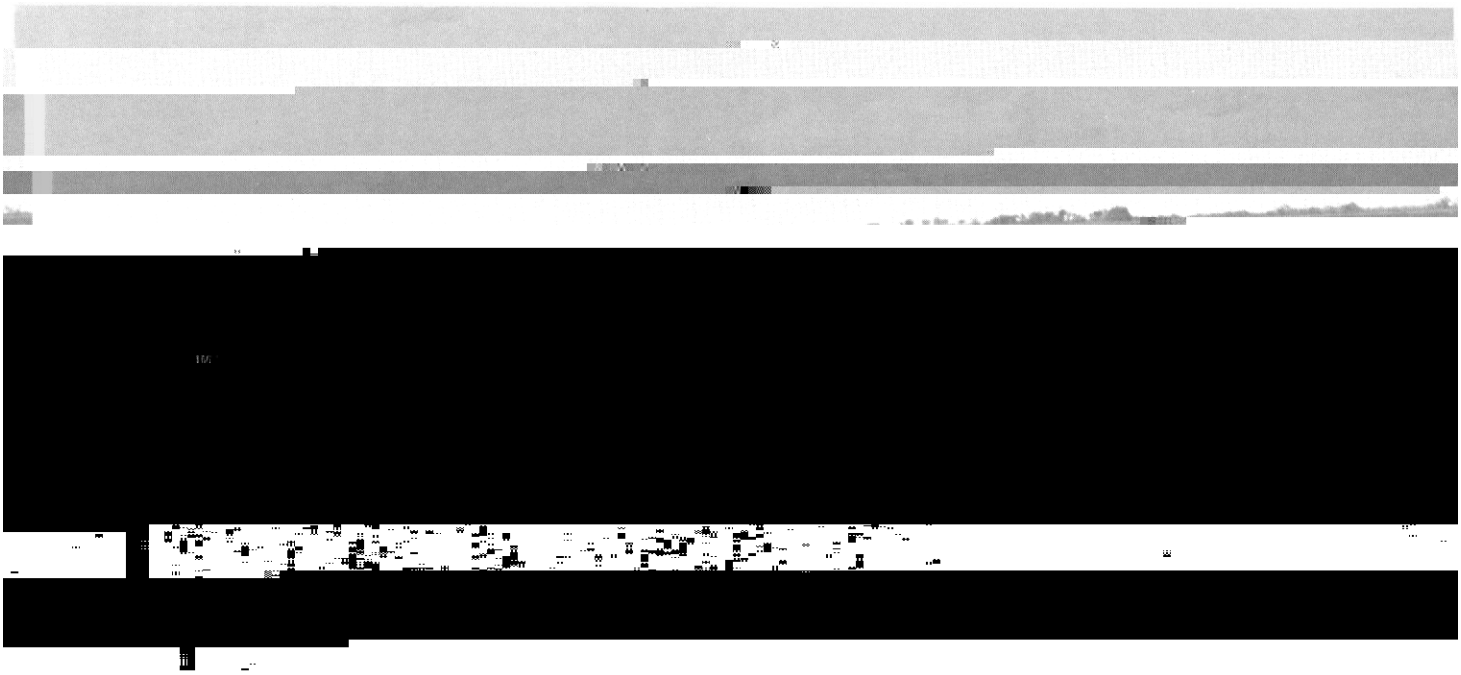
SOIL SURVEY OF

Sedgwick County, Kansas



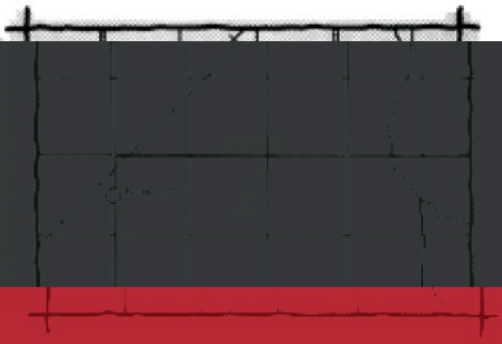
United States Department of Agriculture
Soil Conservation Service

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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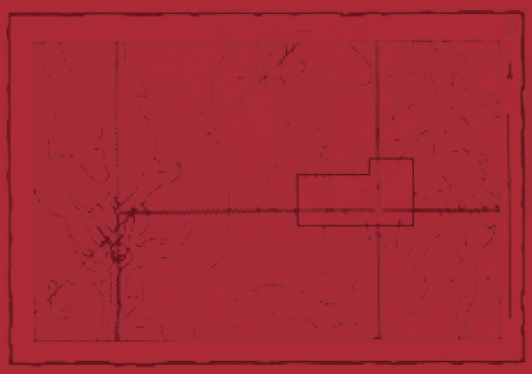

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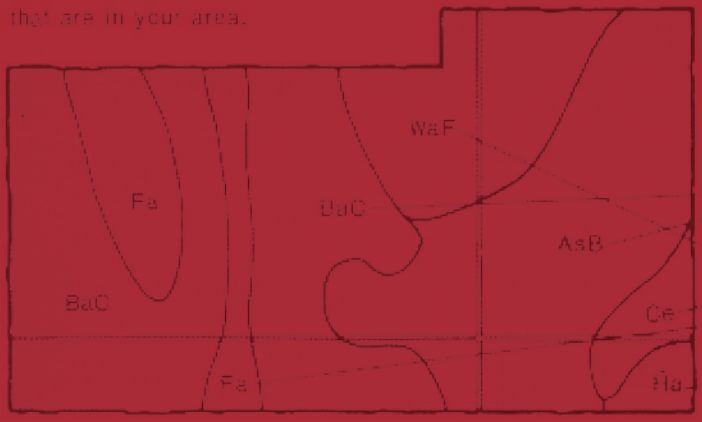

Symbols

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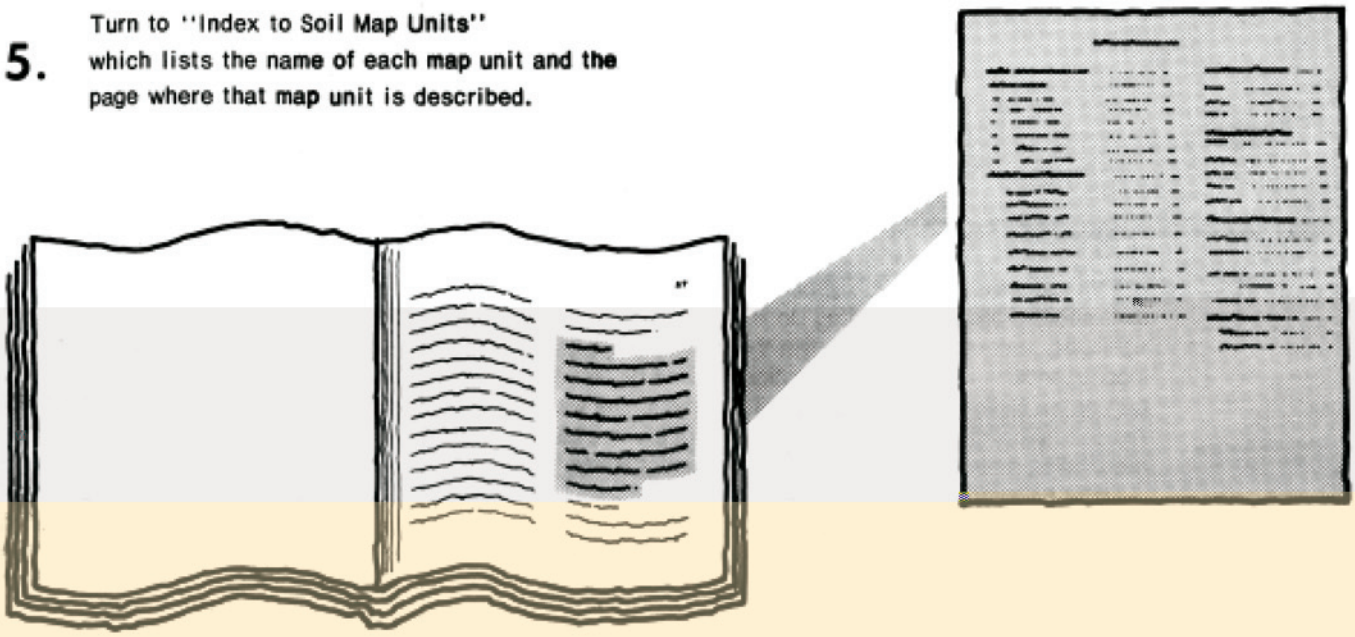
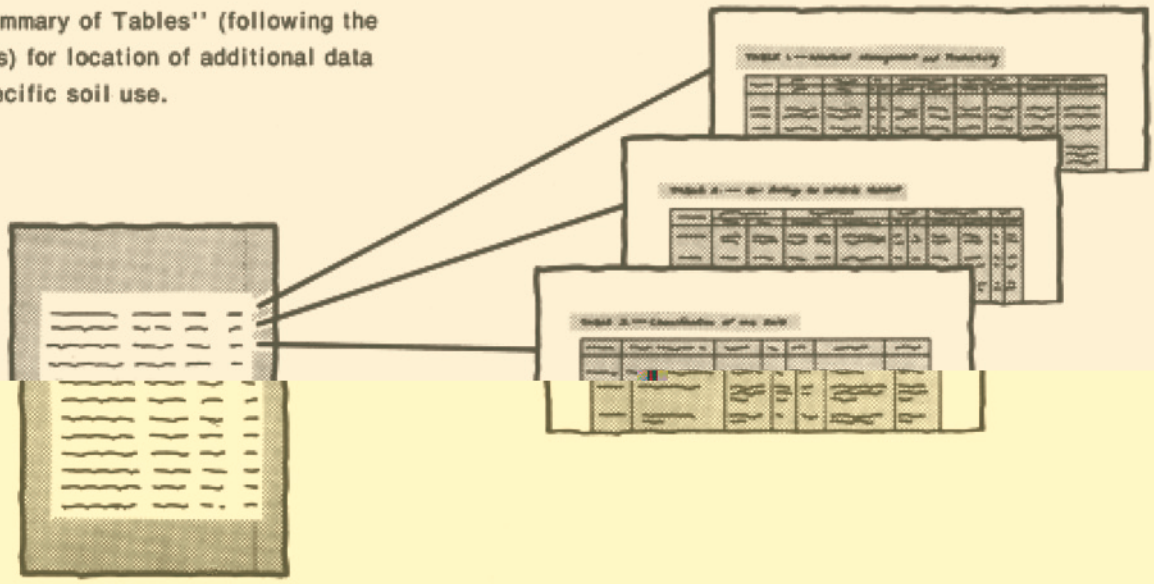
THIS SOIL SURVEY

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.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

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

Major fieldwork for this soil survey was completed in the period 1969-75. Soil names and descriptions were approved in 1975. Unless otherwise indicated, statements in the publication refer to conditions in the survey area in 1975. This survey was made cooperatively by the Soil Conservation Service and the Kansas Agricultural Experiment Station. It is part of the technical assistance furnished to the Sedgwick County Conservation District.

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

Cover: Wheat and milo on Blanket silt loam, 1 to 3 percent slopes. The soil is terraced, farmed on the contour, and stubble mulched.

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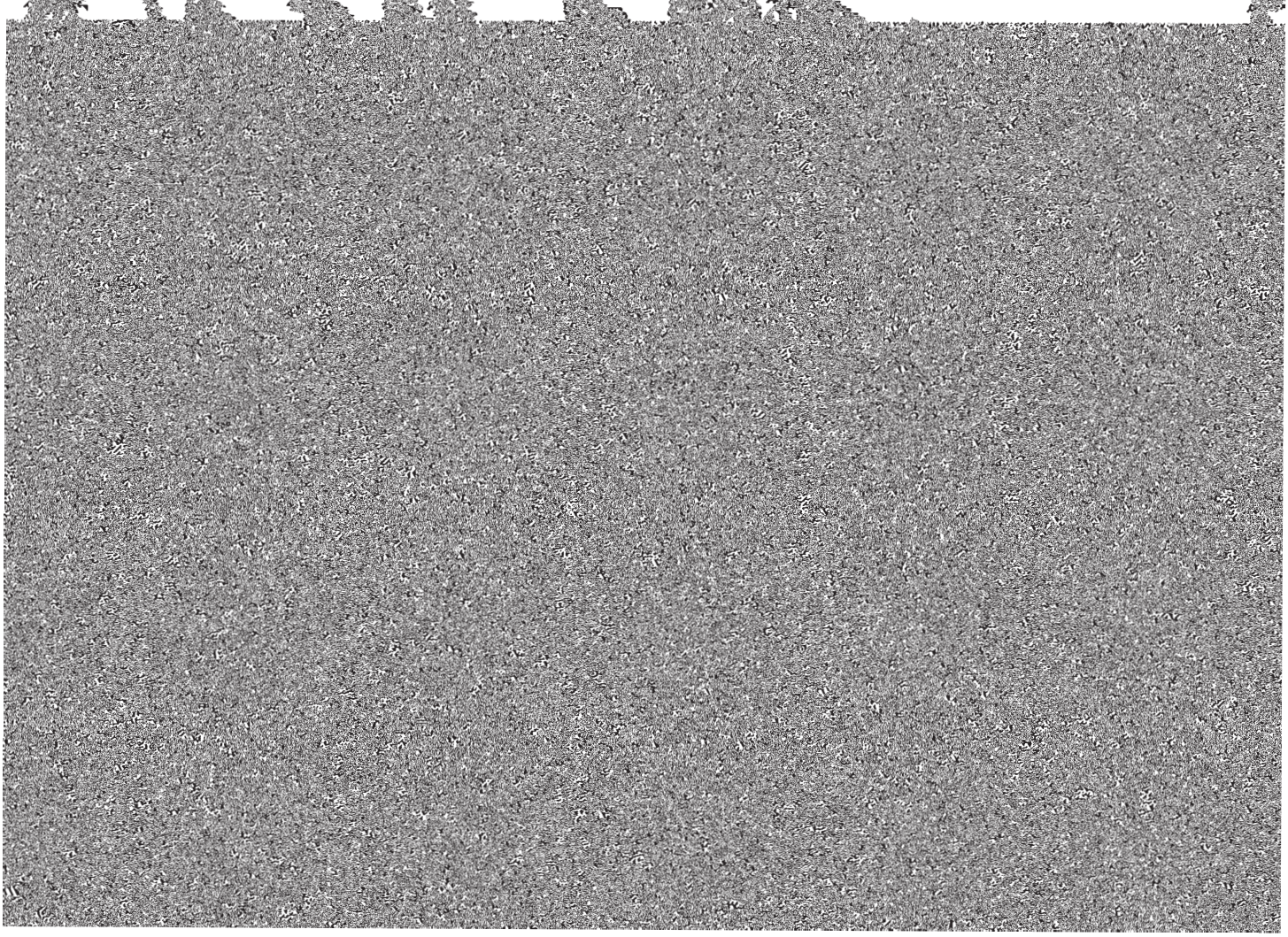

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Foreword

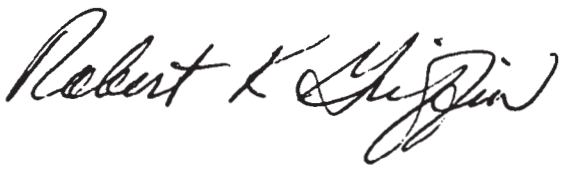
The Soil Survey of Sedgwick County, Kansas, contains much information useful in any land-planning program. Of prime importance are the predictions of soil behavior for selected land uses. Also highlighted are limitations or hazards to land uses that are inherent in the soil, improvements needed to overcome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

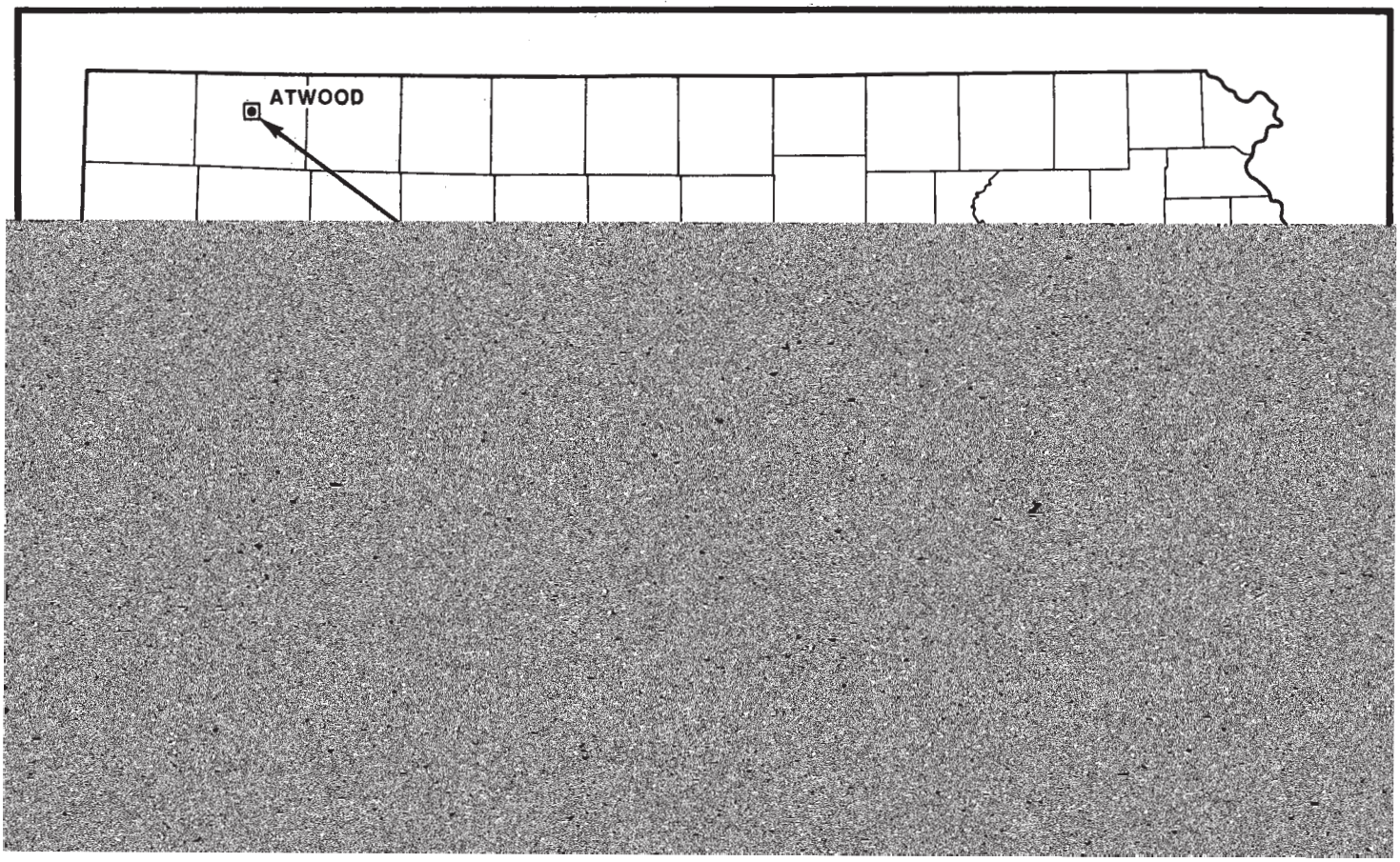
Great differences in soil properties can occur even within short distances. Soils may be seasonally wet or subject to flooding. They may be shallow to bedrock. They may be too unstable to be used as a foundation for buildings or roads. Very clayey or wet soils are poorly suited to septic tank absorption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

