absorb the precipitation, it is subject to erosion if not protected. The soil may never develop as thick a surface layer as less sloping soils. The vegetation may not grow on the steep slopes because of reduced water infiltration and reduced nutrient availability. Soils on north-facing slopes may not have temperature favorable for plants as early in the spring as those on south-facing slopes. The reduced amount of organic matter from less plant production may result in less organic matter being added to the soil.

Time

The time required to produce a particular kind of soil is governed by many factors. The kind of material in which the soil develops may be the most important factor. Soil develops more rapidly in the silty alluvium parent material of the Reinach and Dale soils than in the clayey shale parent material of the Renfrow soils, if all other factors are equal. In general the soils that formed in alluvium and the sandy Pratt and Tivoli soils are the youngest in Sumner County. The oldest soils are the upland soils that have a clayey B horizon, such as Bethany, Kirkland, and Tabler.

(5) Frye, John C. and Byron A. Leonard. 1952. Pleistocene geology of Kansas. Univ. Kans., State Geol. Surv. Kans. Bull. 99, 230 pp., illus.
(6) Kansas State Board of Agriculture. 1972. Farm facts 1971-1972. Kans. State Board of Agric. 96 pp., illus.
(7) Kansas State Board of Agriculture. 1974. Farm facts 1973-1974. Kans. State Board of Agric. 94 pp., illus.
(8) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137: 1027-1034.
(9) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]
(10) United States Department of Agriculture. 1975. Soil taxonomy: a basic system of soil classification for making and interpreting soil surveys. U.S. Dep. Agric. Handb. 436, 754 pp., illus.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single mapping unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable [illegible]

Compressible. Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is

Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.

Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from a semisolid to a plastic state.

Poor outlets. Surface or subsurface drainage outlets difficult or expen-

then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake. The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface that is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 millimeters in equivalent

Unstable fill. Risk of caving or sloughing in banks of fill material.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Illustrations

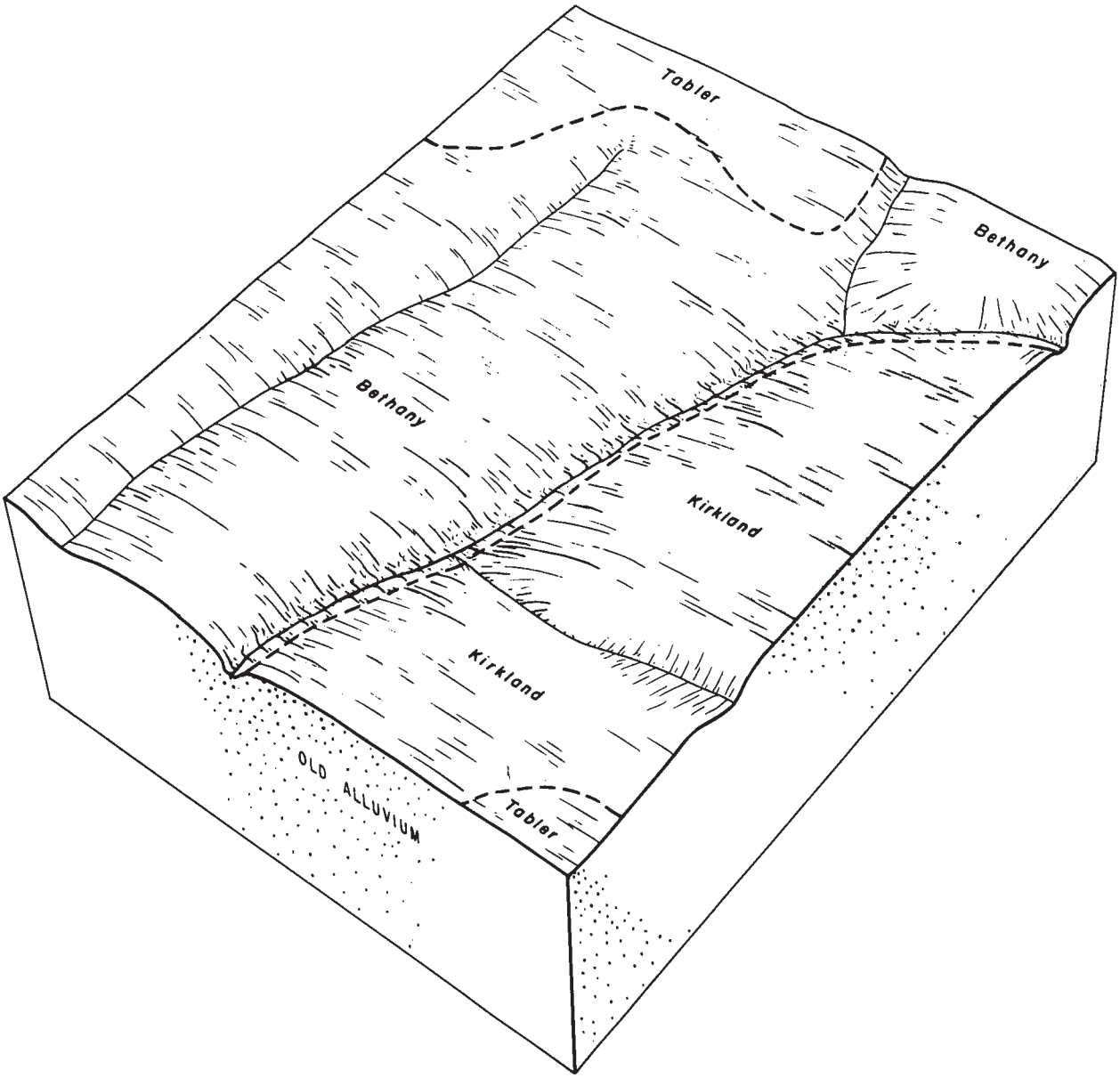
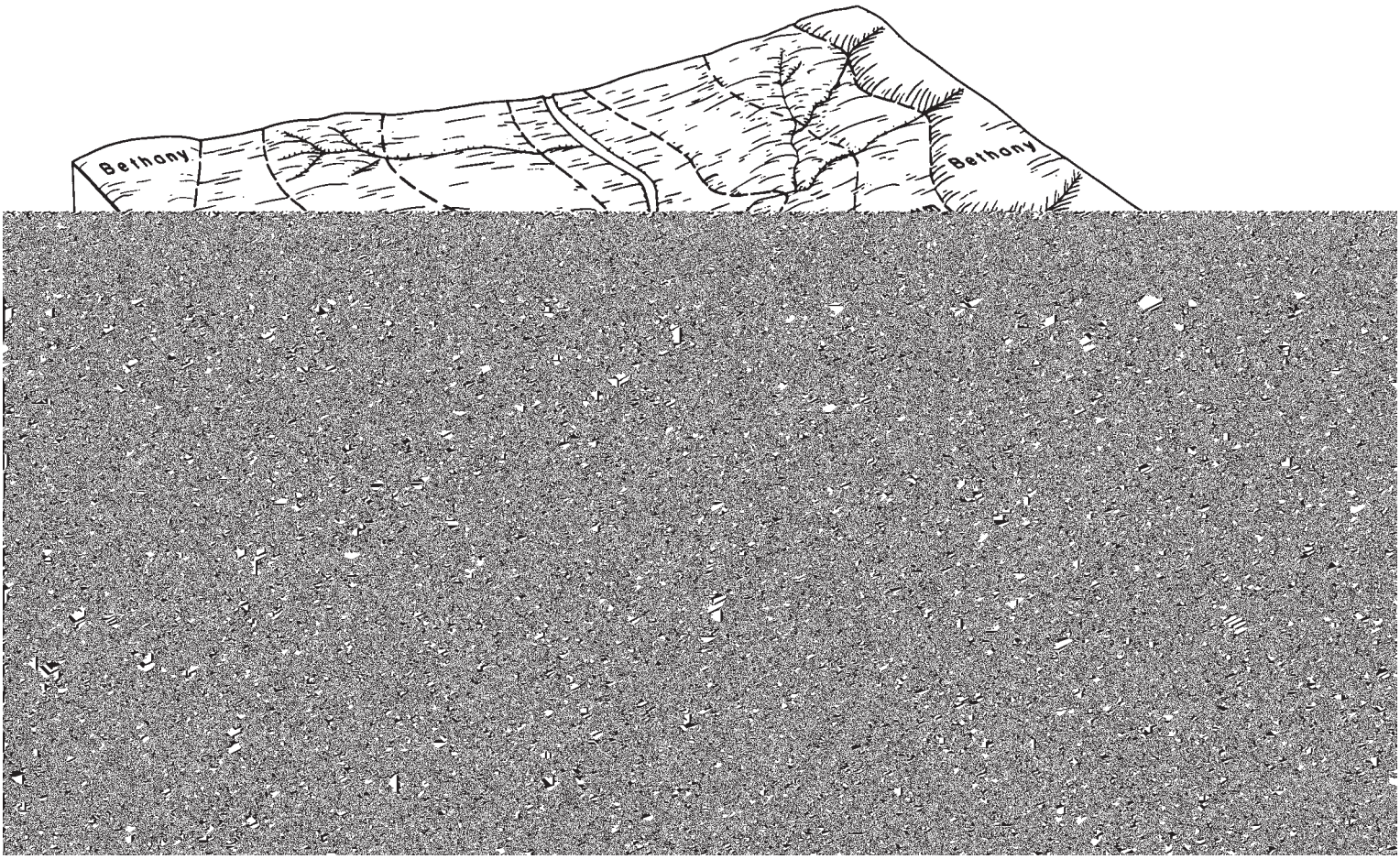
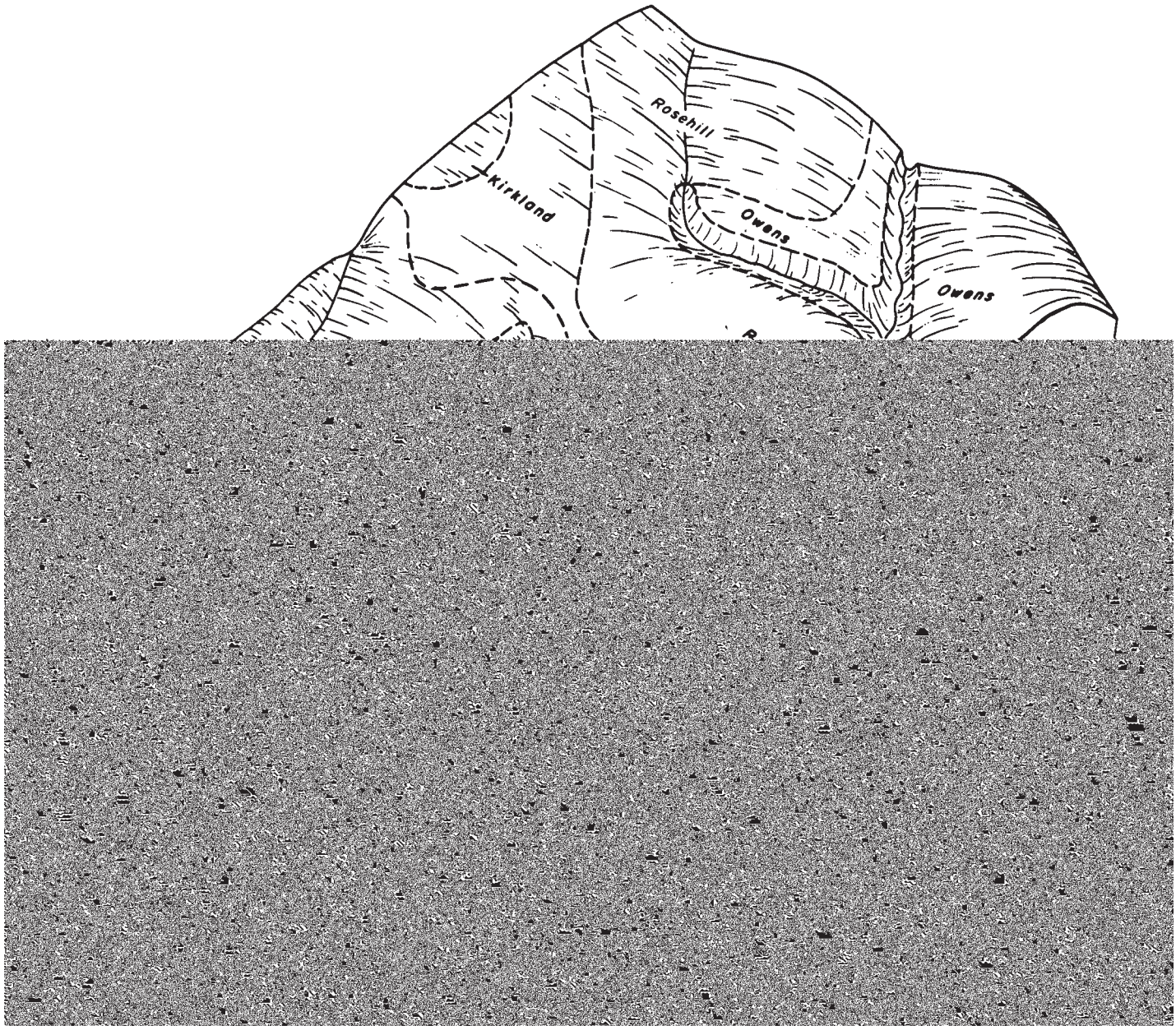