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

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



Robert K. Griffin
State Conservationist
Soil Conservation Service


ATWOOD

SOIL SURVEY OF SEDGWICK COUNTY, KANSAS

By Harold L. Penner and William A. Wehmueller, Soil Conservation Service

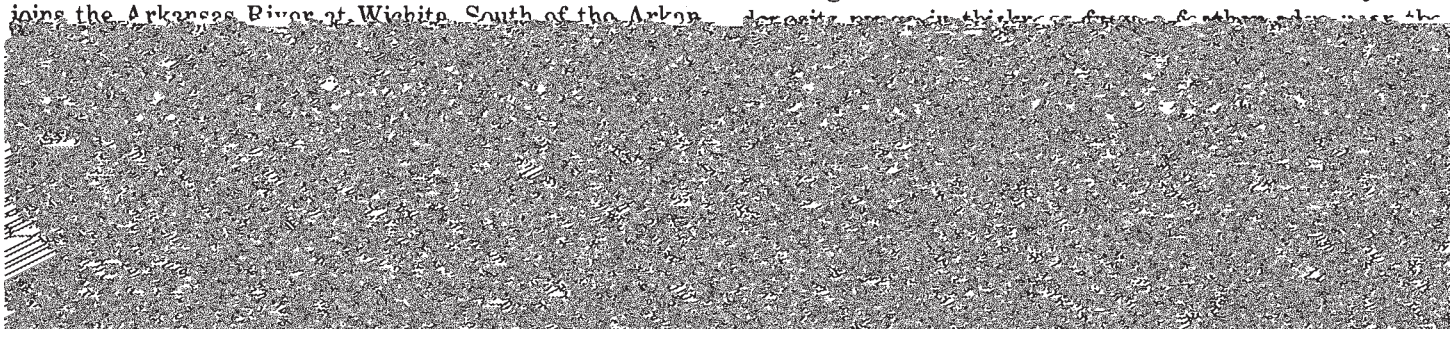
United States Department of Agriculture, Soil Conservation Service
in cooperation with Kansas Agricultural Experiment Station

SEDGWICK COUNTY is in south-central Kansas (see facing page). It has a total of 1,008 square miles, or 645,120 acres. In 1870, the population of the county was 1,095; in 1970, it was 349,039. The population has increased rapidly during the past two decades. It is now about 15.7 percent of the population of Kansas. About 91 percent of the county's population is urban. Wichita, the county seat, has a population of 276,554.

The area now known as Sedgwick County became United States territory in 1803, as part of the Louisiana Purchase. The county was organized in 1870. It was named for Union General John Sedgwick. On March 25, 1870, the Wichita townsite plot was filed at El Dorado, the first county seat.

Except for the northeast corner, the county lies within the Arkansas River Lowlands section of the Central Lowland physiographic province (*3*). The topography is characterized by the extreme flatness of the broad Arkansas River Valley and the gently rolling slopes rising to the uplands adjacent to the valley. The highest point, about 1,540 feet above sea level, is on the west edge, about 5 miles southwest of Andale. The lowest point, about 1,220 feet above sea level, is where the Arkansas River flows out of the county to the south.

Drainage of the county is by way of the Arkansas River and its tributaries. The Arkansas River enters the county at the northwest corner, flows in a southeasterly direction to a point north of Wichita, where it turns south and flows out of the county near the southeast corner. The Little Arkansas River enters the county near the center of the north boundary, flows east-southeast, and joins the Arkansas River at Wichita. South of the Arkan-



General nature of the county

This section gives general information concerning the county. It describes natural resources, industry, farming, and climate.

Natural resources

Soil is the most important natural resource in the county. Livestock that graze the grassland and crops produced on farms are marketable products that are affected by the soil.

Ground water is an important mineral resource of the county (*3*). Most water used in the county is ground water. The principal source of the ground water is the unconsolidated deposits underlying the Arkansas Valley, where well yields of a few gallons per minute to over 2,000 gallons per minute are readily obtained. The chemical quality of the ground water ranges from moderately hard to extremely hard, depending on the source of the water. Ground water in the Arkansas Valley is generally of moderate hardness, but locally it contains undesirable quantities of dissolved salt and iron. Water from the Permian rocks is generally extremely hard and of limited use because of its high content of chloride and sulfate ions.

Other mineral resources of Sedgwick County are oil and gas, salt, gypsum, and sand and gravel.

Oil was first discovered in the county in 1928. Development in the county has continued, and in 1960 oil and gas were produced from 631 wells.

Salt deposits in the Wellington Formation of early Permian age underlie the western half of the county. The

Sand and gravel deposits of Pleistocene age, which underlie about one-third of the county, have been worked commercially for many years. Most of the pits are near the Arkansas and Little Arkansas Rivers, where the overburden is thin. The water table is shallow adjacent to the rivers, and the sand and gravel is quarried hydraulically. These deposits are used extensively for concrete aggregate and as road metal.

Industry

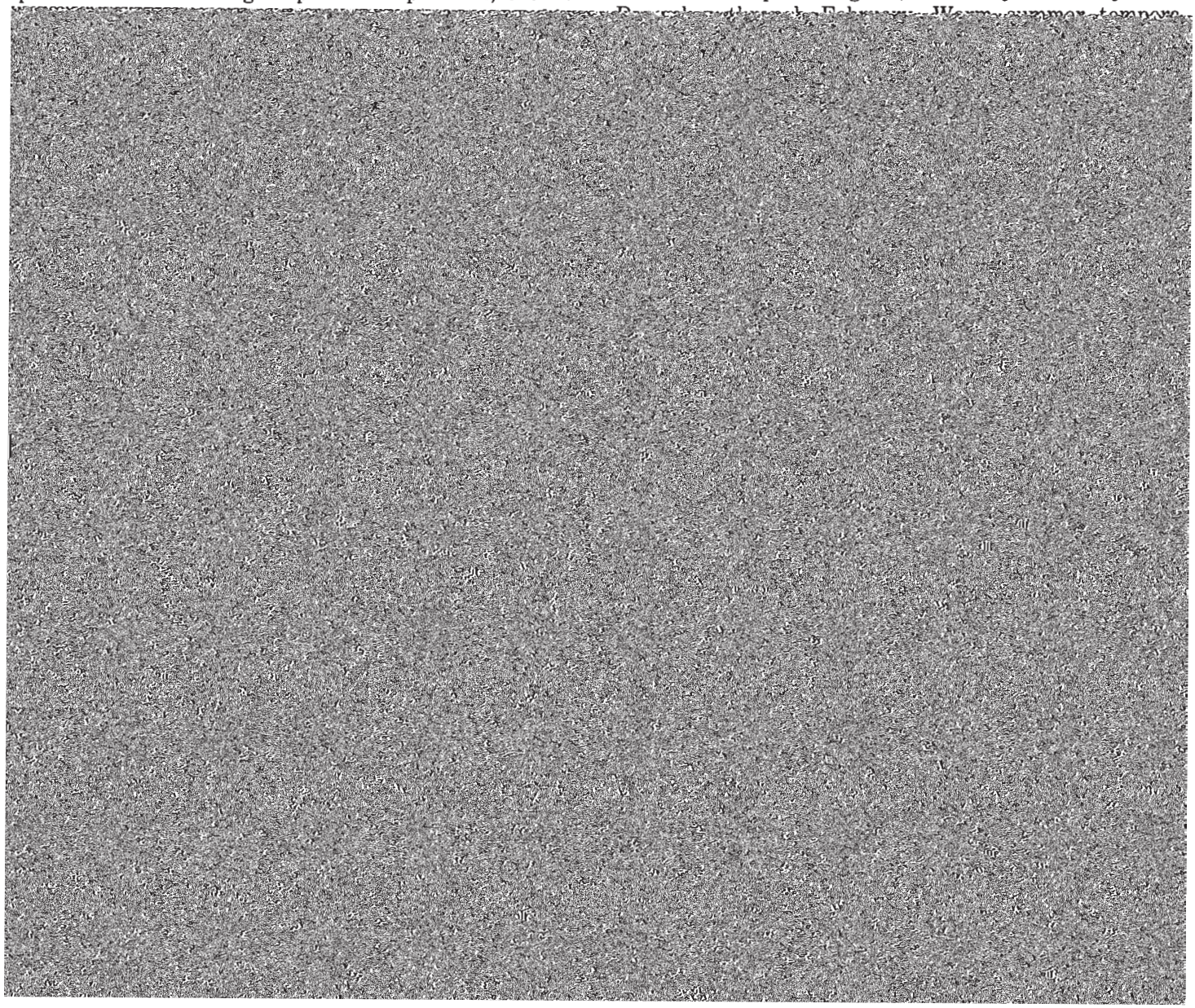
The metropolitan area of Wichita is the most heavily industrialized area in the State and is the most important transportation and distribution center. The area is nationally prominent in the manufacture of military and private aircraft. Other important industries include the production and refining of petroleum products, chemical

Most of the towns have facilities for handling and storing grain. Railroads provide a means of transporting grain to terminal elevators and of transporting grain, livestock, and livestock products to markets to the east and west. The Federal and State highways that cross the county provide access to markets by truck.

Climate

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

Sedgwick County has a typical continental climate, as would be expected of a location in the interior of a large land mass in the middle latitudes. Such a climate is characterized by large daily and annual variations in temperature. Winters are cold because air frequently moves in from the polar regions, but they last only from



miles per hour; it is highest, 15 miles per hour, in March and April. The percent of possible sunshine averages 77 in summer and 61 in winter.

Tornadoes and severe thunderstorms occur occasionally in Sedgwick County. These storms are usually local in extent and of short duration so that the risk of damage is small. Hail falls during the warmer part of the year, but it is infrequent and local in extent. Crop damage by hail is less in this part of the State than it is further west.

How this survey was made

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

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

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

The areas shown on a soil map are called soil map units. Some map units are made up of one kind of soil, others

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

General soil map for broad land-use planning

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

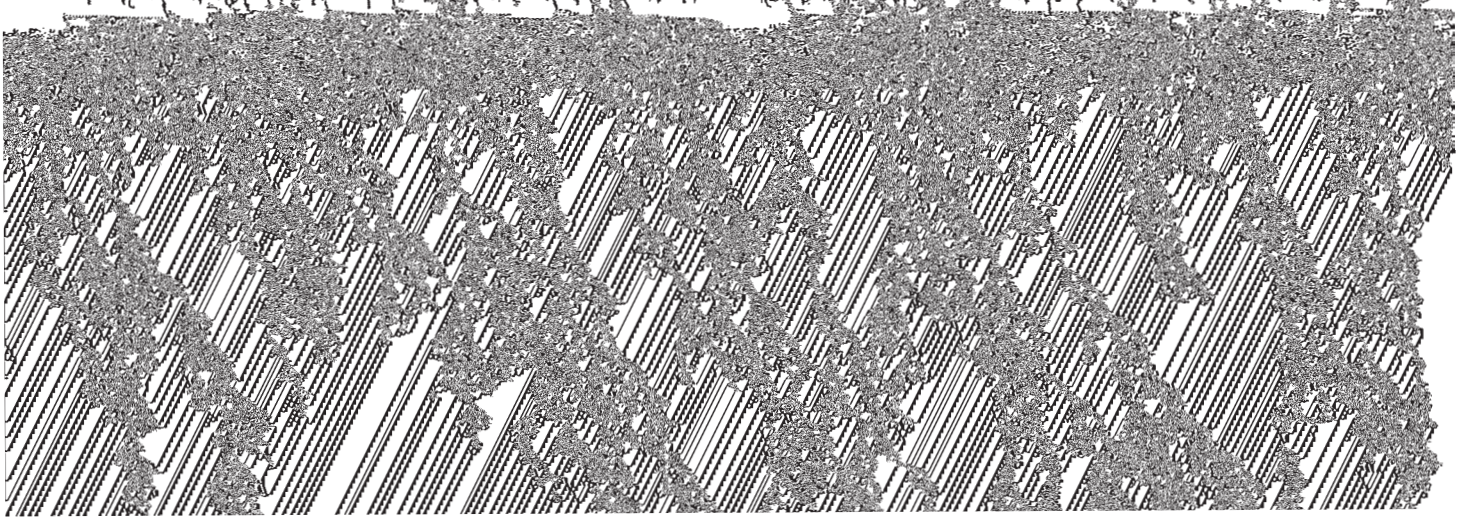
The general soil map provides a broad perspective of the soils and landscapes in the survey area. It provides a basis for comparing the potential of large areas for general kinds of land use. Areas that are, for the most part, suited to certain kinds of farming or to other land uses can be identified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

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

Map unit descriptions

1. Lesho-Lincoln-Canadian

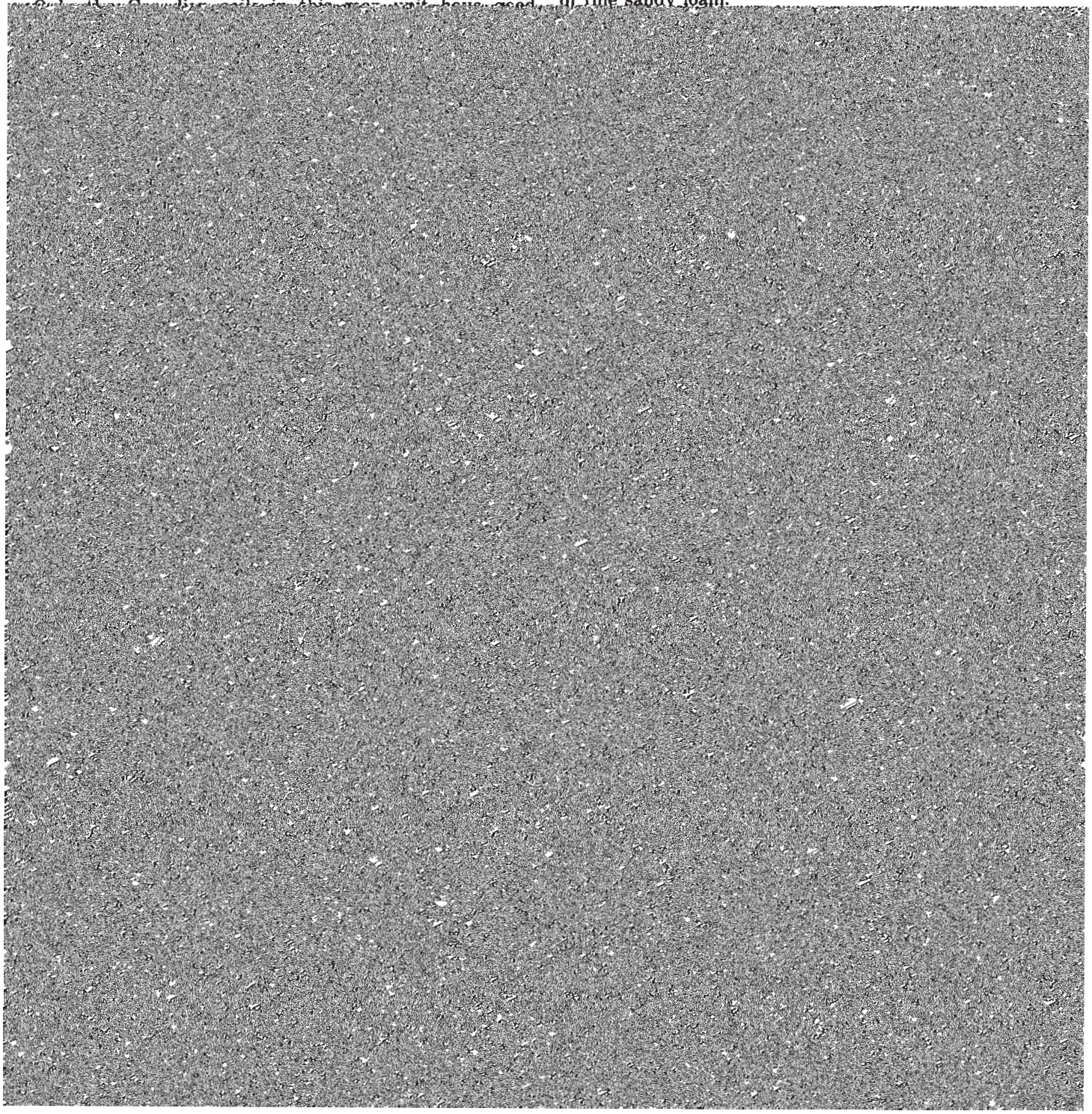
Soils that are shallow to deep over sand; are nearly level



This map unit is used for range and cultivated crops. Most of the range is in poor to fair condition. Lincoln and Lesho soils are used primarily as range, and Canadian soils are dominantly used as cropland. The principal crops planted on Canadian soils are grain sorghum and wheat. Wetness and soil blowing are the main limitations if these soils are used for farming and for most other purposes. Also, flooding is common on the Lesho and Lincoln soils.

soils, somewhat excessively drained Lincoln soils, poorly drained Plevna soils, moderately well drained Tabler soils, and somewhat poorly drained Waldeck soils.

Elandco and Canadian soils are at about the same level on the landscape, but the occasionally flooded and frequently flooded Elandco soils are at lower elevations. Both soils are well drained. Elandco soils have a surface layer of silt loam, and Canadian soils have a surface layer of fine sandy loam.



These nearly level to sloping soils are on uplands in the eastern part of the county. They formed dominantly in clayey alluvial sediments, but in some small areas they formed in shale residuum (fig. 4).

This map unit occupies about 17 percent of the county. It is about 35 percent Irwin soils, 25 percent Goessel soils, 20 percent Rosehill soils, and 20 percent well drained Blanket, Clime, Elandco, and Farnum soils and moderately well drained Tabler soils.

In most places Goessel soils are on the more nearly level parts of the landscape, and Irwin and Rosehill soils are in the more sloping areas. Irwin and Rosehill soils are well drained, and Goessel soils are moderately well drained. Goessel and Rosehill soils have a silty clay surface layer, and Irwin soils have a silty clay loam surface layer.

This map unit is used mainly for cultivated crops. The soils are best suited to small grain because droughtiness is a factor in most years, especially in July and August. Wheat and grain sorghum are the principal crops. Some alfalfa and soybeans are occasionally grown. Most range is in poor to fair condition because most grazing areas are small and have been continuously overused. Most farms are the cash-grain type or are general farms on which some livestock is raised.

If adequately protected against erosion, this map unit has fair to good potential for cultivated crops. The hazard of erosion can be overcome by a terrace system and a selection of crops that include small grain and legumes. The high shrink-swell potential of the major soils is such a severe limitation and is so difficult to overcome that the potential for residential and other urban uses is poor. The potential for development of open wildlife habitat is fair to good.

6. Shellabarger-Milan-Renfrow

Deep, gently sloping and sloping, well drained soils that have a loamy or clayey subsoil; formed in old alluvial sediments and shaly clay residuum

These gently sloping and sloping soils are on uplands in the southwestern part of the county adjoining the Ninnescah River drainage system (fig. 5).

This map unit occupies about 9 percent of the county. It is about 25 percent Shellabarger soils; 25 percent Milan soils; 20 percent Renfrow soils; and 30 percent well drained Blanket, Canadian, Farnum, Naron, Owens, and Vernon soils, moderately well drained Tabler soils, somewhat poorly drained Carwile soils, and poorly drained Plevna soils.

In most places Shellabarger soils occupy the more sloping part of the landscape, whereas Milan soils occupy the intermediate parts of the landscape and Renfrow occupy foot slopes. All the soils are well drained. Shellabarger soils have a sandy loam surface layer, Milan soils have a loam surface layer, and Renfrow soils have a silty clay loam surface layer.

This map unit is used mainly for crops, but some small areas are still in native range. The range is dominantly in areas of Renfrow, Owens, and Vernon soils. The soils in this map unit are subject to soil blowing and water erosion. They have fair to good potential for cultivated farm crops if conservation practices protect them against erosion. Shellabarger and Milan soils have slight to moderate limitations for urban and residential development. The potential for development of openland wildlife habitat is good.

7. Renfrow-Blanket-Owens

Deep and shallow, nearly level to strongly sloping, well drained soils that have a clayey subsoil; formed in clay shale residuum and old clayey alluvial sediments

These nearly level to strongly sloping soils are on uplands in the western part of the county, in the Ninnescah River watershed. Renfrow and Owens soils formed in clayey shale residuum, and Blanket soils formed in old clayey alluvial sediments (fig. 5).

This map unit occupies about 5 percent of the county. It is about 50 percent Renfrow soils; 30 percent Blanket soils; 10 percent Owens soils; and 10 percent well drained Milan and Vernon soils, moderately well drained Tabler soils, and somewhat poorly drained Carwile soils.

Owens soils are typically on the strongly sloping parts of the landscape, Renfrow soils are typically in the gently sloping areas, and Blanket soils are in the nearly level areas. Renfrow soils have a silty clay loam surface layer, Blanket soils have a silt loam surface layer, and Owens soils have a clay loam surface layer.

This map unit is used mainly for crops. Most of the acreage is used for wheat and grain sorghum. Some areas, especially areas of Owens soils, are used as range. Erosion and droughtiness are the main limitations of these soils for farming and for most other purposes.

This map unit has poor to good potential for cultivated farm crops. Protection against erosion is needed. Owens soils are better suited to native grass range than to other uses. Good range management is needed on the shallow Owens soils to control erosion and keep the range in good condition. Nearly all the farms are the cash-grain type or cattle farms. The potential for development of openland wildlife habitat is fair to good.

8. Blanket-Farnum-Vanoss

Deep, nearly level to sloping, well drained soils that have a loamy or clayey subsoil; formed in old clayey, silty, and loamy sediments

This map unit occupies uplands in the central third of the county (fig. 6). It makes up about 35 percent of the county. It is about 35 percent Blanket soils; 30 percent Farnum soils; 15 percent Vanoss soils; and 20 percent well drained Elandco and Milan soils, moderately well drained Tabler soils, and somewhat poorly drained Drummond and Waurika soils.

Blanket soils typically are on the nearly level and gently sloping parts of the landscape. Farnum soils typically are on gently sloping parts, and Vanoss soils typically are on the gently sloping and sloping parts of the landscape. Blanket and Vanoss soils have a silt loam surface layer, and Farnum soils have a loam surface layer.

This map unit is used mainly for crops. Wheat and grain sorghum are the main crops. Some small areas are used as range and pasture. The soils are well suited to all dryland crops and grasses commonly grown in the county. Shortages of moisture may be a limitation, and in places there is not enough ground water for irrigation. Water erosion is a hazard in the gently sloping and sloping areas. Flooding sometimes occurs along drainageways. Most farms are the cash-grain type, but some are dairies and others are general farms on which some livestock is raised.

If adequately protected against erosion, this map unit has good potential for cultivated farm crops. Erosion is the main limitation of these soils for farming and for most other purposes. This map unit has slight and moderate limitations for urban and residential development. The potential for development of openland wildlife habitat is good.

Broad land-use considerations

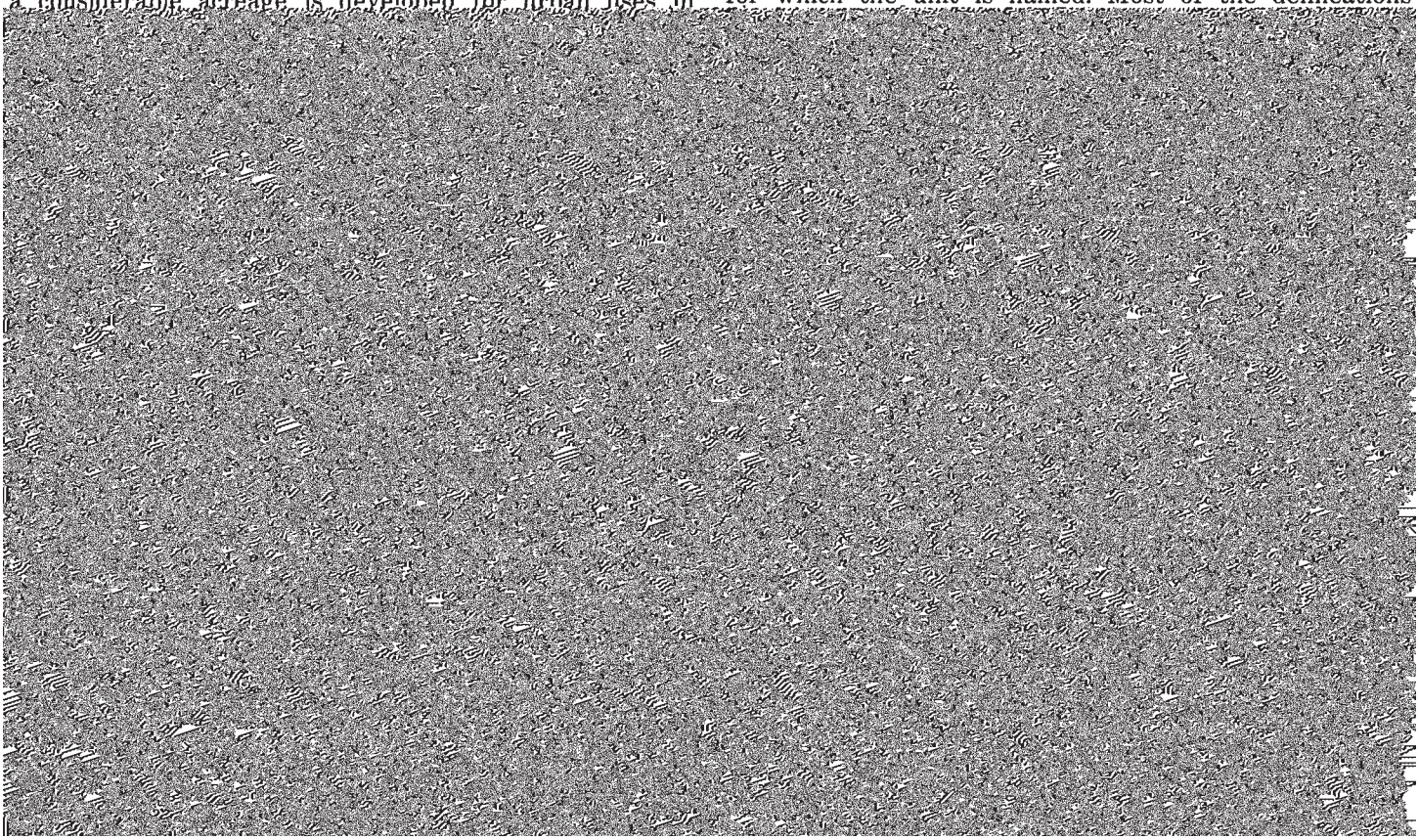
Deciding which land should be used for urban development is an important issue in the survey area. Each year a considerable acreage is developed for urban uses in good for such crops are parts of the Lesho-Lincoln-Canadian and the Blanket-Farnum-Vanoss map units. These soils are well drained and warm up earlier in spring than the more clayey, wetter soils. Where bedrock is not too shallow, nurseries are also well suited to these well drained soils.

Soil maps for detailed planning

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

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

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



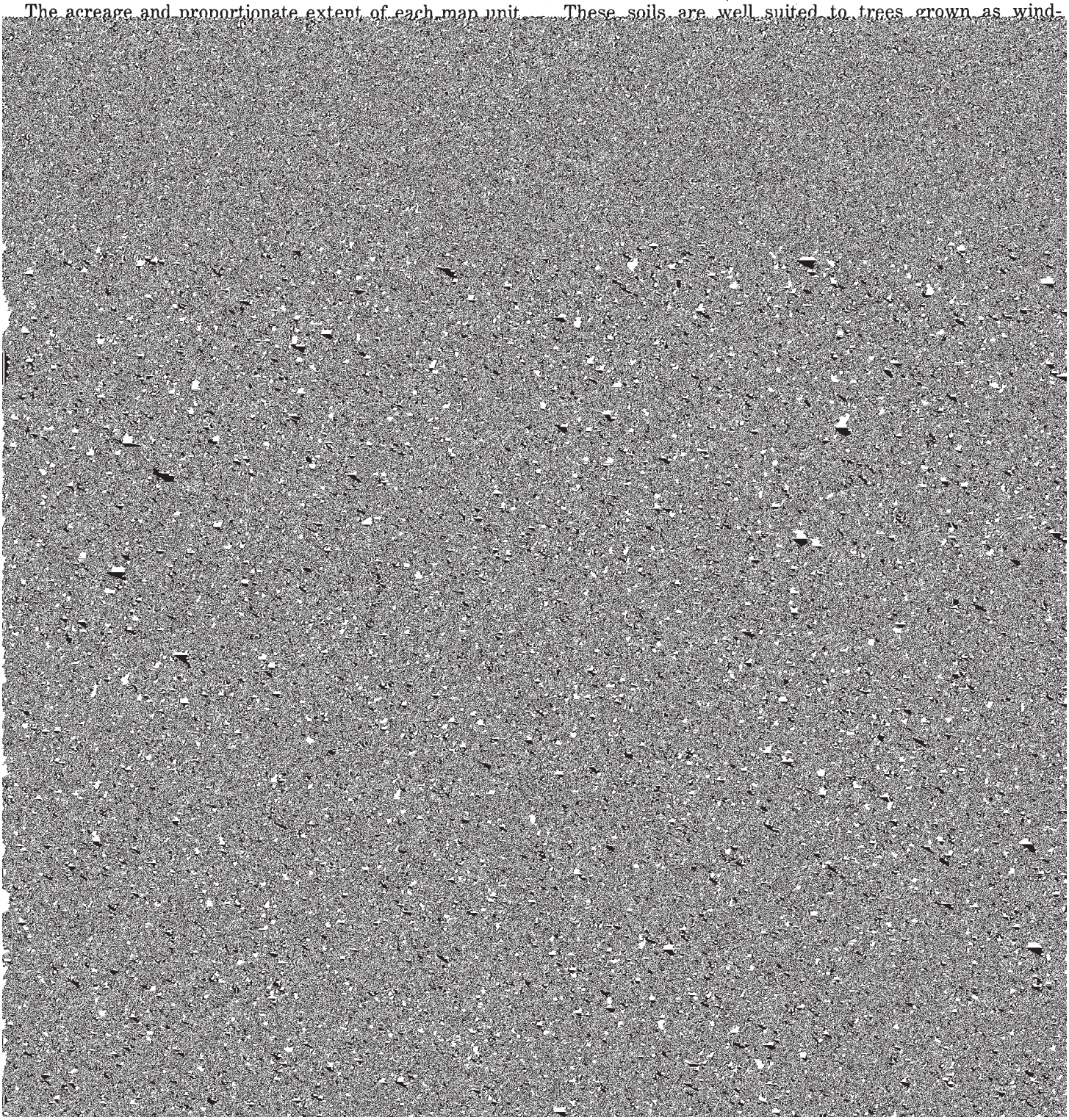
Most mapped areas include places that have little or no soil material and support little or no vegetation. Such places are called *miscellaneous areas*; they are delineated on the soil map and given descriptive names. Pits is an example. Some of these areas are too small to be delineated and are identified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

The acreage and proportionate extent of each map unit

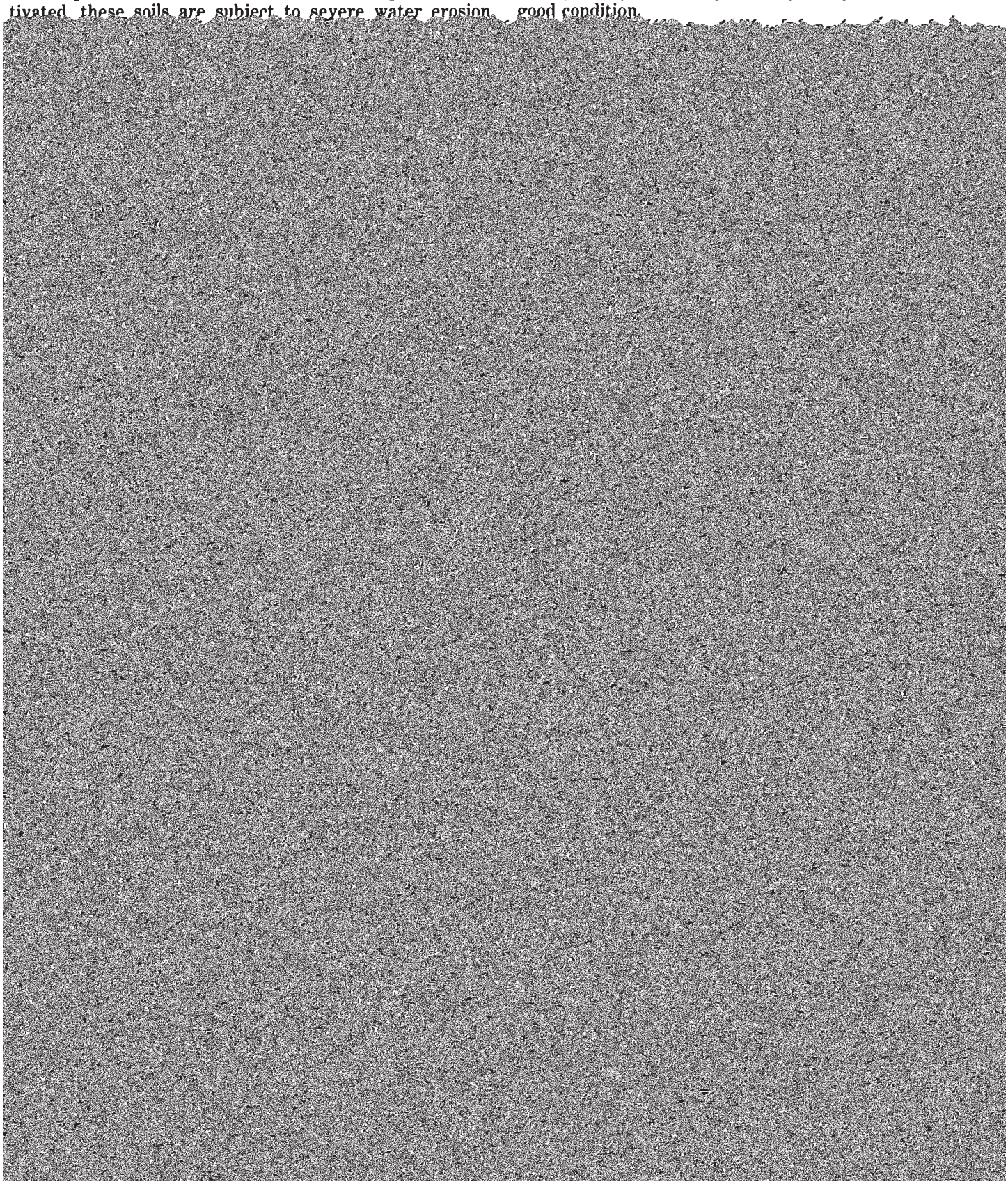
residue to the soil or regularly adding other organic material improves fertility and helps control soil blowing.

The use of these soils as pastureland or hayland is effective in controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in condition.

These soils are well suited to trees grown as wind-



Nearly all areas of this unit are in native grass. If cultivated, these soils are subject to severe water erosion during wet periods help to keep the pasture and soil in good condition.



The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

This soil is suitable for building sites, but the moderate shrink-swell potential and low strength adversely affect construction. The slow percolation rate is a severe limitation if the soil is used for septic tank absorption fields. This limitation can be overcome, to a degree, by increasing the size of the filter field. The soil has slight limitations if it is used for sewage lagoons. It has slight to moderate limitations if used for recreational purposes. Capability unit IIe-2; Loamy Upland range site.

Ca—Canadian fine sandy loam. This nearly level, well drained soil is on low terraces that are rarely flooded. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is brown fine sandy loam about 20 inches thick. The subsoil is about 15 inches of brown, very friable sandy loam. The substratum to a depth of 60 inches is light brown sandy loam.