Figure 1.—Typical pattern of soils in the Bethany-Kirkland-Tabler association.


Bethany
Bethany


Rosehill
Kirkland
Owens
Owens

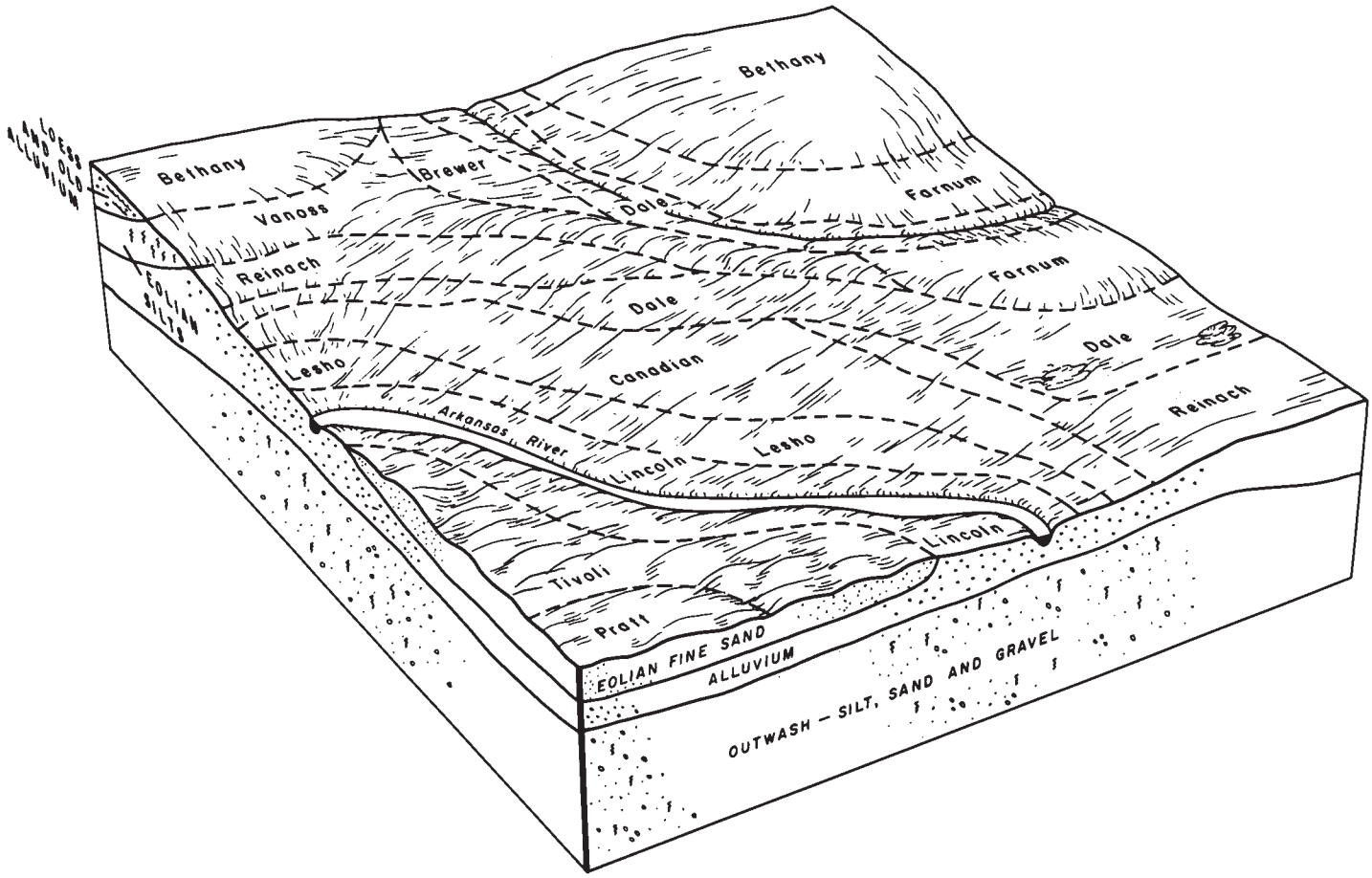


Figure 4.—Pattern of soils in northeastern Sumner County in the Arkansas River Valley and adjacent uplands.

Figure 5.—Salt-affected soils in an area of Brewer complex.

Figure 6.—Peach orchard on Dale and Reinach silt loams.

Figure 7.—Bales of sudangrass hay on Farnum loam, 0 to 1 percent slopes.

Figure 8.—Sorghum for silage on Kirkland silt loam, 0 to 1 percent slopes.