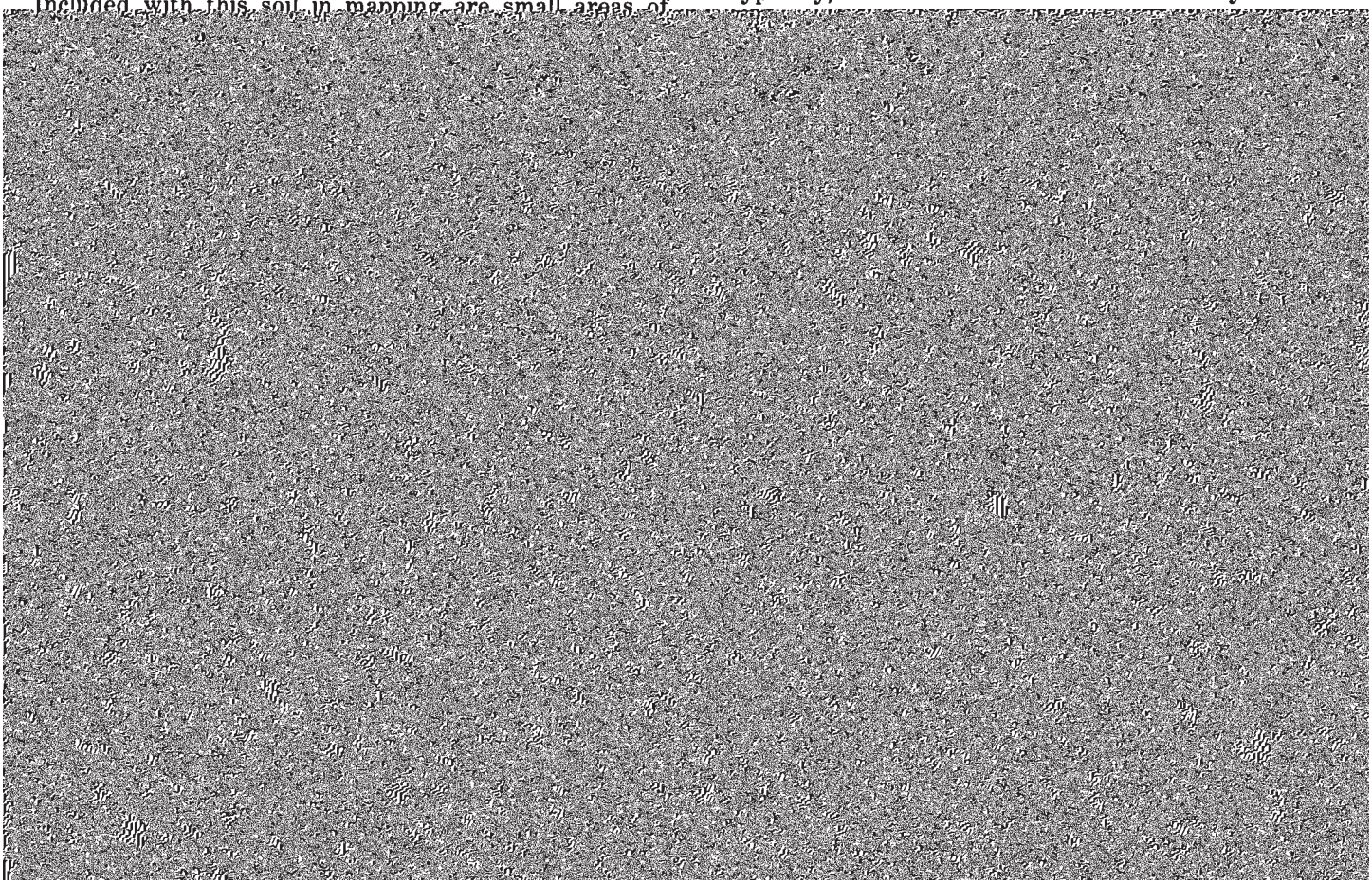
Included with this soil in mapping are small areas of

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used and if areas are protected against flooding. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. The soil has slight to severe limitations for recreational areas, depending on the frequency of flooding. Capability unit I-1; Sandy range site.

Cb—Canadian-Waldeck fine sandy loams. This map unit consists of nearly level to gently undulating, well drained and somewhat poorly drained soils on flood plains and low terraces that are rarely flooded. Individual areas of this unit range from 40 to several hundred acres in size and are from 60 to 80 percent Canadian soils and 20 to 35 percent Waldeck soils. Canadian soils have plane or convex surfaces. Waldeck soils are in swales, drainageways, and low-lying areas. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Canadian soil has a surface layer of brown fine sandy loam about 20 inches thick. The subsoil is about 15 inches of brown, very friable sandy loam. The substratum is light brown sandy loam.

Typically, the Waldeck soil has a surface layer of dark



procedures are needed. The soils lack sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. The Waldeck soil has severe limitations for sanitary facilities and community development. The main limitation is the high water table. Little can be done to lower the water table.

The Waldeck soil has favorable characteristics for excavated ponds. Both soils have slight to moderate limitations if they are used for recreational purposes. Capability unit I-1; Canadian soil in Sandy range site, Waldeck soil in Subirrigated range site.

Cc—Carwile fine sandy loam. This nearly level, somewhat poorly drained soil is on uplands. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is dark brown fine sandy loam about 18 inches thick. The subsoil is about 42 inches thick. The upper part is dark grayish brown, firm clay loam with strong brown mottles; the lower part is dark grayish brown clay loam with common strong brown mottles.

Included with this soil in mapping are small areas of moderately well drained Tabler soils, somewhat poorly drained Drummond soils, and well drained Farnum soils. The Tabler soils are better drained than this Carwile soil. The Drummond soils occupy shallow depressions, and the Farnum soils occupy narrow ridges at a slightly higher elevation. These included areas make up 10 to 20 percent of the unit.

Water and air move through this soil at a slow rate, and runoff is slow or ponded. Unless the soil is drained, a water table is at or near the surface for short periods during winter and spring. Available water capacity is high. Reaction ranges from slightly acid to moderately alkaline in the subsoil and varies widely in the surface layer as a result of local liming practices. Natural fertility is medium, and organic-matter content is moderately low. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. When the subsoil becomes saturated, however, the surface layer is slow to dry and fieldwork may be delayed.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is suited to corn, soybeans, sorghum, and small grain and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, crop loss is a hazard because the surface can be ponded unless the soil is artificially drained. Alfalfa is especially susceptible to drowning in these ponded areas. If the soil is bare late in winter and early in spring, soil blowing can be a hazard. Minimum tillage and winter cover crops help prevent excessive soil blowing.

The use of soil as pastureland or hayland is also effective in controlling soil blowing. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is suited to trees grown as windbreaks and environmental plantings. Suitable species and site preparation are necessary for successful tree culture.

This soil has poor potential for building sites unless areas are artificially drained and the clayey subsoil is stabilized. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. This soil is not well suited to septic tank filter fields because of wetness and slow permeability. If the soil is used for sewage lagoons, onsite evaluation is needed because the substratum may be too porous below a depth of 60 inches.

This soil has severe limitations if it is used for recreational purposes. Artificial drainage is needed to alleviate surface ponding. Capability unit IIw-1; Sandy range site.

Cd—Clark-Ost clay loams, 1 to 4 percent slopes. This map unit consists of gently sloping, well drained soils on uplands. Most areas are dissected by shallow drainageways. Small depressions are in some areas. Individual areas of this unit range from 10 to 100 acres in size and are from 55 to 75 percent Clark soils and 15 to 25 percent Ost soils. Typically, Clark soils are on convex undulations and Ost soils are in plane or depressional areas. The two soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Clark soil has a surface layer of very dark gray clay loam about 11 inches thick. The next layer is about 13 inches thick. The upper part is brown, very firm clay loam containing common lime concretions; the lower part is grayish brown, very firm clay loam that is about 20 percent soft masses of lime and lime concretions. The substratum to a depth of 60 inches is light brownish gray clay loam that is about 30 percent lime.

Typically, the Ost soil has a surface layer of very dark grayish brown clay loam about 7 inches thick. The subsoil is about 12 inches thick. The upper part is brown, very firm clay loam; the lower part is brown, firm, calcareous clay loam. The substratum to a depth of 60 inches is brown, calcareous clay loam that is about 35 percent lime.

Included with these soils in mapping are small areas of Blanket soils, which make up 5 to 15 percent of the unit. Blanket soils have a thicker surface layer than these Clark and Ost soils and do not have the high concentration of lime characteristic of the Clark and Ost soils. Also, Blanket soils are on smoother landscapes.

Permeability is moderate through the Clark soil and moderately slow through the Ost soil. Available water capacity in both soils is high. The shrink-swell potential of both soils is moderate. Reaction is mildly alkaline or moderately alkaline throughout the Clark soil. It is slightly acid to neutral in the surface layer of Ost soil and neutral to moderately alkaline in the subsoil.

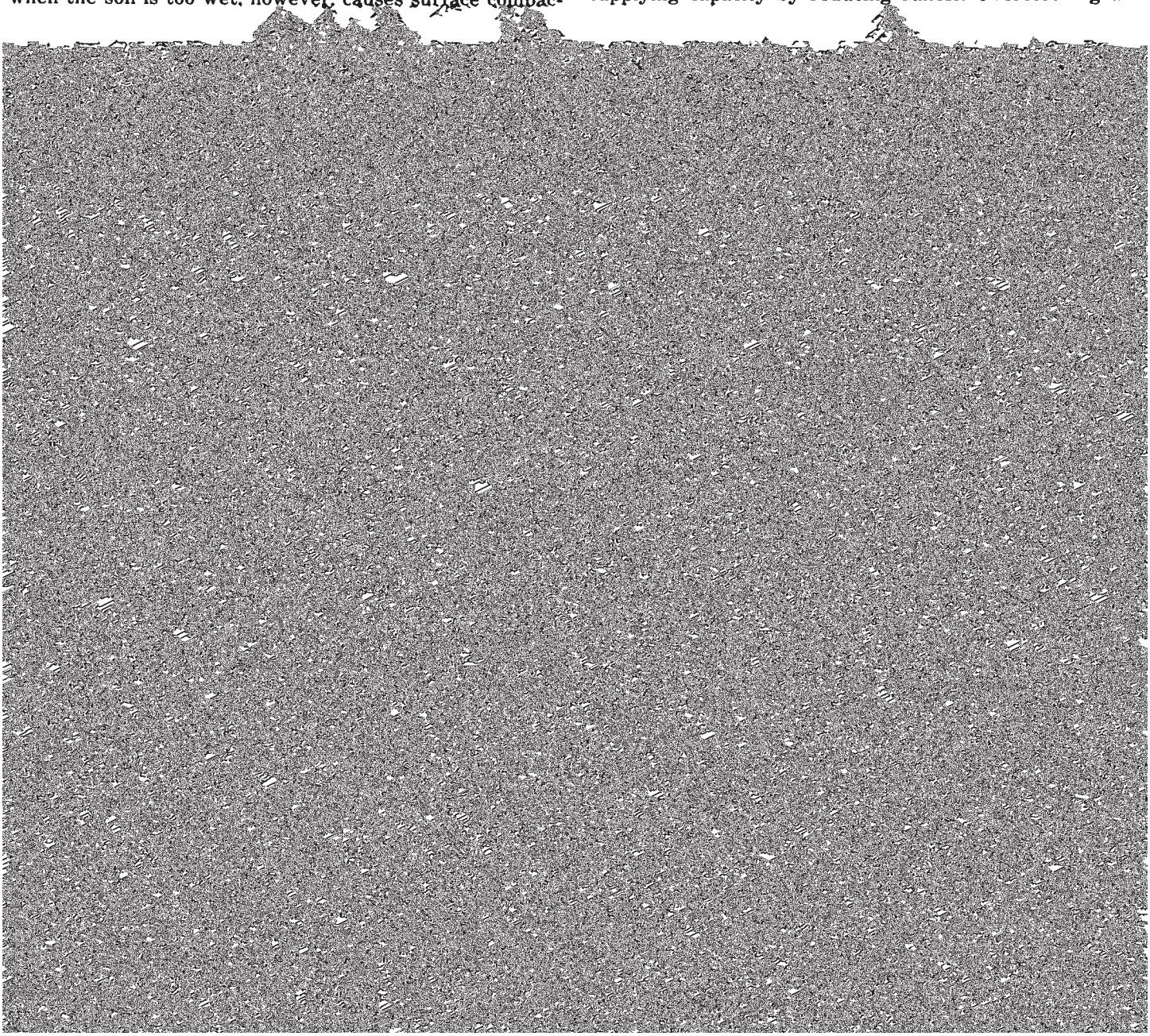
These soils are suited to small grain and sorghum and to grasses and legumes for hay and pasture. Unless irrigated, they are not well suited to corn and soybeans because these crops are frequently affected by drought at critical stages in their development. The high content of lime in the Clark soil causes some chlorosis in sorghum.

If these soils are used for cultivated crops, there is a hazard of erosion. Minimum tillage, winter cover crops, terraces, and waterways help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of these soils as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction. Available water capacity is low, and plants are frequently affected by periods of drought.

About half of the acreage of this soil is in native grass, and half is in cultivated small grain and sorghum. The soil has fair potential for range and rangeland wildlife. It has fair potential for farming and trees and shrubs and poor potential for most engineering uses.

This soil is best suited to small grain and range. The major problems of range management are related to the hazard of erosion and the low available water supply. The soil is somewhat droughty because of the low available water capacity and the water losses by runoff. Maintaining an adequate vegetative cover and ground mulch helps prevent excessive soil losses and improves the moisture supplying capacity by reducing runoff. Overstocking and



Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to moderately alkaline below the surface layer and varies widely in the surface layer as a result of local liming practices. Natural fertility and organic-matter content are high. The surface layer is very friable and can be easily tilled throughout a wide range of moisture content. Root growth is not impaired by any restrictive layer within a depth of 60 inches.

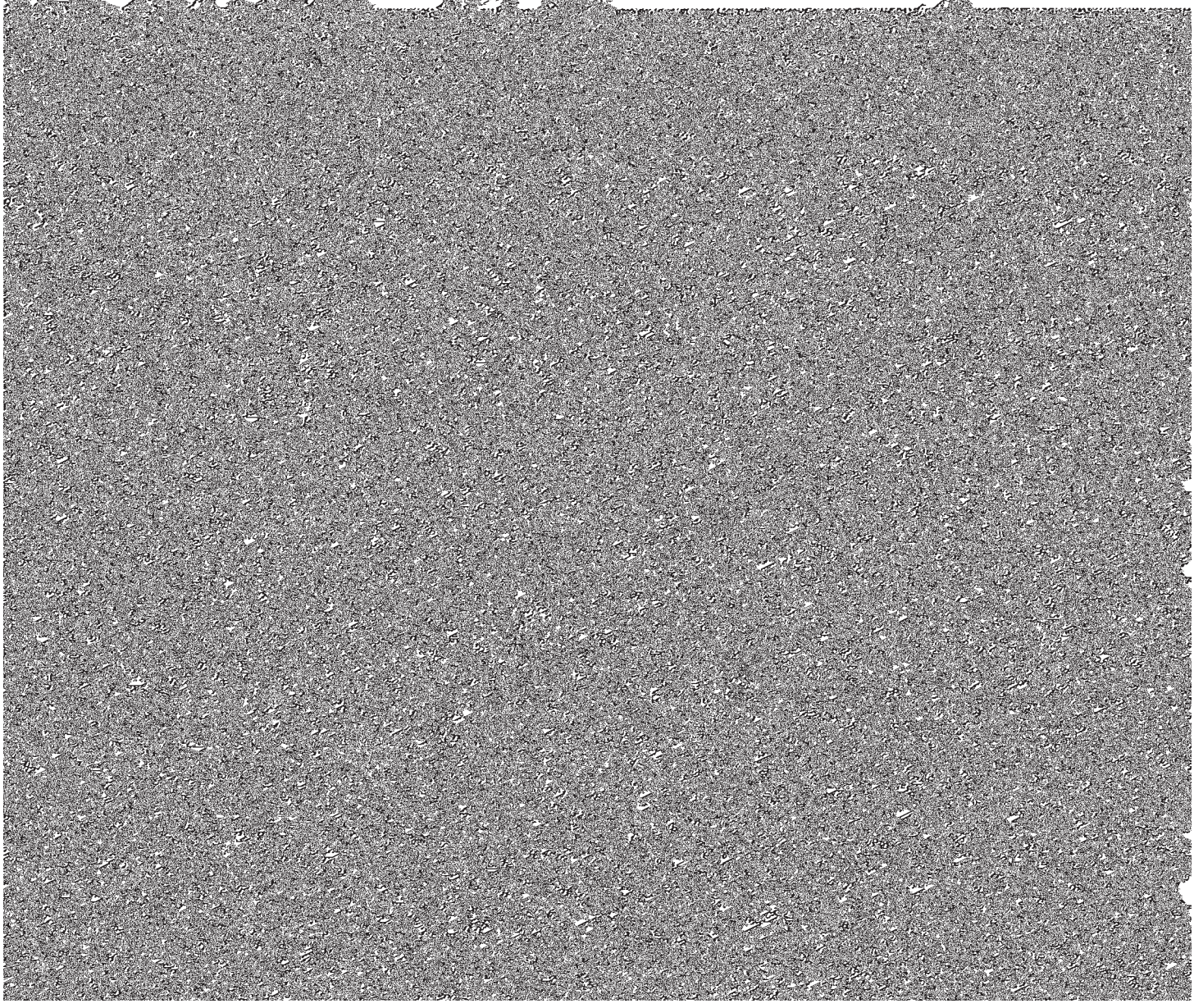
Most areas of this soil are in a variety of crops. The soil has good potential for crops, hay, pasture, and trees. If protected against flooding, it has fair to good potential for most engineering uses. Most areas are protected against flooding.

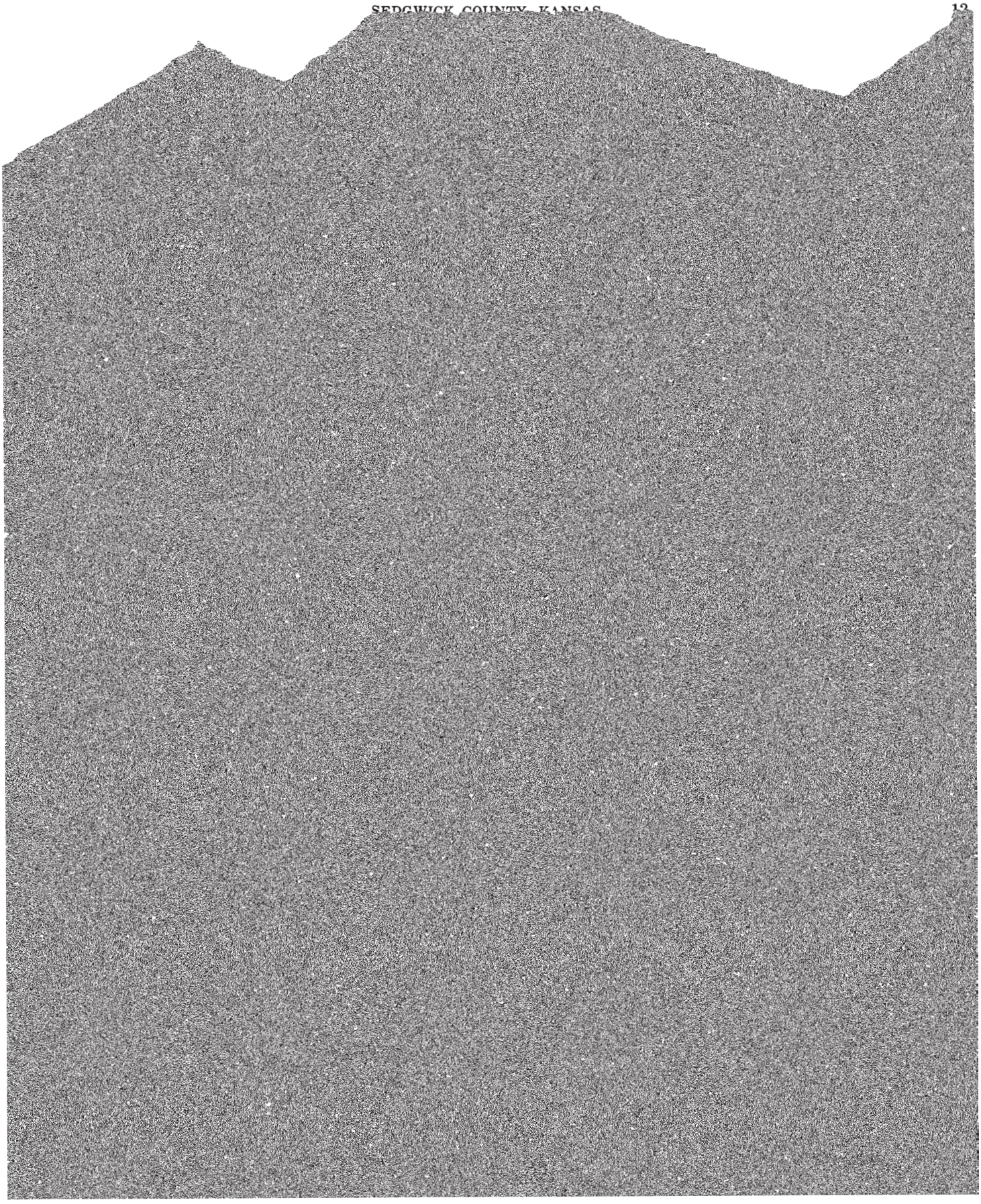
This soil is suited to corn, soybeans, small grain, and orchards and to grasses and legumes for hay and pasture. Minimum tillage and winter cover crops help maintain

Included with this soil in mapping are small areas of somewhat poorly drained Lesho soils in areas that are lower on the landscape and are typically adjacent to drainageways. These soils make up 2 to 10 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction is slightly acid or neutral in the surface layer and ranges from slightly acid to moderately alkaline below the surface layer. Natural fertility and organic-matter content are high. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. Root growth is not impaired by any restrictive layer within a depth of 60 inches.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has severe limitations for most engineering uses.





This soil is suited to small grain, sorghum, soybeans, and corn and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, erosion is a hazard. Minimum tillage, winter cover crops, terraces, and contour farming help prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. If irrigation water is available, there are no hazards or limitations to be concerned about when planting or harvesting.

This soil is suitable for building site development but has severe limitations for onsite waste disposal. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening [illegible] material. The [illegible] rate

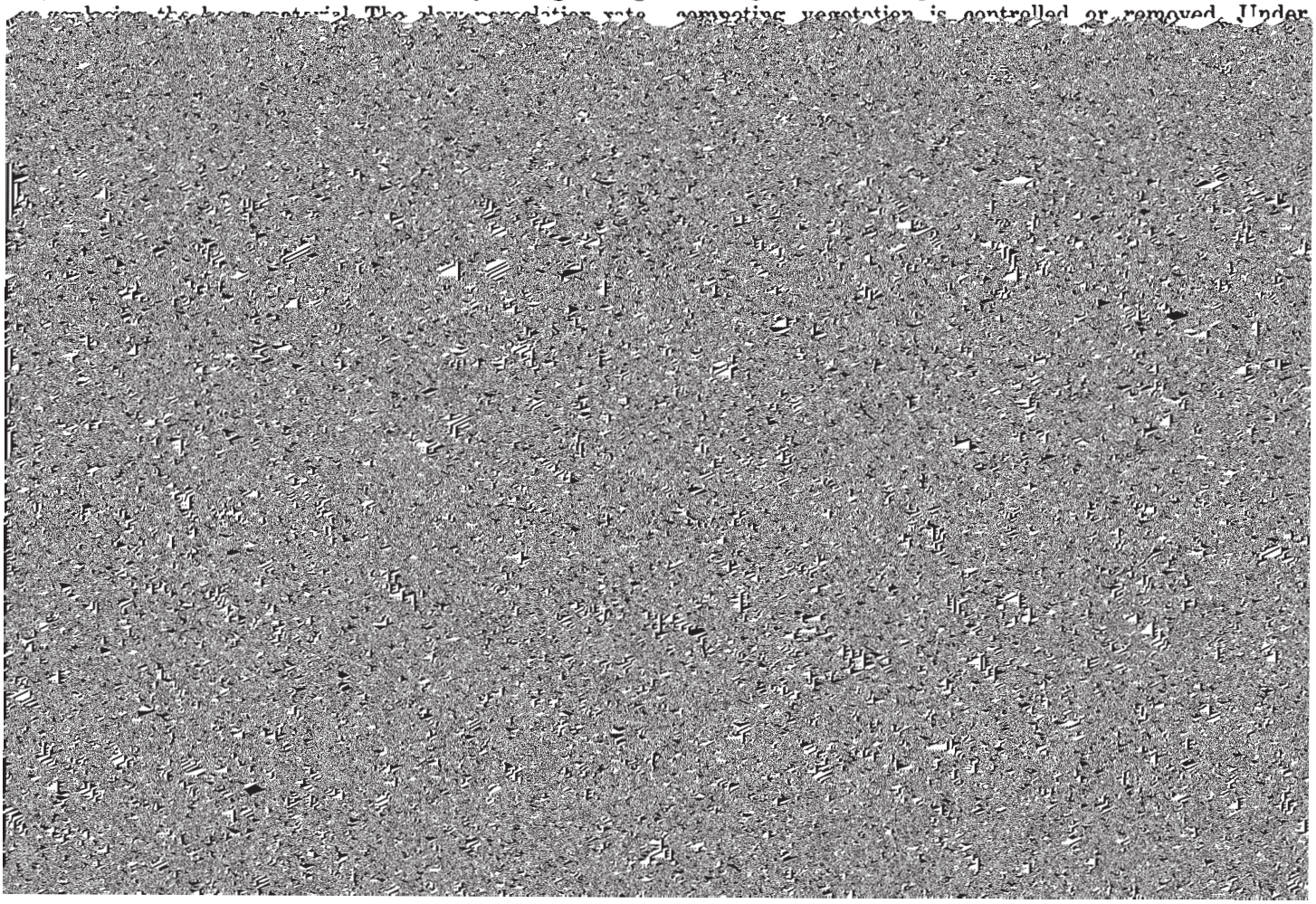
rises to within about 40 inches of the surface, but in most years depth to the water table exceeds 6 feet.

Most areas of this soil are farmed. Many areas have been leveled and irrigated. The soil has good potential for crops, hay, pasture, and trees. It has fair potential for most engineering uses.

This soil is suited to small grain, sorghum, and grass. If the soil is irrigated, corn, soybeans, and alfalfa are well suited. If corn, soybeans, and alfalfa are grown under dryland conditions, they are frequently affected by drought at critical stages in their development. Minimum tillage and winter cover crops help maintain good soil tilth. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water storage.

The use of this soil as pastureland or hayland is effective in keeping the soil in good condition. Overgrazing or grazing when the soil is too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

This map unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if the soil is irrigated and competing vegetation is controlled or removed. Under



Water and air move through this soil at a very slow rate, and runoff is slow to very slow. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and mildly alkaline or moderately alkaline below the surface layer. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very firm, and it shrinks and cracks when dry and swells when moist. It is difficult to till. If the surface layer is worked when moist, a crust that retards plant germination forms. Root growth is restricted by the shrinking and swelling of the heavy silty clay.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops, hay, pasture, and trees. It has poor potential for most engineering uses.

This soil is suited to small grain, sorghum, and soybeans and to corn for ensilage and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, some type of surface drainage should be provided in most areas. A system of bedding or open ditches is generally needed to adequately drain this soil. Minimum tillage and winter cover crops help maintain soil tilth. Returning crop residue to the soil or regularly adding other organic material maintains fertility, reduces crusting, and increases water infiltration.

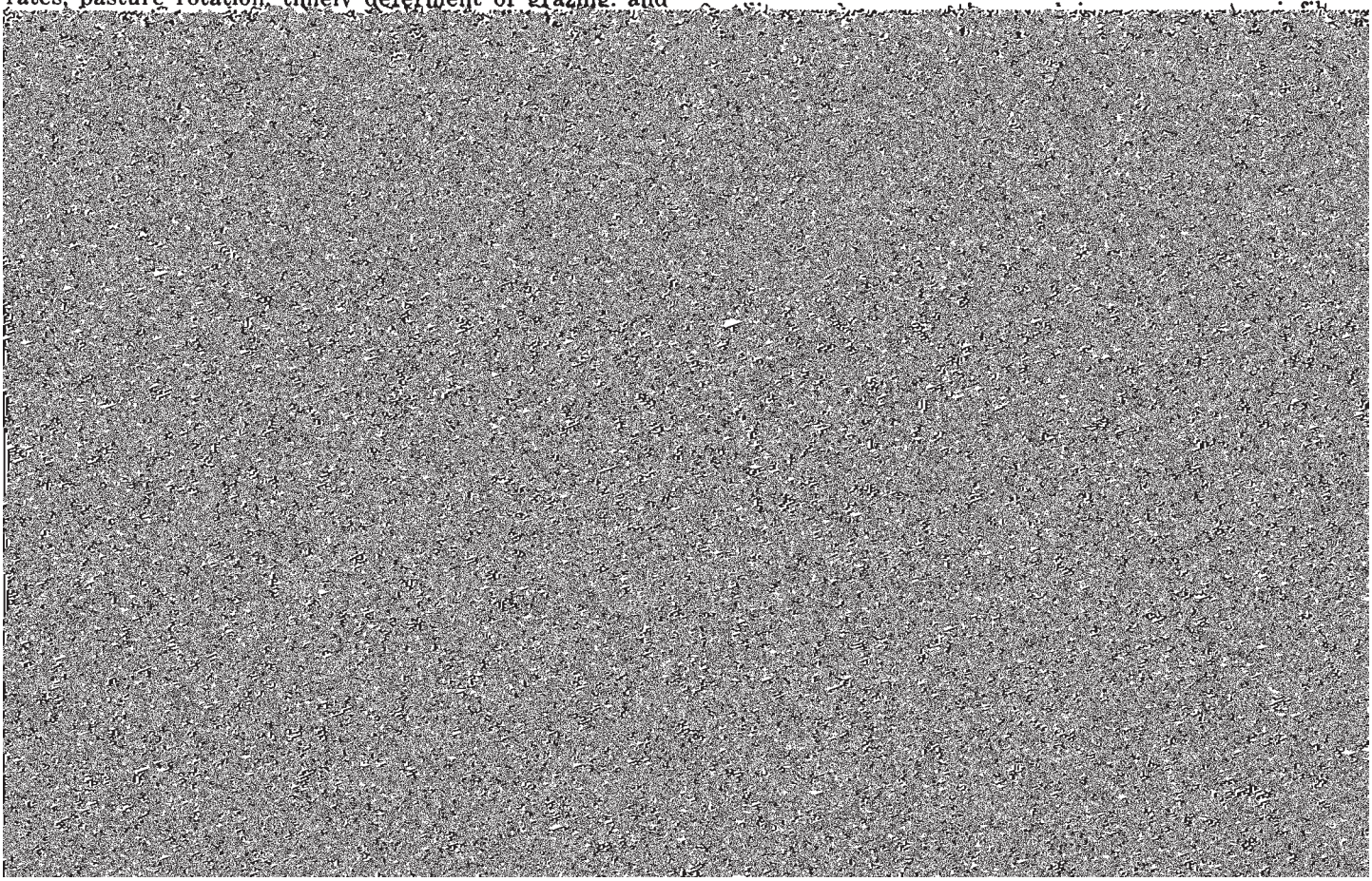
If this soil is used as pastureland or hayland, grazing when the soil is wet should be limited because it results in surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and

Included with this soil in mapping are small areas of well drained Irwin and Rosehill soils and moderately well drained Tabler soils. The Irwin soils typically occupy the steeper slopes, and the Rosehill and Tabler soils occupy the lower slopes adjacent to some of the drainageways. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is slow to medium. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and mildly alkaline or moderately alkaline below the surface layer. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very firm, and it shrinks and cracks when dry and swells when moist. It is difficult to till. If the surface layer is worked when moist, a crust that retards plant germination forms. Root growth is restricted by the shrinking and swelling of the heavy silty clay.

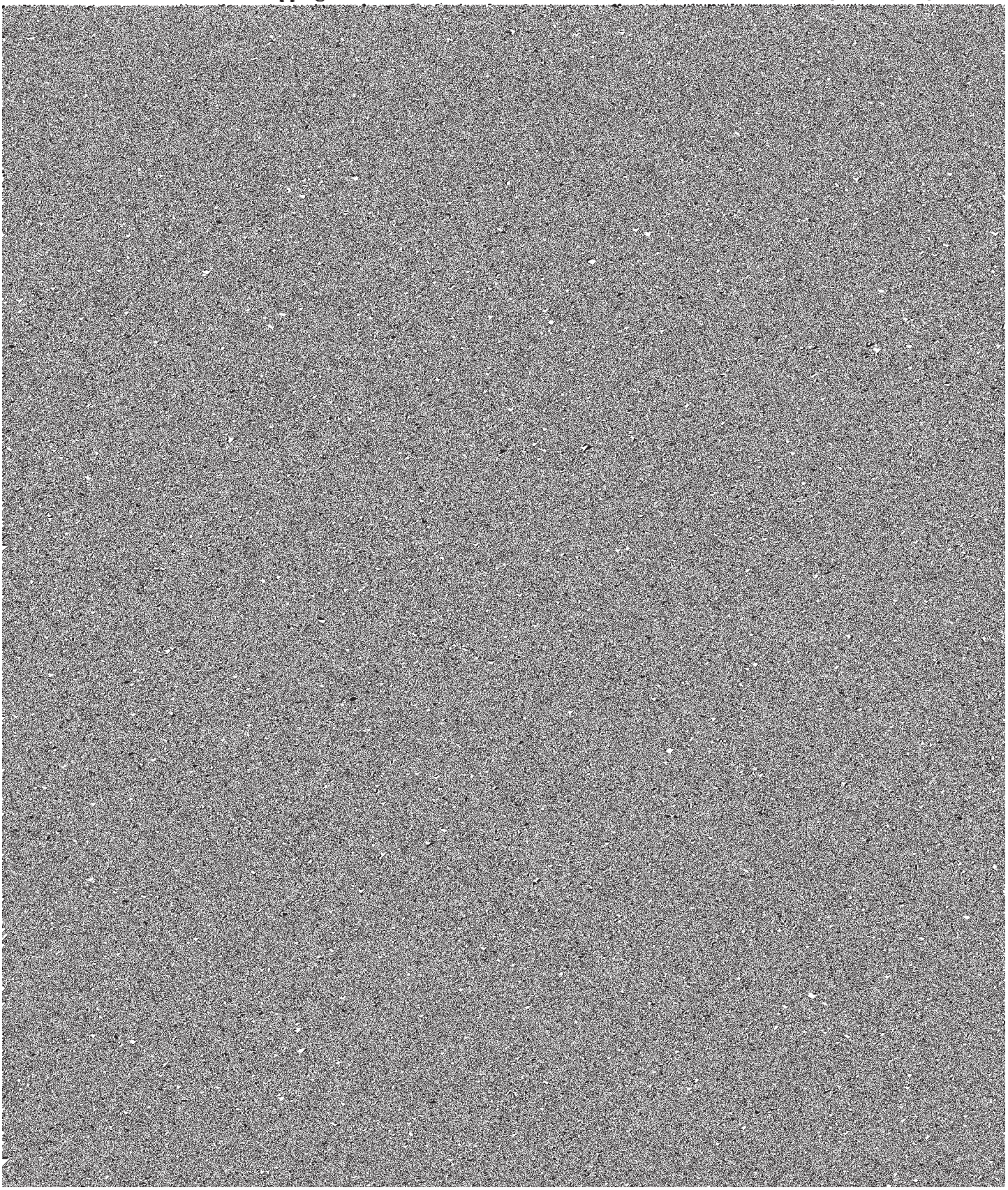
Most areas of this soil are farmed. The soil has fair potential for cultivated crops, hay, pasture, and trees.

This soil is suited to small grain, sorghum, and soybeans and to corn for silage and grasses and legumes for hay and pasture. If the soil is used for cultivated crops, minimum tillage and winter cover crops maintain tilth. If slopes are long enough, a terrace system and contour farming help to reduce the risk of erosion and increase water infiltration. Returning crop residue to the soil or regularly adding other organic material maintains



Included with this soil in mapping are small areas of

Ib—Irwin silty clay loam, 3 to 6 percent slopes. This



base material should be hauled in from outside the area. This soil has slight to severe limitations if it is used for recreational purposes. Capability unit IIIe-9; Clay Upland range site.

Ic—Irwin silty clay loam, 2 to 6 percent slopes, eroded. This gently sloping and sloping, well drained soil is on side slopes adjacent to moderately broad ridgetops. Individual areas are narrow and irregular in shape and range from 5 to 30 acres in size.

Typically, the surface layer is dark grayish brown heavy silty clay loam about 5 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark brown to brown; the lower part is brown. The substratum to a depth of 60 inches is brown silty clay. In places the upper part of the subsoil is redder. In areas where the upper part of the subsoil has been mixed with the surface layer by plowing, the surface layer is brown silty clay loam to silty clay.

Included with this soil in mapping are small, long and narrow areas of well drained Clime and Rosehill soils. These soils make up 5 to 10 percent of the unit.

Water and air move through this soil at a very slow rate, and runoff is rapid. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the surface layer and from slightly acid to mildly alkaline in the subsoil. Natural fertility and organic-matter content are low because of the loss of surface soil through erosion. The surface layer is firm and is difficult to till. It tends to crust or puddle after hard rains, especially in areas where the plow layer contains subsoil material. Root growth is restricted by the silty clay subsoil.

About half of the acreage of this soil is farmed, and half is pasture or range. This soil is suited to small grain and to grasses and legumes for hay and pasture.

If the soil is used for cultivated crops, there is a hazard of further erosion damage. Minimum tillage, winter cover crops, and terrace systems help prevent excessive soil loss. Returning crop residue to the soil or regularly used

installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to lagoons. Local roads should be graded to shed water, and suitable material should be hauled in from outside the area. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IVe-2; Clay Upland range site.