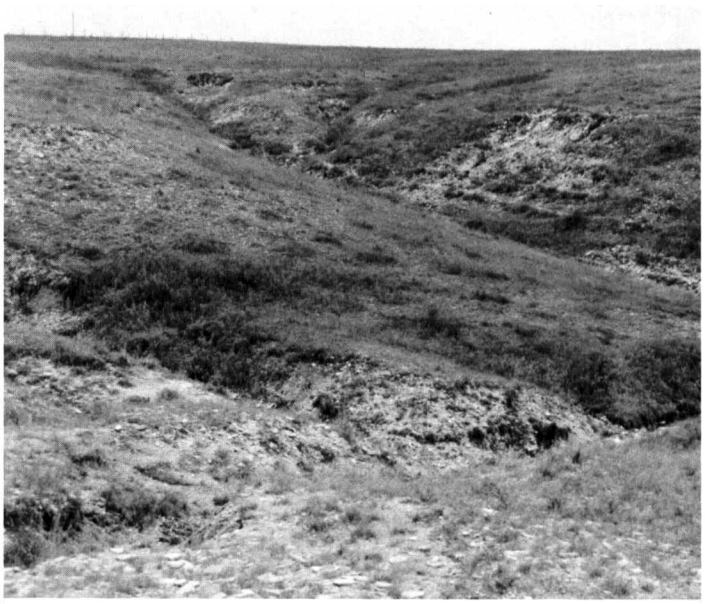


Figure 9.—Native range on Owens-Shale outcrop complex, 8 to 25 percent slopes.

Figure 10.—Water ponded on Tabler silty clay loam.

Figure 11.—Profile of Vanoss silt loam, 1 to 3 percent slopes.

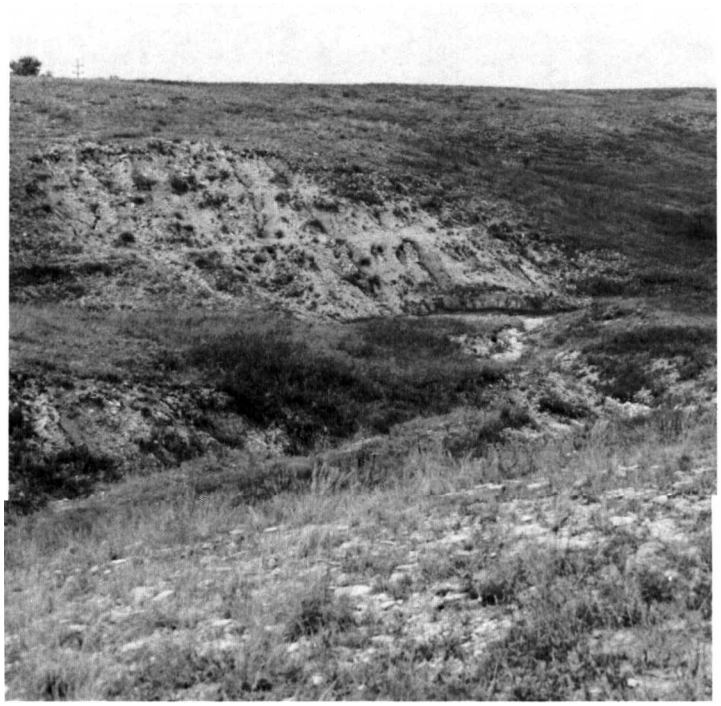


Figure 12.—Range on Owens-Shale outcrop complex, 8 to 25 percent slopes.

Figure 13.—Windbreak of coniferous and broadleaf species on Shellabarger sandy loam, 1 to 3 percent slopes.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data are from Wellington, Kansas, 1941-70]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	In	In	In		In
January---	44.7	22.8	70	-5	0.89	0.37	1.11	2	4.0
February--	50.8	27.2	75	4	1.20	0.42	1.96	2	2.8
March-----	58.3	33.4	85	6	1.80	0.94	2.96	4	2.5
April-----	71.2	46.0	91	25	3.51	1.35	6.23	4	0.2
May-------	79.5	55.2	98	33	4.13	1.43	6.64	6	0
June------	88.6	64.8	102	46	5.41	2.57	7.39	7	0
July------	93.6	69.2	106	53	4.16	2.14	5.78	6	0
August----	93.4	68.2	109	51	3.56	1.80	4.65	5	0
September-	84.6	59.6	102	39	3.73	0.96	6.57	6	0
October---	74.1	48.4	94	26	2.67	0.61	4.89	4	0
November--	58.9	34.8	79	11	1.53	0.02	2.69	2	1.0
December--	47.5	26.1	70	-1	1.36	0.40	2.54	3	3.3
Year---	70.4	46.3	109	-5	33.95	24.50	41.42	51	13.8

TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Temperature[1]		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than-----	April 7	April 15	April 27
2 years in 10 later than-----	April 2	April 10	April 22
5 years in 10 later than-----	March 24	April 3	April 12
First freezing temperature in fall:			
1 year in 10 earlier than---	November 3	October 20	October 13
2 years in 10 earlier than---	November 7	October 25	October 17
5 years in 10 earlier than---	November 17	November 5	October 27

[1]Recorded in the period 1941-70 at Wellington, Kansas.

TABLE 3.--GROWING SEASON LENGTH

Probability	Daily minimum temperature during growing season[1]		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	217	199	179
8 years in 10	224	206	185
5 years in 10	239	218	199
2 years in 10	254	231	211
1 year in 10	261	238	218

[1]Recorded in the period 1941-70 at Wellington, Kansas.

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ba	Bethany silt loam, 0 to 1 percent slopes	112,330	14.8
Bb	Bethany silt loam, 1 to 3 percent slopes	80,050	10.5
Br	Brewer silty clay loam	15,130	2.0
Bs	Brewer complex	3,400	0.4
Ca	Canadian sandy loam	11,640	1.5
Cc	Carwile soils	11,890	1.6
Cr	Corbin silt loam	2,710	0.4
Cs	Crisfield sandy loam	2,250	0.3
Da	Dale silt loam, 2 to 8 percent slopes	1,770	0.2
Dr	Dale and Reinach silt loams	32,540	4.3
Ea	Elandco silty clay loam	37,410	4.9
Ec	Elandco silt loam, frequently flooded	9,890	1.3
Fa	Farnum loam, 0 to 1 percent slopes	36,750	4.8

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Grain sorghum	Wheat
	Bu	Bu
Bethany:		
Ba	55	35
Bb	50	32
Brewer:		
Br	55	32
[1]Bs	35	20
Canadian:		
Ca	50	---
Carwile:		
Cc	30	20
Corbin:		
Cr	50	33
Crisfield:		
Cs	50	30
Dale:		
Da	35	20
[1]Dr	55	35
Elandco:		
Ea	55	35
Ec	---	---
Farnum:		
Fa	55	35
Fb	53	32
Fc	49	30
Fd	45	27
Kirkland:		
Ka	42	28
Kb	38	25
Kc	30	20
Lesho:		
Lo	35	21
Lincoln:		
Ls	---	---
Milan:		
Ma	55	35
Mb	53	32
Mc	49	30
Md	45	27

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Grain sorghum	Wheat
	Bu	Bu
Owens:		
On	---	13
Oo	---	---
[1]Op	---	---
[1]Or	20	13
[1]Os	---	---
Pond Creek:		
Pa	50	33
Pb	47	30
Pc	40	26
Pd	32	22
Pratt:		
Px	45	25
Renfrow:		
[1]Ra	34	25
Rosehill:		
Ro	38	26
Rs	35	24
Rx	31	20
Shellabarger:		
Sa	45	26
Sb	40	22
Sc	35	18
Tabler:		
Ta	40	27
Tivoli:		
Tv	---	---
Ustifluvents:		
[1]Us.		
Vanoss:		
Va	55	35
Vb	50	32
Vc	44	27
Waurika:		
Wa	36	23

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION

[Soils not listed are not in range sites; such soils can be used for grazing if grass cover is established]

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Bethany:					
Ba, Bb	Loamy upland	Favorable	5,000	Little bluestem	25
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Side-oats grama	5
				Blue grama	5
				Tall dropseed	5
				Dotted gayfeather	5
				Other trees	5
				Other perennial forbs	5
Brewer:					
Br	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Switchgrass	15
		Unfavorable	4,200	Indiangrass	15
				Prairie cordgrass	10
				Western wheatgrass	5
				Canada wildrye	5
				Perennial sunflower	5
				Goldenrod	5
				Sedges	5
				Other trees	10
[1]Bs:					
Brewer part	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Switchgrass	15
		Unfavorable	4,200	Indiangrass	15
				Prairie cordgrass	10
				Western wheatgrass	5
				Canada wildrye	5
				Perennial sunflower	5
				Goldenrod	5
				Sedges	5
				Other trees	10
Salt-affected part	Saline lowland	Favorable	5,500	Switchgrass	15
		Normal	4,500	Knotroot bristlegrass	15
		Unfavorable	3,500	Big bluestem	20
				Western wheatgrass	10
				Tall dropseed	10
				Illinois bundleflower	5
				Buffalograss	5
				Blue grama	5
				Saltgrass	5
				Other perennial forbs	10
Canadian:					
Ca	Sandy lowland	Favorable	7,000	Big bluestem	25
		Normal	5,500	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Heath aster	5
				Sedges	5
				Other trees	10