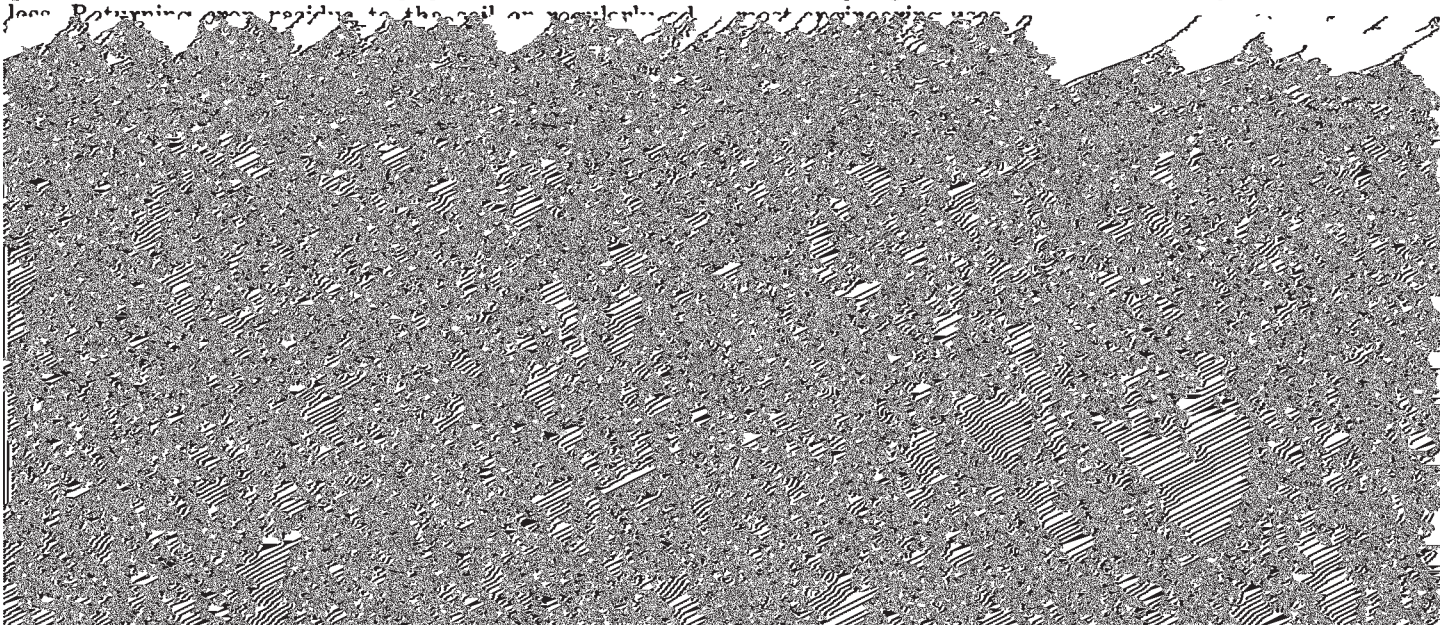
La—Lesho loam. This nearly level, somewhat poorly drained soil is on flood plains and low stream terraces. Flooding is occasional, occurring about once every 3 years. Individual areas of this unit are irregular in shape and range from 5 to several hundred acres in size.

Typically, the surface layer is about 27 inches thick. The upper part is very dark grayish brown loam; the lower part is dark grayish brown, friable loam with distinct, dark brown mottles. The substratum is grayish brown fine sand.

Included with this soil in mapping are small areas of poorly drained Plevna soils and somewhat poorly drained Waldeck soils. The Plevna soils typically occur on the lower levels adjacent to the drainageways. The Waldeck soils are intermingled with the Lesho soil in some areas. The Plevna and Waldeck soils make up 5 to 15 percent of the unit. Slick spots are common on this soil.

Water and air move through this soil at a moderately slow rate, and runoff is slow. Available water capacity is moderate. Reaction ranges from mildly alkaline to strongly alkaline. Natural fertility and organic-matter content are high. The water table usually fluctuates between depths of 3 and 6 feet. It rises to within 2 feet of the surface in some years. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. Root growth is restricted by the fine sand substratum at a depth of about 27 inches.

About two-thirds of the acreage of this soil is farmed, and the rest is in grass. The soil has fair potential for most crops, grasses, and trees. It has poor potential for most engineering uses.



vive and grow well if competing vegetation is controlled or removed. Problems to be concerned about when planting or harvesting trees are wetness and flooding.

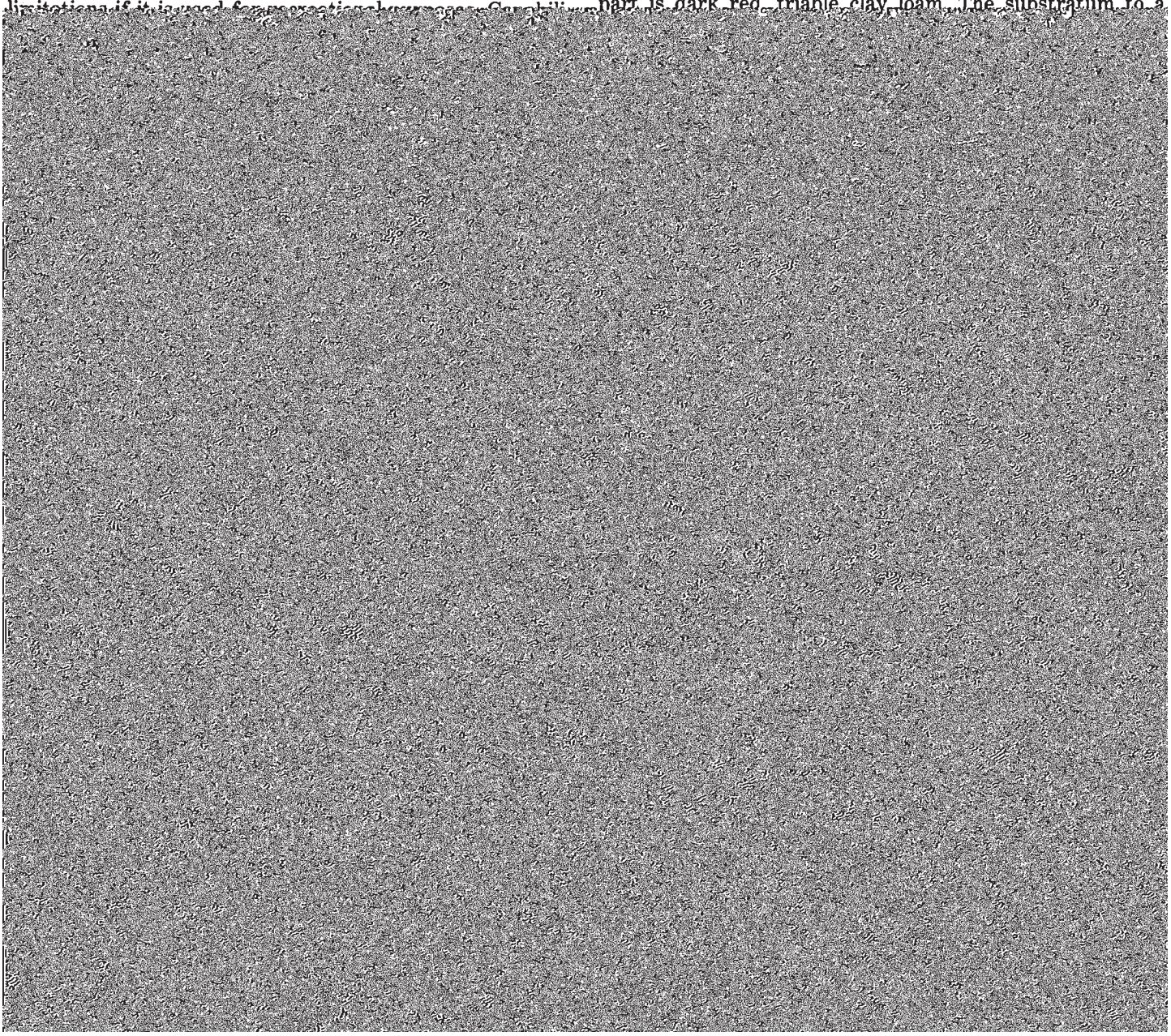
This map unit has severe limitations for building sites. The main problems are wetness and flooding. The risk of structural damage and excessive seepage can be reduced if basement walls, foundations, and footings for dwellings and small buildings are properly designed and drain tiles and sumps are used. Sanitary facilities should be connected to sewers, or sewage should be piped to adjacent areas that are suitable for lagoons. Local roads should be graded to shed water and elevated. Base material should be hauled in from outside of the area.

This soil has favorable characteristics for excavated ponds that are aquifer fed. It has moderate to severe limitations if it is used for recreational purposes. Capability unit Vw-3; Sandy Lowland range site.

These soils have severe limitations for building sites. The main problems are wetness and flooding. Sanitary facilities should be connected to sewers, or sewage should be piped to adjacent areas that are suitable for lagoons. If these soils are used for road building, limitations are severe because of flooding and wetness. The soils have severe limitations if they are used for recreational purposes. Capability unit Vw-3; Sandy Lowland range site.

Ma—Milan loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on uplands. Individual areas of this unit are irregular in shape and range from about 20 to several hundred acres in size.

Typically, the surface layer is brown loam about 11 inches thick. The subsoil is about 33 inches thick. The upper part is reddish brown, firm clay loam; the lower part is dark red, friable clay loam. The substratum to a



design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. The moderate percolation rate should present few problems for septic tank absorption fields. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIe-1; Loamy Upland range site.

Mb—Milan loam, 3 to 6 percent slopes. This sloping, well drained soil is on uplands. Individual areas of this unit are narrow and long and range from 15 to 60 acres in size.

Typically, the surface layer is brown loam about 8 inches thick. The subsoil is about 33 inches thick. The upper part is reddish brown, firm clay loam; the lower part is dark red, friable clay loam. The substratum to a depth of 60 inches is yellowish red clay loam.

Included with this soil in mapping are small areas of Farnum, Renfrow, and Shellabarger soils. The Farnum soils occupy areas near drainageways, the Renfrow soils occupy foot slopes, and the Shellabarger soils are on narrow ridgetops. These included areas make up 5 to 15 percent of the unit.

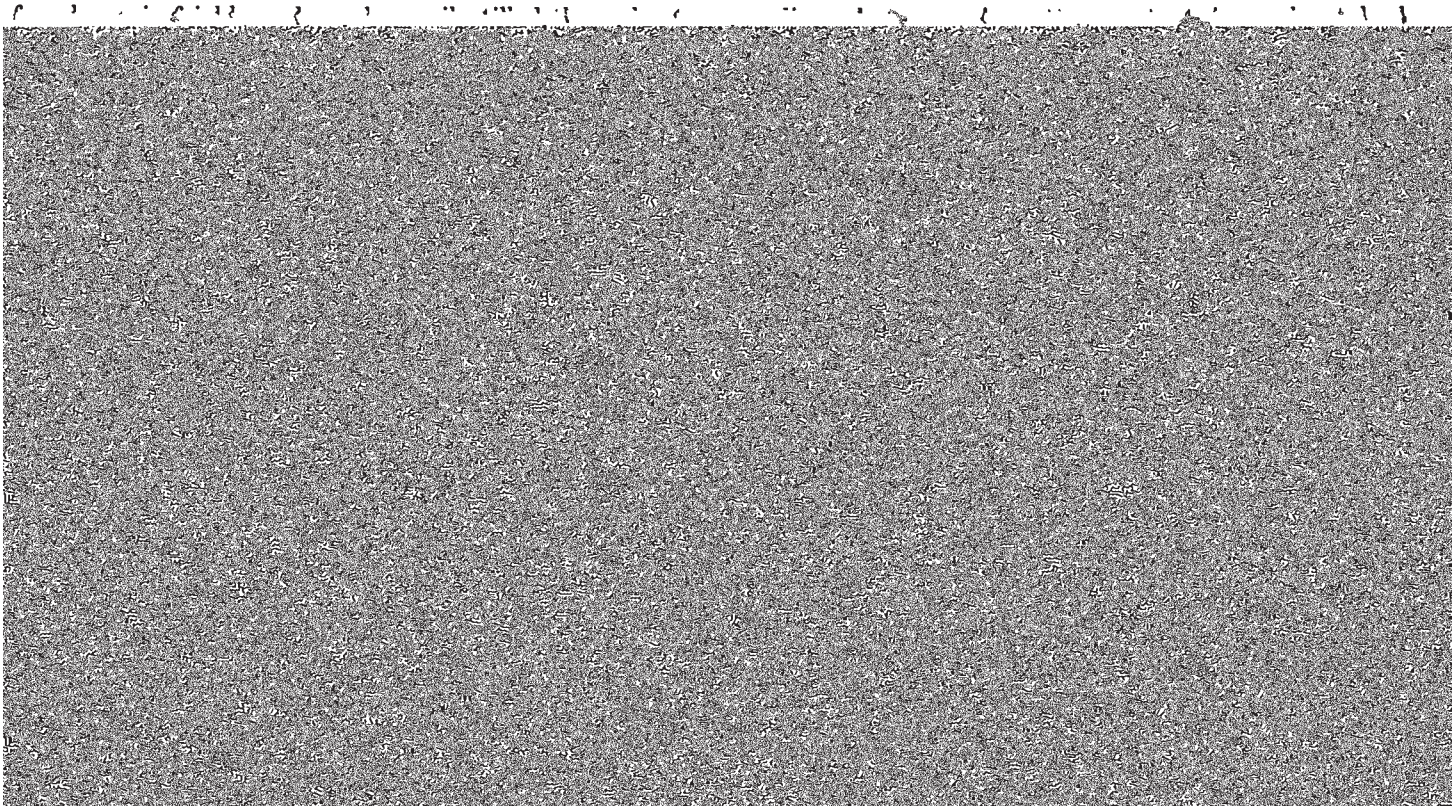
Water and air move through this soil at a moderately slow rate, and runoff is medium on cultivated fields. Available water capacity is high. Reaction is medium acid or slightly acid in the surface layer and ranges from medium acid to neutral in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. The moderate percolation rate should present few problems for septic tank absorption fields. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-2; Loamy Upland range site.

Mc—Milan clay loam, 2 to 6 percent slopes, eroded. This gently sloping and sloping, well drained soil is on uplands. Individual areas of this unit are irregularly shaped and range from 10 to 30 acres in size.

Typically, the surface layer is brown clay loam about 6 inches thick. The subsoil is about 33 inches thick. The upper part is reddish brown, firm clay loam; the lower part is dark red, friable clay loam. The substratum to a depth of 60 inches is yellowish red clay loam. In places where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown clay loam.

Included with this soil in mapping are small areas of Farnum, Renfrow, and Shellabarger soils. The Farnum soils occupy areas near drainageways, the Renfrow soils occupy foot slopes, and the Shellabarger soils are on narrow ridgetops. These included areas make up 5 to 15 percent of the unit.

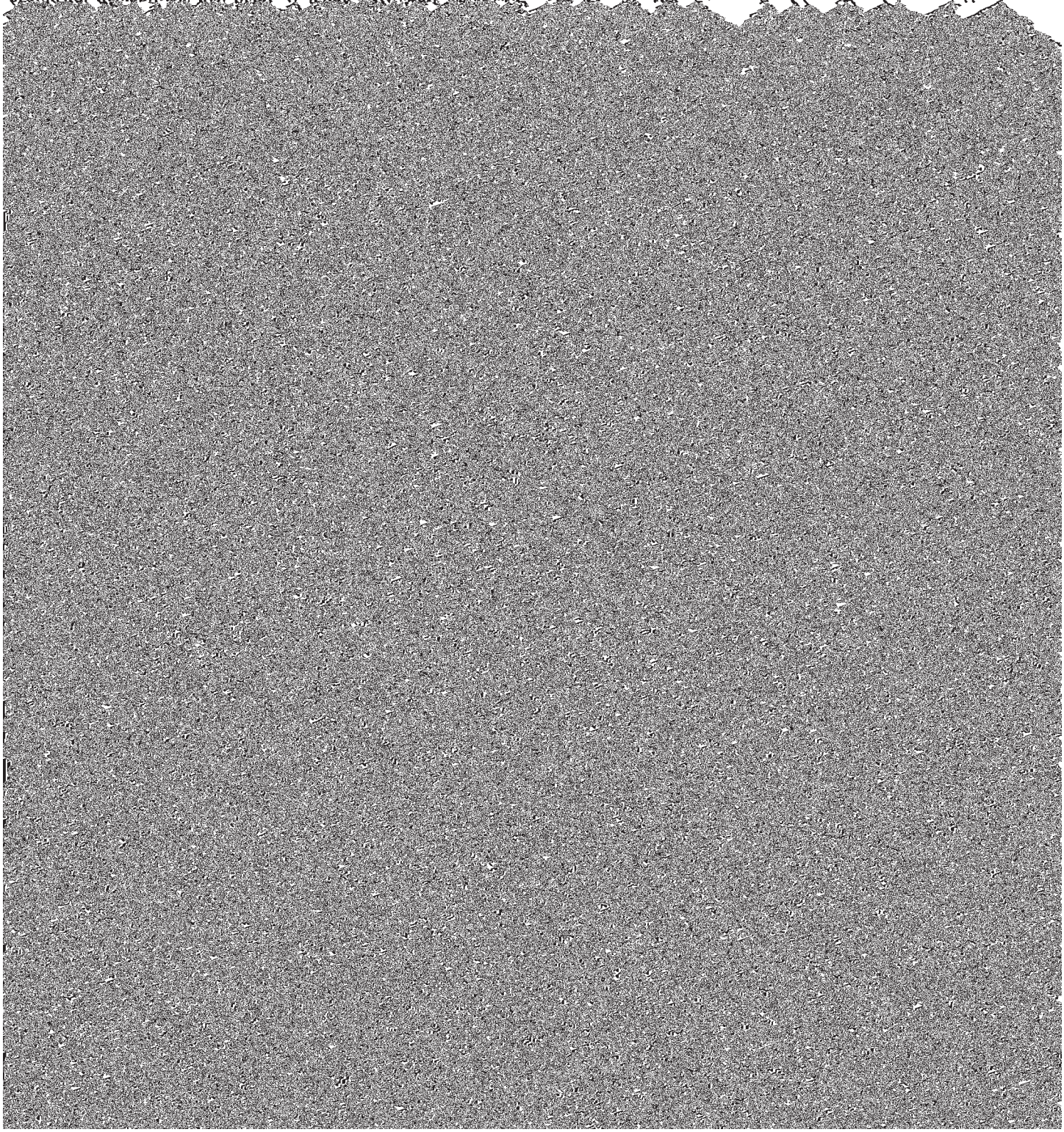
Water and air move through this soil at a moderately slow rate, and runoff is medium on cultivated fields. Available water capacity is high. Reaction is medium acid or slightly acid in the surface layer and ranges from medium acid to neutral in the subsoil. Natural fertility is



is controlled or removed. If erosion is controlled and irrigation water is available, there are few limitations to be concerned about when planting or harvesting.