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Carwile:					
Cc	Sandy	Favorable	5,000	Switchgrass	20
		Normal	3,800	Little bluestem	10
		Unfavorable	3,000	Indiangrass	15
				Sand bluestem	15
				Scribner panicum	5
				Canada wildrye	5
				Side-oats grama	5
				Other perennial grasses	10
				Other perennial forbs	10
				Other shrubs	5
Corbin:					
Cr	Loamy upland	Favorable	5,500	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Western wheatgrass	5
				Side-oats grama	3
				Sedges	3
				Louisiana sagewort	3
				Blue grama	2
				Buffalograss	2
				Western ragweed	2
				Other perennial forbs	5
Crisfield:					
Cs	Sandy lowland	Favorable	7,000	Sand bluestem	35
		Normal	5,500	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Maximilian sunflower	10
				Canada wildrye	3
				Western wheatgrass	3
				Tall dropseed	1
				Blue grama	1
				Side-oats grama	1
				Purpletop	1
				Other perennial forbs	5
Dale:					
Da	Loamy lowland	Favorable	8,500	Big bluestem	30
		Normal	6,100	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Dale:					
Reinach part	Loamy lowland	Favorable	8,000	Big bluestem	30
		Normal	6,000	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Heath aster	5
				Sedges	5
				Other trees	5
Elandco:					
Ea, Ec	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Indiangrass	15
		Unfavorable	4,000	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Sedges	5
				Prairie cordgrass	5
				Other perennial forbs	5
Farnum:					
Fa, Fb, Fc, Fd	Loamy upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Side-oats grama	5
				Tall dropseed	3
				Western wheatgrass	3
				Slimflower scurfpea	3
				Blue grama	2
				Canada wildrye	2
				Leadplant	2
				Maximilian sunflower	2
				Missouri goldenrod	2
				Buffalograss	1
Kirkland:					
Ka, Kb, Kc	Clay upland	Favorable	4,500	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2.000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5
				Goldenrod	5
				Other shrubs	5
				Leadplant	3
				Other perennial forbs	2
Lesho:					
Lo	Subirrigated	Favorable	9,000	Sand bluestem	15
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Eastern gamagrass	15
				Switchgrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Tall dropseed	5
				Western wheatgrass	5
				Sedges	5
				Other shrubs	5
				Maximilian sunflower	5
				Other perennial forbs	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Lincoln:					
Ls	Sandy lowland	Favorable	4,000	Switchgrass	20
		Normal	3,000	Sand bluestem	15
		Unfavorable	2,000	Indiangrass	15
				Little bluestem	5
				Purpletop	5
				Maximilian sunflower	5
				Goldenrod	5
				Other trees	15
				Other perennial grasses	10
				Other perennial forbs	5
Milan:					
Ma, Mb, Mc, Md	Loamy upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Side-oats grama	5
				Tall dropseed	3
				Western wheatgrass	3
				Slimflower scurfpea	3
				Blue grama	2
				Canada wildrye	2
				Leadplant	2
				Maximilian sunflower	2
				Missouri goldenrod	2
				Buffalograss	1
Owens:					
On, Oo	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
[1]Op:					
Owens part	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
Elandco part	Loamy lowland	Favorable	8,000	Big bluestem	25
		Normal	6,000	Indiangrass	15
		Unfavorable	4,500	Switchgrass	15
				Little bluestem	10
				Eastern gamagrass	5
				Tall dropseed	5
				Compassplant	5
				Sedges	5
				Other trees	5
				Prairie cordgrass	5
				Other perennial forbs	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Owens:					
[1]Or:					
Owens part	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
Renfrow part	Clay upland	Favorable	4,500	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5
				Leadplant	5
				Goldenrod	5
				Other perennial forbs	5
[1]Os:					
Owens part	Clay upland	Favorable	4,000	Big bluestem	15
		Normal	3,200	Switchgrass	20
		Unfavorable	2,500	Compassplant	15
				Little bluestem	20
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
				Catclaw sensitivebrier	5
				Other perennial forbs	5
Shale outcrop part	Not assigned.				
Pond Creek:					
Pa, Pb, Pc, Pd	Loamy upland	Favorable	5,000	Little bluestem	25
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Side-oats grama	5
				Blue grama	5
				Tall dropseed	5
				Prairieclover	5
				Dotted gayfeather	5
				Other shrubs	5
Pratt:					
Px	Sands	Favorable	4,500	Sand bluestem	25
		Normal	3,500	Little bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Sand lovegrass	10
				Switchgrass	5
				Blue grama	5
				Texas bluegrass	5
				Sand dropseed	5
				Western wheatgrass	3
				Western ragweed	3
				Sedges	2
				Louisiana sagewort	2
				Other perennial forbs	5

See footnote at end of table.

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Renfrow:					
[1]Ra	Clay upland	Favorable	4,000	Little bluestem	25
		Normal	2,800	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5
				Leadplant	5
				Goldenrod	5
				Coralberry	5
Rosehill:					
Ro, Rs, Rx	Clay upland	Favorable	4,500	Big bluestem	30
		Normal	3,000	Little bluestem	15
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	5
				Side-oats grama	5
				Tall dropseed	5
				Western wheatgrass	5
				Dotted gayfeather	5
				Leadplant	5
				Western ragweed	2
				Maximilian sunflower	3
				Other perennial forbs	5
Shellabarger:					
Sa, Sb, Sc	Sandy	Favorable	5,000	Sand bluestem	35
		Normal	3,500	Little bluestem	25
		Unfavorable	2,500	Indiangrass	15
				Switchgrass	10
				Blue grama	2
				Roundhead lespedeza	2
				Chickasaw plum	2
				Sand dropseed	1
				Sand paspalum	1
				Louisiana sagewort	1
				Scribner panicum	1
				Other perennial forbs	5
Tabler:					
Ta	Clay upland	Favorable	4,000	Little bluestem	25
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	10
				Other perennial forbs	10

TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lb/acre		Pct
Vanoss:					
Va, Vb, Vc	Loamy upland	Favorable	5,500	Little bluestem	25
		Normal	4,000	Big bluestem	20
		Unfavorable	2,500	Indiangrass	10
				Switchgrass	10
				Canada wildrye	5
				Side-oats grama	5
				Blue grama	5
				Tall dropseed	5
				Dotted gayfeather	5
				Slender lespedeza	3
				Roundhead lespedeza	2
				Other trees	5
Waurika:					
Wa	Clay upland	Favorable	3,500	Little bluestem	20
		Normal	2,300	Big bluestem	20
		Unfavorable	1,500	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	10
				Buffalograss	5
				Leadplant	5
				Goldenrod	5
				Other perennial forbs	5

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[Absence of an entry means the species is not rated for this soil]

Soil name and map symbol	Expected heights in feet of specified trees at 20 years of age								
	Osage-orange	Eastern cotton-wood	Eastern redcedar	Hackberry	Honey-locust	White mulberry	Ponderosa pine	Russian-olive	Siberian elm
Bethany:									
Ba, Bb	20	35	25	26	24	20	24	18	35
Brewer:									
Br, [1]Bs	20	50	25	30	26	22	--	--	35
Canadian:									
Ca	23	55	30	30	28	22	25	20	45
Carwile:									
Cc	18	45	25	22	20	15	--	--	25
Corbin:									
Cr	20	35	25	26	24	20	23	17	40
Crisfield:									
Cs	22	50	25	30	28	24	26	19	45
Dale:									
Da	23	55	30	30	30	24	24	20	45
[1]Dr:									
Dale part	23	55	30	30	30	24	24	20	45
Reinach part	23	50	30	30	30	22	25	20	45
Elandco:									
Ea	23	50	30	30	28	22	20	18	40
Ec	20	55	30	30	30	24	25	20	45
Farnum:									
Fa, Fb, Fc, Fd	19	35	25	25	24	15	20	17	37
Kirkland:									

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Expected heights in feet of specified trees at 20 years of age								
	Osage-orange	Eastern cotton-wood	Eastern redcedar	Hackberry	Honey-locust	White mulberry	Ponderosa pine	Russian-olive	Siberian elm
Pond Creek:									
Pa, Pb, Pc, Pd	24	50	25	24	24	20	24	17	40
Pratt:									
Px	15	35	16	--	25	20	20	15	30
Renfrow:									
[1]Ra	17	35	19	26	20	16	--	16	25
Rosehill:									
Rx, Rs, Ro	15	--	17	25	20	15	--	16	23
Shellabarger:									
Sa, Sb, Sc	24	--	18	--	26	21	24	17	25
Tabler:									
Ta	18	40	20	22	20	21	--	--	35
Tivoli:									
Tv	10	25	15	--	18	17	--	15	25
Ustifluvents:									
[1]Us	18	50	25	30	28	24	24	19	42
Vanoss:									
Va, Vb, Vc	23	40	20	25	29	22	25	20	40
Waurika:									
Wa	16	40	20	20	20	20	--	--	35

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Bethany: Ba, Bb	Severe: too clayey.	Severe: shrink-swell,	Severe: shrink-swell,	Severe: shrink-swell,	Severe: shrink-swell,

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Kirkland:					
Ka, Kb, Kc	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Lesho:					
Lo	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Moderate: low strength, wetness, shrink-swell.
Lincoln:					
Ls	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Milan:					
Ma, Mb, Mc, Md	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Owens:					

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Rosehill:					
Rx, Rs, Ro	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Shellabarger:					
Sa	Slight	Slight	Slight	Slight	Moderate: low strength.
Sb, Sc	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength.
Tabler:					
Ta	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Tivoli:					
Tv	Severe: cutbanks cave, too sandy.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Ustifluvents:					
[1]Us	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, slope.	Severe: floods.
Vanoss:					
Va, Vb, Vc	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength, shrink-swell.
Waurika:					
Wa	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: low strength, shrink-swell.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 9.--SANITARY FACILITIES

[“Percs slowly” and some of the other terms that describe restrictive soil features are defined in the glossary.]

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Lincoln:					
Ls	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy.
Milan:					
Ma	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Mb, Mc, Md	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Tivoli:					
Tv	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy.
Ustifluvents:					
[1]Us	Severe: floods.	Severe: floods, slope.	Severe: floods.	Severe: floods.	Poor: slope.
Vanoss:					
Va, Vb, Vc	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Waurika:					
Wa	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Severe: wetness.	Poor: thin layer.

TABLE 10.--CONSTRUCTION MATERIALS

["Shrink-swell" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited"]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Bethany:				
Ba, Bb	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Brewer:				
Br, [1]Bs	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey.
Canadian:				
Ca	Fair: low strength.	Unsuited	Unsuited	Good.
Carwile:				
Cc	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: thin layer.
Corbin:				
Cr	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Crisfield:				
Cs	Fair: low strength.	Poor: excess fines.	Unsuited	Good.
Dale:				
Da	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
[1]Dr:				
Dale part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
Reinach part	Fair: low strength.	Unsuited	Unsuited	Good.
Elandco:				
Ea	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Ec	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
Farnum:				
Fa, Fb, Fc, Fd	Poor: low strength.	Unsuited	Unsuited	Good.
Kirkland:				
Ka, Kb, Kc	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Lesho:				
Lo	Fair: shrink-swell, low strength, wetness.	Fair: excess fines.	Unsuited	Fair: area reclaim.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Lincoln:				
Ls	Good	Fair	Unsuited	Poor: too sandy.
Milan:				
Ma, Mb, Mc, Md	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Owens:				
On, Oo	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
[1]Op:				
Owens part	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Elandco part	Fair: low strength, shrink-swell.	Unsuited	Unsuited	Good.
[1]Or:				
Owens part	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Renfrow part	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: too clayey, thin layer.
[1]Os:				
Owens part	Poor: shrink-swell.	Unsuited	Unsuited	Poor: too clayey.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Vanoss: Va, Vb, Vc	Poor: low strength.	Unsuited	Unsuited	Fair: thin layer.
Waurika: Wa	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 11.--WATER MANAGEMENT

["Seepage," and some of the other terms that describe restrictive soil features are defined in the Glossary]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Bethany:						
Ba, Bb	Favorable	Unstable fill, compressible.	Not needed	Slow intake	Percs slowly	Percs slowly.
Brewer:						

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Milan:						
Ma	Favorable	Low strength, shrink-swell.	Not needed	Slow intake	Favorable	Favorable.
Mb, Mc, Md	Favorable	Low strength, shrink-swell.	Not needed	Slow intake, slope.	Favorable	Favorable.
Owens:						
On	Favorable	Compressible	Not needed	Droughty, percs slowly.	Rooting depth, percs slowly.	Droughty, erodes easily.
Oo	Favorable	Compressible	Not needed	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
[1]Op:						
Owens part	Favorable	Compressible	Not needed	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
Elandco part	Seepage	Unstable fill, compressible, piping.	Not needed	Floods	Not needed	Favorable.
[1]Or:						
Owens part	Favorable	Compressible	Not needed	Droughty, percs slowly.	Rooting depth, percs slowly.	Droughty, erodes easily.
Renfrow part	Favorable	Unstable fill, compressible.	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
[1]Os:						
Owens part	Favorable	Compressible	Not needed	Droughty, percs slowly.	Slope, rooting depth.	Droughty, erodes easily.
Shale outcrop part not rated.						
Pond Creek:						
Pa	Seepage	Unstable fill, piping.	Not needed	Favorable	Favorable	Favorable.
Pb, Pc, Pd	Seepage	Unstable fill, piping.	Not needed	Slope	Favorable	Favorable.
Pratt:						
Px	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, soil blowing, fast intake.	Too sandy, complex slope, soil blowing.	Soil blowing, droughty.
Renfrow:						
[1]Ra	Favorable	Unstable fill, compressible.	Not needed	Erodes easily, percs slowly.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Rosehill:						
Ro, Rs, Rx	Depth to rock	Low strength, shrink-swell.	Not needed	Slow intake, slope.	Depth to rock	Rooting depth.
Shellabarger:						
Sa, Sb, Sc	Seepage	Low strength, piping.	Not needed	Fast intake, slope, erodes easily.	Piping	Favorable.
Tabler:						
Ta	Favorable	Unstable fill, compressible.	Percs slowly	Slow intake	Percs slowly	Percs slowly.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Tivoli:						
Tv	Seepage	Unstable fill, seepage, piping.	Not needed	Complex slope, erodes easily, droughty.	Complex slope, erodes easily, fast intake.	Erodes easily, droughty, seepage.
Ustifluvents:						
[1]Us	Favorable	Low strength	Floods	Slope, erodes easily.	Floods, slope.	Erodes easily, slope.
Vanoss:						
Va, Vb, Vc	Seepage	Unstable fill, low strength, piping.	Not needed	Favorable	Favorable	Favorable.
Waurika:						
Wa	Favorable	Compressible, unstable fill, shrink-swell.	Wetness	Wetness, slow intake.	Not needed	Not needed.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

["Percs slowly" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Bethany:				
Ba, Bb	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Brewer:				
Br, [1]Bs	Severe: floods.	Moderate: floods, too clayey.	Moderate: floods, too clayey, percs slowly.	Moderate: too clayey.
Canadian:				
Ca	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
Carwile:				
Cc	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Corbin:				
Cr	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Crisfield:				
Cs	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
Dale:				
Da	Moderate: floods.	Slight	Moderate: slopes.	Slight.
[1]Dr:				
Dale part	Moderate: floods.	Slight	Slight	Slight.
Reinach part	Moderate: floods.	Slight	Slight	Slight.
Elandco:				
Ea	Moderate: floods, too clayey.	Moderate: too clayey.	Moderate: too clayey.	Moderate: too clayey.
Ec	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
Farnum:				
Fa, Fb, Fc, Fd	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Kirkland:				
Ka, Kb	Severe: percs slowly.	Slight	Severe: percs slowly.	Slight.
Kc	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Lesho:				
Lo	Severe: floods, wetness.	Moderate: floods, wetness.	Moderate: floods, wetness, percs slowly.	Moderate: wetness.
Lincoln:				
Ls	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Milan:				
Ma, Mb, Mc, Md	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Owens:				
On, Oo	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
[1]Op:				
Owens part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: slope, too clayey.	Severe: too clayey.
Elandco part	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods.
[1]Or:				
Owens part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
Renfrow part	Severe: percs slowly, too clayey.	Moderate: too clayey.	Severe: percs slowly, slope.	Moderate: too clayey.
[1]Os:				
Owens part	Severe: slope, too clayey.	Severe: slope, too clayey.	Severe: slope, too clayey.	Severe: too clayey.
Shale outcrop part not rated.				
Pond Creek:				
Pa	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Pb, Pc, Pd	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
Pratt:				
Px	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.	Moderate: too sandy.
Renfrow:				
[1]Ra	Severe: percs slowly, too clayey.	Moderate: too clayey.	Severe: percs slowly, slope.	Moderate: too clayey.
Rosehill:				
Ro, Rs, Rx	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Shellabarger:				
Sa, Sb, Sc	Slight	Slight	Moderate: slope.	Slight.
Tabler:				
Ta	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Tivoli:				
Tv	Severe: too sandy, dusty.	Severe: too sandy, dusty.	Severe: too sandy, dusty.	Severe: too sandy, dusty.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Ustifluvents:				
[1]Us	Severe: floods.	Severe: floods.	Severe: floods, slope.	Severe: floods.
Vanoss:				
Va	Slight	Slight	Slight	Slight.
Vb, Vc	Slight	Slight	Moderate: slope.	Slight.
Waurika:				
Wa	Severe: wetness, percs slowly.	Moderate: wetness.	Severe: wetness, percs slowly.	Moderate: wetness.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Bethany:												
Ba, Bb	Good	Good	Fair	Fair	Poor	Fair	Poor	Very poor.	Good	Fair	Very poor.	Fair.
Brewer:												
Br, [1]Bs	Good	Good	Fair	Good	Poor	Good	Poor	Poor	Good	Good	Poor	Fair.
Canadian:												
Ca	Good	Good	Good	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Carwile:												
Cc	Fair	Good	Good	Fair	Poor	Good	Good	Fair	Good	Fair	Fair	Good.
Corbin:												
Cr	Good	Good	Fair	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Crisfield:												
Cs	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Dale:												
Da	Fair	Good	Fair	Good	Poor	Good	Poor	Very poor.	Fair	Fair	Very poor.	Fair.
[1]Dr:												
Dale part	Good	Good	Fair	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Fair.
Reinach part	Good	Good	Good	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Elandco:												
Ea	Good	Good	Fair	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Fair.
Ec	Poor	Fair	Fair	Good	Poor	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
Farnum:												
Fa, Fb	Good	Good	Good	Good	Poor	Fair	Fair	Poor	Good	Good	Poor	Fair.
Fc, Fd	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Kirkland:												
Ka, Kb, Kc	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Lesho:												
Lo	Fair	Fair	Fair	Good	Poor	Fair	Fair	Fair	Fair	Good	Fair	Fair.
Lincoln:												
Ls	Poor	Fair	Fair	Poor	Very poor.	Fair	Very poor.	Very poor.	Fair	Poor	Very poor.	Fair.
Milan:												
Ma, Mb	Good	Good	Good	Good	Poor	Fair	Fair	Poor	Good	Good	Poor	Fair.
Mc, Md	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Owens:												
On	Fair	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Oo	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
[1]Op:												
Owens part	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Elandco part	Poor	Fair	Fair	Good	Poor	Good	Poor	Very poor.	Fair	Good	Very poor.	Fair.
[1]Or:												
Owens part	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Renfrow part	Good	Good	Fair	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
[1]Os:												
Owens part	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Shale outcrop part not rated.												
Pond Creek:												
Pa, Pb, Pc, Pd	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Pratt:												
Px	Fair	Good	Fair	Fair	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Renfrow:												
[1]Ra	Good	Good	Fair	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Rosehill:												
Ro, Rs, Rx	Fair	Good	Fair	Poor	Poor	Fair	Poor	Very poor.	Fair	Poor	Very poor.	Fair.
Shellabarger:												
Sa	Good	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Sb, Sc	Fair	Good	Good	Good	Poor	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
Tabler:												
Ta	Good	Good	Fair	Good	Good	Fair	Poor	Poor	Good	Good	Poor	Fair.
Tivoli:												
Tv	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Ustifluvents:												
[1]Us	Very poor.	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Vanoss:												
Va, Vb, Vc	Good	Good	Good	Good	Poor	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Waurika:												
Wa	Fair	Good	Fair	Poor	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair.