This soil has moderate limitations for building site development because of low shear strength. It is suitable for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength

This soil is suitable for building site development and for onsite waste disposal if proper design and proper installation procedures are used. It lacks sufficient strength and stability to support vehicular traffic, but this limitation can be overcome by strengthening or replacing the base material. Excessive seepage from sewage lagoons



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 keep the range and soil in good condition.

If buildings are constructed on this soil, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling. Artificial drainage should be provided around the buildings to keep the soil and shale from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite waste disposal. Suitable sites for lagoons generally can be located in some areas of deeper soil. This soil has severe limitations if it is used for recreational purposes. Capability unit IVe-3; Red Clay Prairie range site.

Od—Owens-Rock outcrop complex, 3 to 10 percent slopes. This map unit consists of Rock outcrop and sloping and strongly sloping, well drained soils on upland ridges and side slopes. Most areas are dissected by shallow drainageways. Individual areas of this unit are oblong and range from 10 to 160 acres in size. They are 50 to 60 percent Owens soils and 20 to 40 percent shale outcrop. The Owens soils are on ridgetops and side slopes. The shale outcrop is adjacent to the drainageways and sharp slope breaks. The soils and the Rock outcrop are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Owens soil has a surface layer of reddish brown clay loam about 7 inches thick. The subsoil is reddish brown, very firm silty clay about 8 inches thick. The substratum is calcareous, platy clayey shale.

Typically, the Rock outcrop is exposed shale that dominantly is red but is also gray, green, and yellow. The shale is moderately alkaline, fine grained, and platy.

Included with this unit in mapping are small areas of Vernon soils on foot slopes and in depressional areas. These soils make up 5 to 15 percent of the unit.

Permeability is very slow through the Owens soil. Available water capacity is very low. This soil contains a fine, elastic clay that holds some of the soil moisture under too much tension to be extracted by plant roots. Runoff is rapid. The soil shrinks and swells markedly upon drying and wetting. Reaction is dominantly moderately alkaline, but in places the surface layer is neutral. Fertility and organic-matter content are low. The root zone extends to the shale bedrock.

Most areas of this unit remain in native grass and are used for grazing. The unit has fair potential for range and poor potential for rangeland wildlife habitat. It has poor potential for farming, for trees and shrubs, and for most engineering uses.

This unit is best suited to range. The major problems of range management are related to the available water supply. The soil is droughty because of the very low available water capacity and the water losses by runoff. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves the water 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 keep the range and soil in good condition.

If buildings are constructed on this unit, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling. Artificial drainage should be provided around the buildings to keep the soil and shale from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite waste disposal. Suitable sites for lagoons generally can be located on some of the deeper soils adjacent to this unit. This unit has severe limitations if it is used for recreational purposes. Capability unit VIe-2; Owens part in Red Clay Prairie range site.

Pa—Pits. This map unit is in areas where the soil has been excavated and the substratum has been used for sand or gravel. The excavated areas are on uplands, terraces, and flood plains. Most pits are excavated to a depth of 15 feet or more. The entire solum is removed, and the water table or the sand substratum is exposed. In some areas shale bedrock is exposed. Most pits are dominantly water and piles of sand. Soil blowing, very low fertility, unstable slopes, and a high water table are the principal hazards for any type of land use. Some pits are used for recreational facilities and fish ponds. A typical pit is in the NE1/4NE1/4 section 14, T. 25 S., R. 2 W. Not assigned to a capability unit or range site.

Pb—Plevna fine sandy loam. This nearly level, poorly drained soil is on flood plains and in depressions in subirrigated valleys. It is adjacent to drainageways. Flooding is frequent, occurring about once every year. Individual areas of this unit are narrow and range from 15 to 120 acres in size.

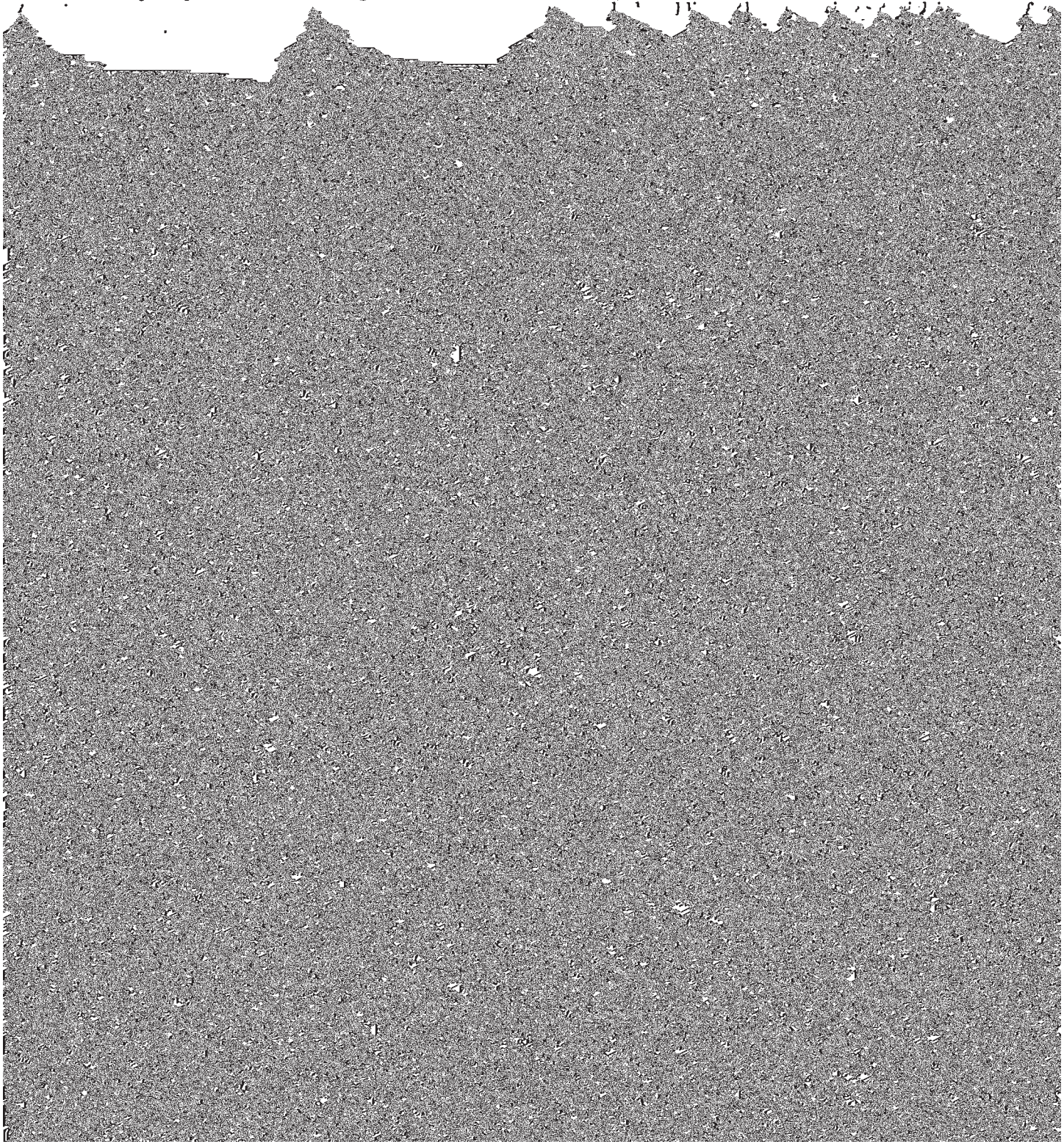
Typically, the surface layer is about 20 inches thick. The upper part is very dark gray fine sandy loam; the lower part is dark gray sandy loam. The subsoil is about 15 inches of grayish brown, very friable sandy loam with distinct mottles. The substratum to a depth of 60 inches is grayish brown loamy sand or fine sand.

Included with this soil in mapping are small areas of Lincoln and Waldeck soils. The Lincoln soils occupy areas of more recent deposition, and the Waldeck soils are better drained than this Plevna soil.

Water and air move through this soil at a moderately rapid rate. The ground water table is 1 1/2 to 3 feet below the surface during much of the growing season. It rises to within a few inches of the surface during wet periods and drops to about 4 feet late in summer and early in autumn. Available water capacity is moderate. Reaction ranges from neutral to moderately alkaline throughout the profile. Natural fertility and organic-

matter content are high. Root growth is restricted below a depth of 35 inches by the saturated loamy sand.

Most areas of this soil remain in native grass (fig. 9) and are used for grazing and hay. The soil has good potential for range, trees and shrubs, and wetland wildlife habitat. It has poor potential for farming and for most enwell suited to alfalfa and forage sorghum. If the soil is used for cultivated crops, the hazard of soil blowing is severe. Minimum tillage and winter cover crops help prevent excessive soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil



Permeability is rapid and available water capacity is low in the Pratt and Tivoli soils. Runoff is slow on the Pratt soil and very slow on the Tivoli soil. The Pratt soil is medium acid to neutral throughout. It is low in fertility and organic-matter content. The surface layer of the Tivoli soil is slightly acid to mildly alkaline, and the underlying material is slightly acid to moderately alkaline. The Tivoli soil is low in fertility and very low in organic-matter content.

Most areas of these soils remain in native grass and are used for grazing. The soils have fair to good potential for range and poor to fair potential for rangeland wildlife habitat. They have poor potential for farming, good potential for trees and shrubs, and poor potential for most engineering uses.

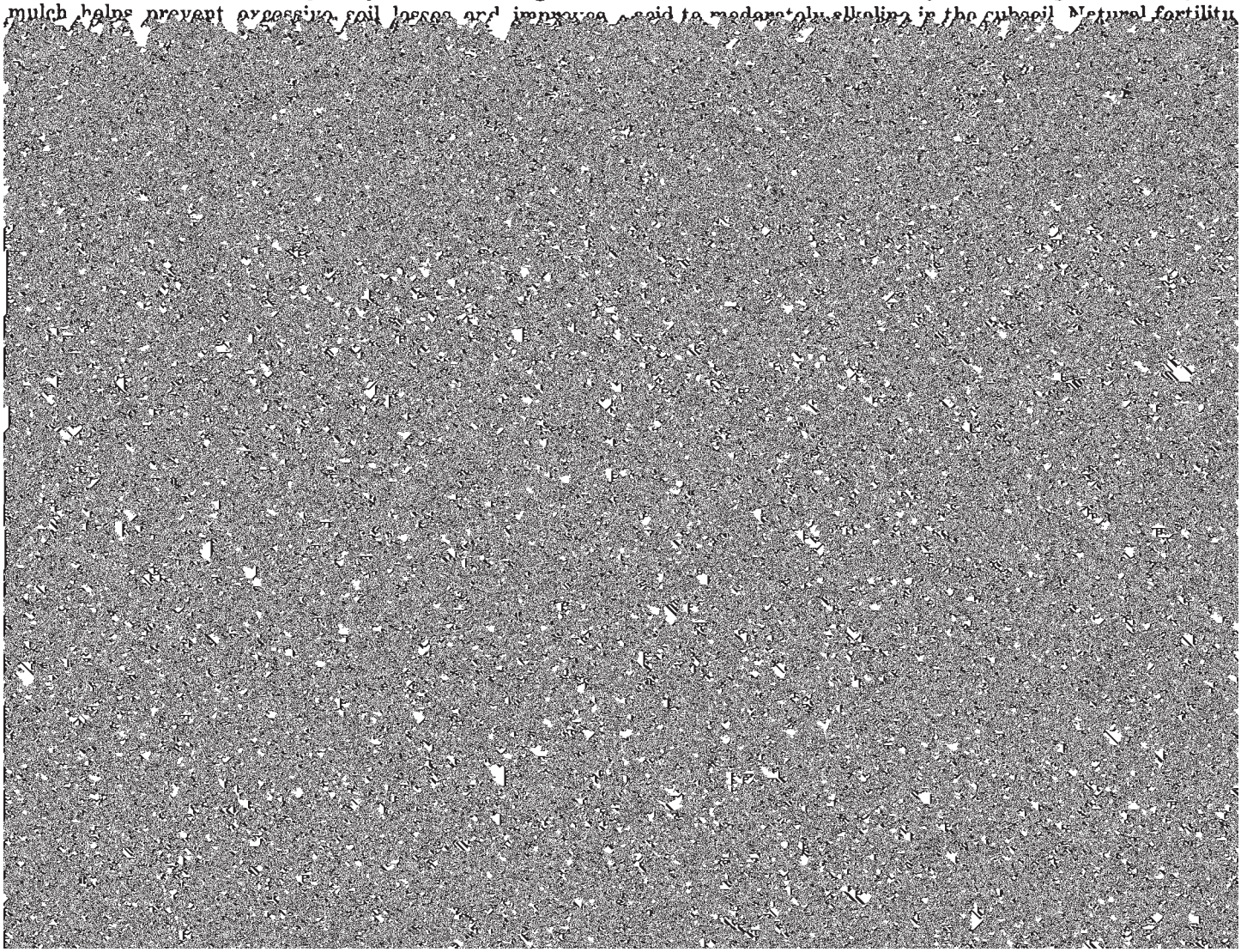
This unit is best suited to range. Most of the range is in fair condition and has an abundance of woody increasers. The major problems are related to the hazard of soil blowing and the available water supply. The soils are somewhat droughty because of the low available water capacity. Maintaining an adequate plant cover and ground mulch helps prevent excessive soil losses and improves

Ra—Renfrow silty clay loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on convex ridgetops, knolls, and uneven side slopes. Individual areas of this unit are irregular in shape and range from 20 to several hundred acres in size.

Typically, the surface layer is brown silty clay loam about 9 inches thick. The subsoil is about 41 inches thick. The upper part is dark reddish brown, very firm silty clay loam; the next part is dusky red and dark reddish brown, extremely firm silty clay; the lower part is reddish brown, very firm silty clay with many shale fragments. The underlying material is red silty and clayey shale.

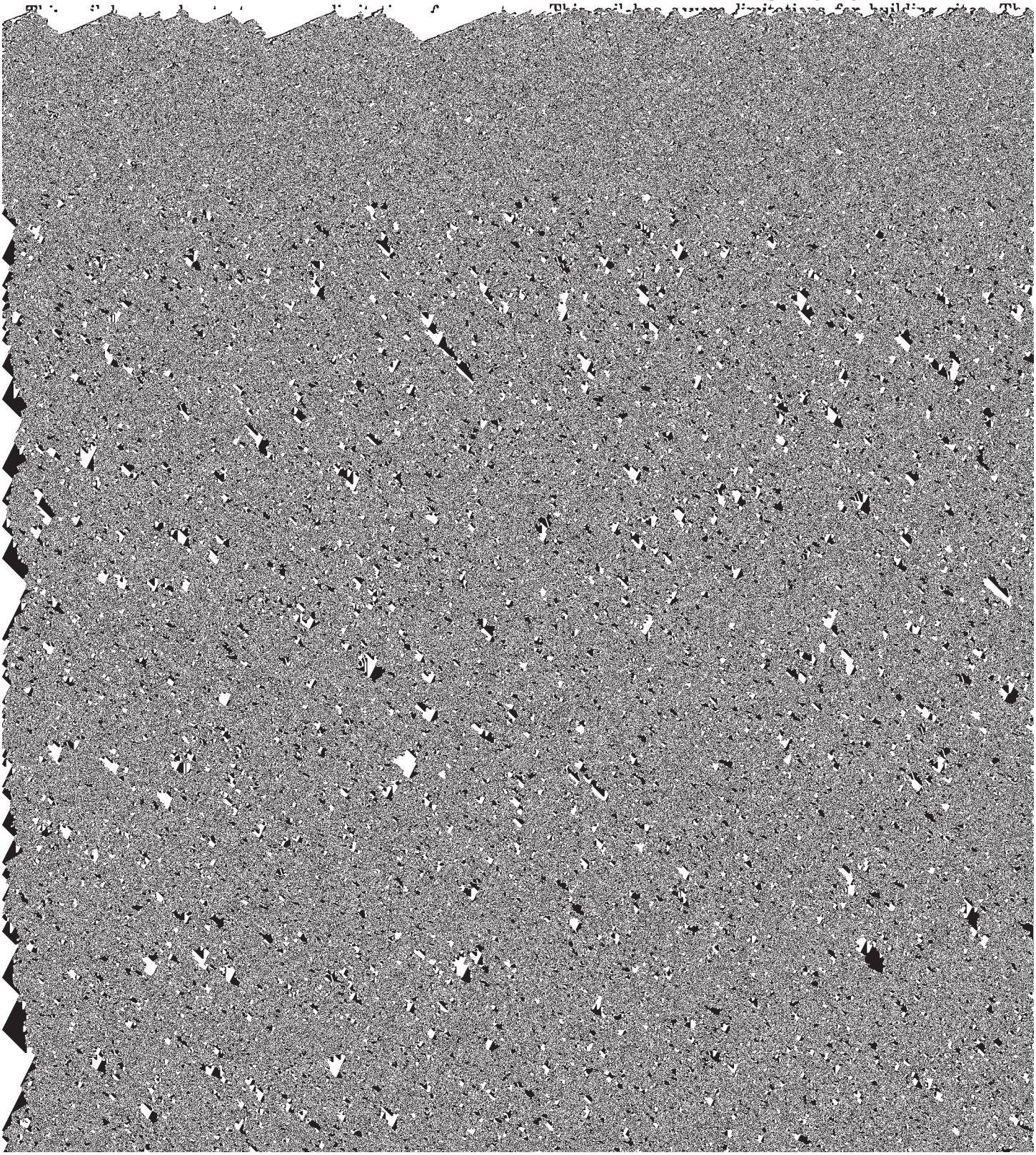
Included with this soil in mapping are small areas of Owens and Vernon soils. These soils are on knolls and short, uneven side slopes. They make up 5 to 15 percent of the unit.