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Bethany:											
Ba, Bb	0-17	Silt loam	CL, ML	A-4, A-6	0	100	100	96-100	80-98	21-40	1-20
	17-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	100	95-100	96-100	90-99	37-60	15-33
Brewer:											
Br, [1]Bs	0-14	Silty clay loam	CL	A-6, A-7	0	100	100	96-100	80-98	30-43	10-19
	14-60	Silty clay	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	16-38
Canadian:											
Ca	0-40	Sandy loam	SM, ML, SC	A-4	0	100	98-100	94-100	36-85	<31	[2]NP-10
	40-60	Loamy fine sand, fine sandy loam, sandy loam.	SM, ML, SC	A-4, A-2	0	100	98-100	90-100	15-85	<31	NP-10
Carwile:											
Cc	0-10	Fine sandy loam	ML, CL, CL-ML, SM	A-4	0	100	98-100	94-100	36-85	<30	NP-10
	10-39	Clay, clay loam, sandy clay.	CL, CH, SC	A-6, A-7	0	100	100	90-100	40-95	35-70	14-38
	39-60	Sandy clay loam, clay loam, clay.	CL, CH, SC	A-4, A-6, A-7	0	100	100	90-100	36-95	25-70	7-38
Corbin:											
Cr	0-16	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	75-100	25-35	5-15
	16-29	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-100	35-45	10-25
	29-48	Clay, silty clay	CH, CL	A-7-6	0	100	100	95-100	90-100	45-60	25-35
	48-60	Silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	85-100	35-45	12-25
Crisfield:											
Cs	0-60	Sandy loam	SM, ML	A-4	0	100	100	85-100	40-70	<26	NP-6
Dale:											
Da	0-24	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	65-98	27-43	7-20
	24-60	Silt loam, loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	65-98	27-43	7-20
[1]Dr:											
Dale part	0-24	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	65-98	27-43	7-20
	24-60	Silt loam, loam, silty clay loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	65-98	27-43	7-20
Reinach part	0-60	Silt loam	CL, ML	A-4	0	100	100	94-100	51-97	<31	NP-10
Elandco:											
Ea	0-45	Silty clay loam	CL	A-6, A-7	0	100	100	96-100	85-98	30-43	8-20
	45-60	Silty clay loam, silt loam, loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	75-98	30-43	7-20
Ec	0-45	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	85-98	24-43	5-20
	45-60	Silty clay loam, silt loam, loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	75-98	27-43	5-20

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Farnum:											
Fa, Fb, Fc, Fd----	0-11	Loam----------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	<30	5-15
	11-60	Clay loam, sandy clay loam.	SC, CL, CH	A-6, A-7-6	0	100	100	65-100	45-80	32-55	10-25
Kirkland:											
Ka, Kb----------	0-9	Silt loam-------	CL	A-4, A-6	0	100	100	96-100	80-98	30-40	8-19
	9-60	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-38
Kc----------	0-7	Silty clay loam-	CL	A-6	0	100	100	96-100	80-98	30-45	8-19
	7-60	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-38
Lesho:											
Lo----------	0-30	Clay loam-------	CL	A-6, A-7-6	0	100	100	95-100	65-85	30-45	8-25
	30-60	Loamy fine sand, sand.	SM, SP-SM	A-2, A-3	0	100	100	30-85	5-45	---	NP
Lincoln:											
Ls----------	0-10	Loamy fine sand-	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
	10-60	Fine sand, loamy fine sand.	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
Milan:											
Ma, Mb, Mc, Md----	0-10	Loam----------	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	65-85	20-30	5-15
	10-60	Clay loam, sandy clay loam.	SC, CL, CH	A-6, A-7-6	0	95-100	95-100	65-100	45-80	35-55	11-27
Owens:											
On, Oo----------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	40-60	20-32
	20-22	Shale----------	---	---	---	---	---	---	---	---	---
[1]Op:											
Owens part-------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	40-60	20-32
	20-22	Shale----------	---	---	---	---	---	---	---	---	---
Elandco part-----	0-45	Silty clay loam	ML, CL	A-4, A-6, A-7	0	100	100	96-100	85-98	31-43	8-20
	45-60	Silty clay loam, clay loam, loam.	ML, CL	A-4, A-6, A-7	0	100	100	96-100	75-98	27-43	7-20
[1]Or:											
Owens part-------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	40-60	20-32
	20-22	Shale----------	---	---	---	---	---	---	---	---	---
Renfrow part-----	0-12	Clay loam-------	CL	A-6, A-7	0	100	100	96-100	80-98	33-49	12-26
	12-60	Clay, silty clay, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	15-38
[1]Os:											
Owens part-------	0-4	Clay loam-------	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	4-20	Clay, silty clay, clay loam.	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	40-60	20-32
	20-22	Shale----------	---	---	---	---	---	---	---	---	---

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Owens: Shale outcrop part not rated.											
Pond Creek:											
Pa, Pb, Pc	0-13	Silt loam	ML, CL, CL-ML	A-4, A-6	0	100	100	96-100	65-97	22-37	3-14
	13-60	Silty clay loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	7-20
Pd	0-7	Silty clay loam	CL, CL-ML	A-6	0	100	100	96-100	65-97	27-43	8-20
	7-60	Silty clay loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	65-98	30-43	7-20
Pratt:											
Px	0-14	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	95-100	70-100	7-35	---	NP
	14-38	Loamy fine sand, loamy sand.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	38-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
Renfrow:											
[1]Ra	0-12	Clay loam	CL	A-6, A-7	0	100	100	96-100	80-98	33-49	12-26
	12-60	Clay, silty clay, silty clay loam, clay loam.	CL, CH	A-6, A-7	0	100	100	96-100	80-99	37-70	15-38
Rosehill:											
Ro, Rs, Rx	0-10	Clay loam	CH, CL	A-7	0	100	100	95-100	90-100	40-55	20-30
	10-40	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	50-70	25-50
	40-48	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Shellabarger:											
Sa, Sb, Sc	0-11	Sandy loam	SM, ML	A-4, A-2	0	95-100	95-100	75-100	30-55	<30	NP-5
	11-38	Sandy clay loam, sandy loam.	SC, CL	A-4, A-6	0	95-100	95-100	70-90	35-55	25-40	8-25
	38-60	Sandy loam, loamy sand, sand.	SC, SM	A-2, A-4	0	70-100	70-100	50-80	10-40	<30	NP-5
Tabler:											
Ta	0-9	Silty clay loam	CL, CL-ML	A-6, A-7	0	100	100	96-100	80-98	20-40	3-18
	9-40	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-35
	40-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0	96-100	96-100	92-100	80-99	33-60	13-33
Tivoli:											
Tv	0-7	Fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-100	5-35	---	NP
	7-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-98	5-20	---	NP
Ustifluvents:											
[1]Us	0-60	Variable	---	---	---	---	---	---	---	---	---
Vanoss:											
Va, Vb, Vc	0-16	Silt loam	ML, CL	A-4, A-6	0	100	100	96-100	65-95	22-37	2-14
	16-40	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	33-43	12-20
	40-60	Loam, silt loam, clay loam.	CL, ML	A-4, A-6, A-7	0	100	100	96-100	65-98	22-43	2-20

See footnotes at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Waurika:											
Wa----------	0-14	Silt loam-------	CL, ML	A-4, A-6	0	100	100	96-100	80-95	22-37	3-14
	14-40	Clay, silty clay	CL, CH	A-7	0	95-100	95-100	90-100	80-98	41-66	20-40
	40-60	Clay loam, silty clay loam, clay.	CL, CH	A-6, A-7	0	90-100	90-100	85-100	80-98	38-55	16-30

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

[2]NP=nonplastic.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[Dashes indicate data were not available. The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm						
Bethany:											
Ba, Bb	0-17	0.06-2.0	0.18-0.22	5.6-7.3	<2	Low	Low	Low	0.43	5	6
	17-60	0.06-0.20	0.14-0.18	6.6-8.4	<2	High	High	Low	0.37		
Brewer:											
Br, [1]Bs	0-14	0.2-0.6	0.15-0.24	6.1-7.3	2-16	Moderate	High	Low	0.43	5	7
	14-60	0.06-0.2	0.12-0.22	6.6-8.4	2-16	High	High	Low	0.37		
Canadian:											
Ca	0-40	2.0-6.0	0.11-0.20	6.1-7.3	<2	Low	Low	Low	0.20	5	3
	40-60	2.0-20	0.07-0.20	6.1-8.4	<2	Low	Low	Low	0.20		
Carwile:											
Cc	0-10	0.6-2.0	0.11-0.20	6.1-7.3	<2	Low	Moderate	Moderate	0.37	5	3
	10-39	0.06-0.2	0.12-0.20	6.1-7.3	<2	High	High	Low	0.37		
	39-60	0.2-2.0	0.12-0.20	6.6-8.4	<2	High	High	Low	0.32		
Corbin:											
Cr	0-16	0.6-2.0	0.19-0.24	5.6-7.3	<2	Low	Low	Low	0.37	5	6
	16-29	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	Low	Low	0.37		
	29-48	0.06-0.2	0.09-0.16	6.1-7.3	<2	High	High	Low	0.37		
	48-60	0.2-2.0	0.11-0.18	6.1-7.8	<2	Moderate	Moderate	Low	0.37		
Crisfield:											
Cs	0-60	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low	Low	Low	0.20	5	3
Dale:											
Da	0-24	0.6-2.0	0.15-0.24	6.1-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	24-60	0.6-2.0	0.15-0.24	6.6-8.4	<2	Moderate	Moderate	Low	0.37		
[1]Dr:											
Dale part	0-24	0.6-2.0	0.15-0.24	6.1-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	24-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
Reinach part	0-60	0.6-2.0	0.13-0.24	6.1-8.4	<2	Low	Low	Low	0.37	5	6
Elandco:											
Ea	0-45	0.6-2.0	0.15-0.24	5.6-7.8	<2	Moderate	Moderate	Low	0.37	5	7
	45-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
Ec	0-45	0.6-2.0	0.15-0.24	5.6-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	45-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
Farnum:											
Fa, Fb, Fc, Fd	0-11	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	Low	Low	0.37	5-4	6
	11-60	0.2-0.6	0.14-0.21	6.6-7.8	<2	Moderate	Moderate	Low	0.37		
Kirkland:											
Ka, Kb, Kc	0-9	0.6-2.0	0.15-0.24	5.6-7.3	<2	Low	Low	Low	0.49	5	6
	9-60	<0.06	0.12-0.18	6.6-8.4	<2	High	High	Low	0.37		
Lesho:											
Lo	0-30	0.2-0.6	0.17-0.22	7.4-8.4	<2	Moderate	High	Low	0.32	3	4L
	30-60	>2.0	0.02-0.10	7.4-9.0	<2	Low	Low	Low	0.17		
Lincoln:											
Ls	0-10	6.0-20	0.05-0.10	7.4-8.4	<2	Low	Low	Low	0.17	5	2
	10-60	6.0-20	0.05-0.10	7.9-8.4	<2	Low	Low	Low	0.17		
Milan:											
Ma, Mb, Mc, Md	0-10	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low	Low	Low	0.37	5-4	6
	10-60	0.2-0.6	0.14-0.21	5.6-7.3	<2	Moderate	Moderate	Low	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm						
Owens:											
On, Oo	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32		
	20-22	<0.06	0.03-0.08	7.9-8.4	<2	High	High	Low	0.32		
[1]Op:											
Owens part	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32		
	20-22	<0.06	0.03-0.08	7.9-8.4	<2	High	High	Low	0.32		
Elandco part	0-20	0.6-2.0	0.15-0.24	5.6-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	20-60	0.6-2.0	0.15-0.24	6.1-8.4	<2	Moderate	Moderate	Low	0.37		
[1]Or:											
Owens part	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32		
	20-22	<0.06	0.03-0.08	7.9-8.4	<2	High	High	Low	0.32		
Renfrow part	0-12	0.2-0.6	0.15-0.22	6.1-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	12-60	<0.06	0.12-0.22	6.1-8.4	<2	High	High	Low	0.37		
[1]Os:											
Owens part	0-4	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32	1	6
	4-20	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32		
	20-22	<0.06	0.13-0.17	7.9-8.4	<2	High	High	Low	0.32		
Shale outcrop part not rated.											
Pond Creek:											
Pa, Pb, Pc, Pd	0-13	0.6-2.0	0.15-0.20	6.1-7.3	<2	Low	Low	Low	0.37	5	---
	13-60	0.2-0.6	0.15-0.22	6.1-8.4	<2	Moderate	Moderate	Moderate	0.37		
Pratt:											
Px	0-14	6.0-20	0.10-0.13	6.1-7.3	<2	Low	Low	Moderate	0.17	5	2
	14-38	6.0-20	0.09-0.16	6.1-7.3	<2	Low	Low	Low	0.17		
	38-60	6.0-20	0.08-0.12	6.1-7.3	<2	Low	Low	Low	0.17		
Renfrow:											
[1]Ra	0-12	0.2-0.6	0.15-0.22	6.1-7.8	<2	Moderate	Moderate	Low	0.37	5	6
	12-60	<0.06	0.12-0.22	6.1-8.4	<2	High	High	Low	0.37		
Rosehill:											
Ro, Rs, Rx	0-10	<0.2	0.14-0.20	6.6-7.3	<2	High	High	Low	0.43	3	4
	10-40	<0.06	0.10-0.14	6.6-8.4	<2	High	High	Low	0.37		
	40-48	---	---	---	---	---	---	---	---		
Shellabarger:											
Sa, Sb, Sc	0-11	0.6-2.0	0.13-0.21	5.6-6.5	<2	Low	Low	Moderate	0.24	5-4	3
	11-38	0.6-2.0	0.16-0.18	6.1-7.3	<2	Low	Low	Moderate	0.24		
	38-60	0.6-20.0	0.05-0.16	6.6-7.8	<2	Low	Low	Low	0.24		
Tabler:											
Ta	0-9	0.2-0.6	0.15-0.24	6.1-7.3	<2	Low	Moderate	Low	0.49	5	---
	9-40	<0.06	0.12-0.18	6.1-7.8	<2	High	High	Low	0.37		
	40-60	<0.06	0.12-0.22	6.1-8.4	<2	High	High	Low	0.43		
Tivoli:											
Tv	0-7	6.0-20.0	0.05-0.11	6.1-7.8	<2	Low	Low	Low	0.17	5	1
	7-60	6.0-20.0	0.02-0.06	6.1-7.8	<2	Low	Low	Low	0.17		
Ustifluvents:											
[1]Us	0-60	---	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Erosion factors: K	Erosion factors: T	Wind erodibility group
	In	In/hr	In/in	pH	Mmhos/cm						
Vanoss:											
Va, Vb, Vc--------	0-16	0.6-2.0	0.15-0.20	5.6-6.5	<2	Low-------	Low------	Low------	0.37	5	6
	16-40	0.6-2.0	0.17-0.22	6.1-6.5	<2	Moderate--	Moderate-	Moderate-	0.37		
	40-60	0.6-2.0	0.16-0.21	6.1-7.3	<2	Low-------	Moderate-	Moderate-	0.37		
Waurika:											
Wa----------	0-14	0.6-2.0	0.16-0.20	5.6-7.3	<2	Low-------	High-----	Low------	0.49	5	6
	14-40	<0.06	0.13-0.17	6.6-8.4	<2	High------	High-----	Moderate-	---		
	40-60	0.06-0.2	0.15-0.19	7.4-8.4	<2	Moderate--	High-----	Moderate-	---		

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. The symbol < means less than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Bethany:									
Ba, Bb	C	None	---	---	>6.0	---	---	>60	---
Brewer:									
Br, [1]Bs	C	Rare	---	---	>6.0	---	---	>60	---
Canadian:									
Ca	B	Rare	---	---	>6.0	---	---	>60	---
Carwile:									
Cc	D	Occasional	Brief to very long.	Apr-Oct	2.0-6.0	Apparent	Oct-Apr	>60	---
Corbin:									
Cr	B	None	---	---	>6.0	---	---	>60	---
Crisfield:									
Cs	B	Rare	---	---	>6.0	---	---	>60	---
Dale:									
Da	B	Rare	---	---	>6.0	---	---	>60	---

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Owens:									
Renfrow part----	D	None--------	---	---	>6.0	---	---	>60	---
[1]Os:									
Owens part------	D	None--------	---	---	>6.0	---	---	10-20	Rip-pable
Shale outcrop part not rated.									
Pond Creek:									
Pa, Pb, Pc, Pd---	B	None--------	---	---	>6.0	---	---	>60	---
Pratt:									
Px----------	A	None--------	---	---	>6.0	---	---	>60	---
Renfrow:									
[1]Ra----------	D	None--------	---	---	>6.0	---	---	>60	---
Rosehill:									
Ro, Rs, Rx-------	D	None--------	---	---	>6.0	---	---	20-40	Rip-pable
Shellabarger:									
Sa, Sb, Sc-------	B	None--------	---	---	>6.0	---	---	>60	---
Tabler:									
Ta----------	D	None--------	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
Tivoli:									
Tv----------	A	None--------	---	---	>6.0	---	---	>60	---
Ustifluvents:									
[1]Us----------	B	Frequent----	Very brief to brief.	Jan-Dec	>6.0	---	---	>60	---
Vanoss:									
Va, Vb, Vc-------	B	None--------	---	---	>6.0	---	---	>60	---
Waurika:									
Wa----------	D	None--------	---	---	1.0-2.0	Perched	Mar-May	>60	---

[1]This map unit is made up of two or more dominant kinds of soil. See map unit description for the composition and behavior of the whole map unit.

TABLE 17.--ENGINEERING TEST DATA

. by the State Highway Commission of Kansas in accordance with standard procedures of the American Association of ay and Transportation Officials (AASHTO) except as stated in footnotes 1 and 2]

d	Parent material	Report No.	Depth	Moisture density[1]		Percentage passing sieve--[2]			Percentage smaller than--[2]				Liquid limit	Plasticity index	Classification	
				Maximum	Optimum	No. 10	No. 40	No. 200	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO[3]	Unified[4]
			In	Lb/cu ft	Pct								Pct			
t north st of orner 34 S., 3 1/2 aldwell U.S. 81 iles	Alluvium.	S71-Kans 96-1-1	9-22	106	17	100	100	96	81	44	25	20	36	16	A-6 (10)	CL
		96-1-2	22-36	109	14	100	100	95	77	39	17	15	29	8	A-4 (8)	CL-ML
		96-1-3	50-65	109	14	99	99	91	73	27	13	11	37	15	A-6 (10)	CL
m: t south st of orner 34 S., 1 1/2 aldwell U.S. 81 iles	Old alluvium and loess.	S71-Kans 96-2-1	8-16	102	19	100	99	93	87	56	32	27	37	16	A-6 (10)	CL
		96-2-2	24-45	101	21	100	100	96	92	71	48	41	50	30	A-7-6 (18)	CL
		96-2-3	45-60	103	20	100	98	87	78	52	34	25	41	21	A-7-6 (13)	CL
y loam: and 200 e r of S., 3/4 tersec- and ets in 1 1/2 Modal)	Alluvium.	S71-Kans 96-3-1	10-25	102	19	100	100	98	91	65	39	33	44	23	A-7-6 (14)	CL
		96-3-2	25-43	99	21	100	100	98	94	74	47	36	49	27	A-7-6 (17)	CL
		96-3-3	43-60	102	19	100	100	99	94	72	45	37	49	29	A-7-6 (17)	CL

otes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Report No.	Depth	Moisture density[1]		Percentage passing sieve--[2]			Percentage smaller than--[2]				Liquid limit	Plasticity index	Classification	
				Maximum	Optimum	No. 10	No. 40	No. 200	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO[3]	Unified[4]
			In	Lb/cu ft	Pct								Pct			
Rosehill clay loam: About 525 feet south and 85 feet east of the northwest corner of the northeast quarter of sec. 24, T. 31 S., R. 1 W. About 5 miles north of Wellington city limits on U.S. 81 highway and 1/2 mile east. (Nonmodal in B21t and B22t with regard to color. Nonmodal with regard to depth to shale)	Clayey shale.	S71-Kans 96-4-1	9-27	95	24	100	100	97	93	76	51	44	61	39	A-7-6 (20)	CH
		96-4-2	27-38	99	22	100	100	99	96	79	56	49	64	42	A-7-6 (20)	CH
		96-4-3	38-45	94	25	100	99	95	92	83	63	52	71	47	A-7-6 (20)	CH
		96-4-4	45-54	91	29	100	100	95	88	74	59	47	67	37	A-7-5 (20)	CH
Owens clay: About 200 feet south and 500 feet west of the northeast corner of the southeast quarter of sec. 16, T. 33 S., R. 1 E. (Nonmodal in surface layer with regard to sand content)	Clayey shale.	S71-Kans 96-5-1	0-6	100	21	100	98	94	89	68	49	39	48	25	A-7-6 (16)	CL
		96-5-2	6-18	104	20	100	94	88	83	70	47	29	44	21	A-7-6 (13)	CL
		96-5-3	18-26	110	18	99	97	97	95	91	67	42	39	17	A-6 (11)	CL

[1]Based on AASHTO Designation T99-61, Method A, (1) with the following variations: (1) all material is ovendried at 230° F; (2) all material is crushed in a laboratory crusher after drying; and (3) no time is allowed for dispersion of moisture after mixing with the soil material.

[2]Mechanical analyses according to AASHTO Designation T88-57 (1) with the following variations: (1) all material is ovendried at 230° F and crushed in a laboratory crusher; (2) the sample is not soaked prior to dispersion; (3) sodium silicate is used as the dispersing agent; and (4) dispersing time, in minutes, is established by dividing the plasticity index by 2; the maximum time is 15 minutes, and the minimum time is 1 minute. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method, and the various grain-size fractions are calculated on the basis of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[3]Based on AASHTO Designation M145-49 (1).

[4]Based on the Unified soil classification system (2). The SCS and Bureau of Public Roads have agreed to consider that all soils having plasticity indexes within two points from A-line to be given a borderline classification. An example of a borderline classification obtained by this use is CL-ML.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Bethany	Fine, mixed, thermic Pachic Paleustolls
Brewer	Fine, mixed, thermic Pachic Argiustolls
Canadian	Coarse-loamy, mixed, thermic Udic Haplustolls
Carwile	Fine, mixed, thermic Typic Argiaquolls
Corbin	Fine-silty, mixed, thermic Pachic Argiustolls
Crisfield	Coarse-loamy, mixed, thermic Udic Haplustolls
Dale	Fine-silty, mixed, thermic Pachic Haplustolls
Elandco	Fine-silty, mixed, thermic Cumulic Haplustolls
Farnum	Fine-loamy, mixed, thermic Pachic Argiustolls
Kirkland	Fine, mixed, thermic Udertic Paleustolls
Lesho	Fine-loamy over sandy or sandy-skeletal, mixed, thermic Fluvaquentic Haplustolls
Lincoln	Sandy, mixed, thermic Typic Ustifluvents
Milan	Fine-loamy, mixed, thermic Udic Argiustolls
Owens	Clayey, mixed, thermic, shallow Typic Ustochrepts
Pond Creek	Fine-silty, mixed, thermic Pachic Argiustolls
Pratt	Sandy, mixed, thermic Psammentic Haplustalfs
Reinach	Coarse-silty, mixed, thermic Pachic Haplustolls
Renfrow	Fine, mixed, thermic Udertic Paleustolls
Rosehill	Fine, montmorillonitic, mesic Udertic Haplustolls
Shellabarger	Fine-loamy, mixed, thermic Udic Argiustolls
Tabler	Fine, montmorillonitic, thermic Vertic Argiustolls
Tivoli	Mixed, thermic Typic Ustipsamments
Ustifluvents	Loamy, mixed, thermic Ustifluvents
Vanoss	Fine-silty, mixed, thermic Udic Argiustolls
Waurika	Fine, montmorillonitic, thermic Typic Argialbolls

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