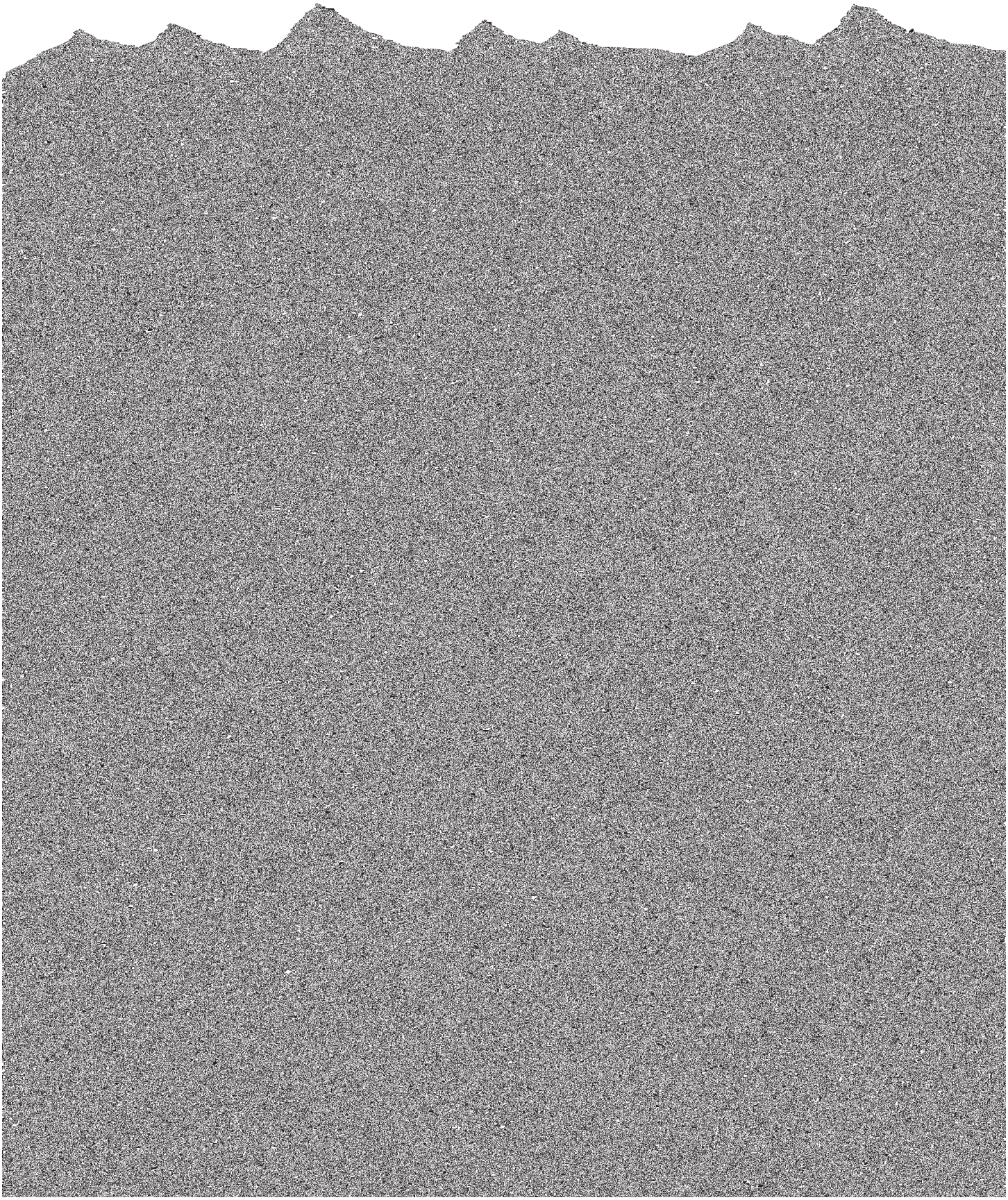
Water and air move though this soil at a very slow rate, and runoff from cultivated areas is medium. Available water capacity is moderate. Reaction is slightly acid or neutral in the surface layer and ranges from slightly



nected to commercial sewers, or sewage should be piped to lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area.

This unit is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however, survive only under good management that includes control of competing vegetation.





tions penetrate the shale beds. This soil has severe limitations if it is used for recreational purposes. Capability unit IIIe-3; Clay Upland range site.

Sa—Shellabarger sandy loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on convex ridgetops, knolls, and uneven side slopes. Individual areas of this unit are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is dark brown sandy loam about 10 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum to a depth of about 60 inches is yellowish red sandy loam. In places the surface layer is loamy fine sand.

Included with this unit in mapping are small areas of well drained Albion and Milan soils. The Albion soils are typically on knobs or knolls. The Milan soils are on the lower foot slopes. These included areas make up 5 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff from cultivated areas is medium. Available water capacity is moderate. Reaction is slightly acid or medium acid in the surface layer and ranges from slightly acid to mildly alkaline in the subsoil. Natural fertility is medium, and organic-matter content in most cultivated fields is moderately low. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. It is subject to soil blowing if it is left bare in winter.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It also has good potential for specialized crops, such as melons and vegetables, if irrigation water is available. It has fair to good potential for most engineering uses.

This soil is suited to wheat and sorghum and to grasses and legumes for hay and pasture. If irrigation water is available, it is also suited to corn and soybeans. Minimum tillage, winter cover crops, and stripcropping help prevent excessive soil loss. A few areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases water retention.

The use of the soil as pastureland or rangeland is an effective way of controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the grass and soil in good condition.

This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species, site preparation, and control of competing vegetation are needed for successful tree culture.

This soil is suitable for building site development and for on site waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. Similar treatment is needed in pond reservoir areas. This soil has fair potential for roadfill because of low shear strength. It has slight limitations if it is used for recreational purposes. Capability unit IIe-3; Sandy range site.

Sb—Shellabarger sandy loam, 3 to 6 percent slopes. This sloping, well drained soil is on uneven side slopes. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 15 to 80 acres in size.

Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is dark reddish brown, friable sandy loam; the lower part is yellowish red, firm sandy clay loam. The substratum to a depth of about 60 inches is yellowish red sandy loam. In places the surface layer is loamy fine sand. In some places where the plow layer has been mixed with the upper part of the subsoil, the surface layer is dark reddish brown.

Included with this soil in mapping are small areas of well drained Albion and Milan soils. The Albion soils are typically on ridges or knolls. The Milan soils are on some of the lower foot slopes and adjacent to some of the drainageways. These included areas make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff from cultivated areas is medium. Available water capacity is moderate. The surface layer is slightly acid or medium acid. The subsoil ranges from slightly acid to mildly alkaline. Natural fertility is medium, and organic-matter content in most cultivated fields is moderately low. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. It is subject to both soil blowing and water erosion unless it is protected.

About two-thirds of the acreage of this soil is farmed, and the rest is native range. The soil has good potential for cultivated crops, hay, pasture, and trees. It also has good potential for specialized crops, such as melons and vegetables, if irrigation water is available. It has fair to good potential for most engineering uses.

This soil is suited to wheat and sorghum and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and stripcropping help prevent excessive soil loss. A few areas have slopes that are long and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases water retention.

The use of the soil as pastureland or rangeland is an effective way of controlling erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and a planned grazing system help to keep the grass and soil in good condition. The soil has fair potential for rangeland wildlife habitat.

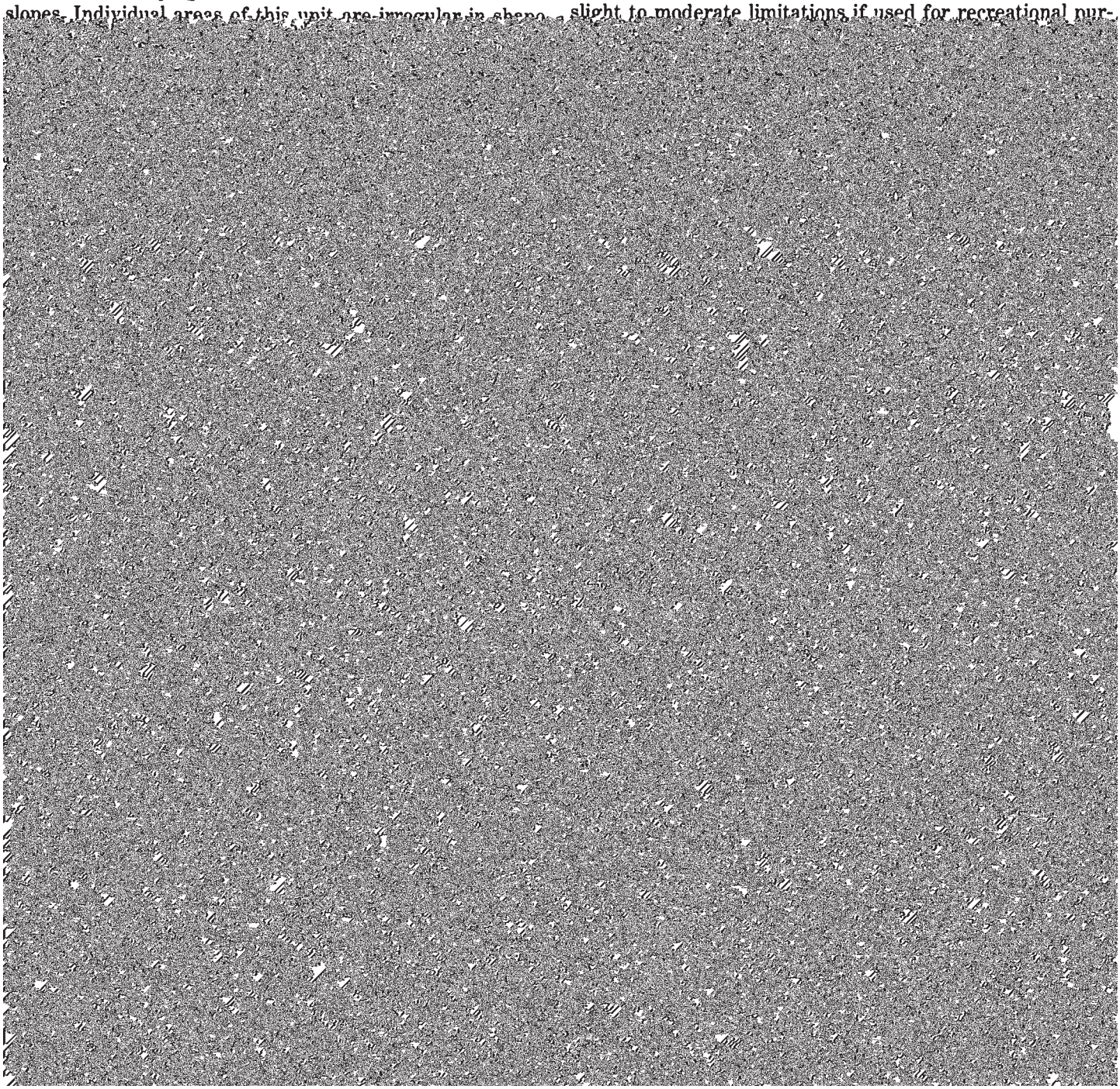
This soil is well suited to trees grown as windbreaks and environmental plantings. Suitable species, site preparation, and control of competing vegetation are needed for successful tree culture.

This unit is suitable for building site development and for on site waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. Similar treatment is needed in pond reservoir areas. This soil has fair potential for roadfill because of low shear strength. It has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-8; Sandy range site.

Sc—Shellabarger sandy loam, 3 to 6 percent slopes, eroded. This sloping, well drained soil is on uneven side slopes. Individual areas of this unit are irregular in shape

This unit is well suited to trees grown as windbreaks and environmental plantings. Suitable species, site preparation, and control of competing vegetation are needed for successful tree culture.

This soil is suitable for building site development and for on site waste disposal if proper design and proper installation procedures are used. Excessive seepage from sewage lagoons can be prevented by special treatment to seal the lagoon. Similar treatment is needed in pond reservoir areas. Because of low shear strength, this soil has only fair potential if used as roadfill material. It has slight to moderate limitations if used for recreational pur-



If this soil is used for pasture or range, proper stocking rates, pasture rotation, timely deferment of grazing, and a planned grazing system are needed.

This soil is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings, however survive only under good management that includes control of competing vegetation.

This soil has severe limitations for building sites. The main problem is the shrink-swell potential. The risk of structural damage caused by shrinking and swelling can be reduced if basement walls, foundations, and footings for dwellings and small buildings are properly designed and reinforced and drain tiles are installed. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to sewage lagoons. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. This soil has moderate to severe limitations if it is used for recreational purposes. Capability unit IIs-1; Clay Upland range site.

Tb—Tabler-Drummond complex. This map unit consists of nearly level, moderately well drained and somewhat poorly drained soils on terraces. Areas are mostly irregularly shaped and range from 5 to 200 acres in size. They are 30 to 40 percent Tabler soils, 30 to 40 percent Drummond soils, and 10 to 20 percent Farnum soils. The Tabler soils are typically on small ridges, and the Drummond soils are in small depressions. The Farnum soils are on the same general landscape but occupy narrow, convex ridges in places. The soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

Typically, the Tabler soil has a surface layer of dark gray silty clay loam about 9 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark gray and firm; the next part is dark grayish brown and very firm; the lower part is grayish brown and very firm. The substratum to a depth of 60 inches is grayish brown silty clay. In places the surface layer is silt loam.

Typically, the Drummond soil has a surface layer of dark grayish brown clay loam about 8 inches thick. The subsoil is about 40 inches thick. The upper part is grayish brown, very firm silty clay; the lower part is grayish brown, firm silty clay with many nests and threads of lime. The substratum to a depth of about 60 inches is very pale brown loam. The entire solum is affected by salt, and the estimated exchangeable sodium content ranges from 15 to 25 percent. In places the surface layer is silt loam or loam.

Included with these soils in mapping are small areas of Carwile soils in similar positions on the landscape. These included soils make up 5 to 10 percent of the unit.

Permeability is very slow in the Tabler and Drummond soils. Runoff is slow to very slow. Available water capacity is moderate. Both soils contain a fine, elastic type of clay that holds some of the soil moisture under too much tension to be extracted by plant roots. Both shrink and swell markedly upon drying and wetting. Reaction ranges from medium acid to moderately alkaline in the surface layer of the Tabler soil and from slightly acid to moderately alkaline in the subsoil. It ranges from slightly acid to moderately alkaline in the surface layer of the Drummond soil and from neutral to strongly alkaline in the subsoil. The salts content in the subsoil of the Drummond soil restricts root growth.

About half of the acreage of these soils remains in native grass and is used for grazing. The rest is used for sorghum, wheat, and alfalfa. If cultivated, these soils crust badly after rains. Yields are very unpredictable and uneven. Some areas are irrigated and have been treated with applications of gypsum with some success. The soils have fair potential for range. They have poor potential for farming, for trees and shrubs, and for most engineering uses.

These soils are not well suited to cultivated crops because of the salinity. Alfalfa grows fairly well, but a good stand is difficult to establish. Barley, sorghum, and rye are moderately tolerant of salts and grow fairly well. Wheat is less tolerant of salts, and stands are generally thin and spotty. Working crop residue into the surface layer improves soil structure and helps prevent crusting.

The major problems of range management are related to maintaining a good stand of grass. Overgrazing and overstocking the range reduces the protective plant cover and causes 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 keep the range and soil in good condition.

If buildings are constructed on these soils, foundations and footings should be designed to prevent structure damage caused by shrinking and swelling. If excavation material is used in yard grading, establishing yard grasses is difficult (fig. 10). Artificial drainage should be provided around the buildings to keep the soils from becoming saturated.

Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sanitary facilities should be connected to commercial sewers, or sewage should be piped to adjacent areas that are suitable for lagoons. These soils have moderate to severe limitations if they are used for recreational purposes. Capability unit IVs-1; Tabler soil in Clay Upland range site, Drummond soil in Saline Lowland range site.

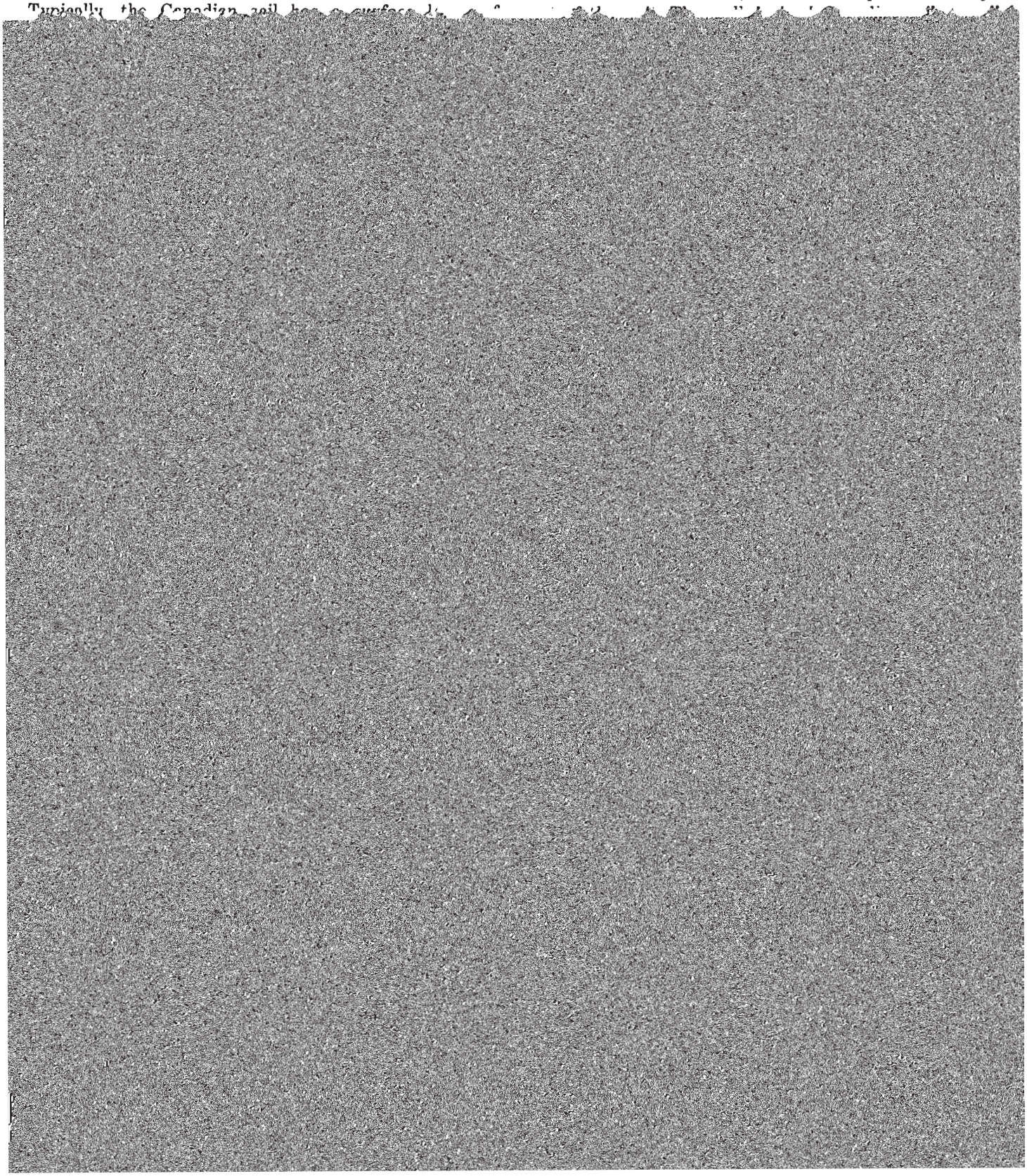
Ua—Urban land-Canadian complex. This map unit consists of Urban land and nearly level and very gently sloping, well drained Canadian soils on smooth terraces that are slightly undulating. Individual areas of this unit range from 80 to several hundred acres in size and are 50 to 70 percent Urban land and 20 to 30 percent Canadian soils. The Urban land and Canadian soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, and buildings and other structures that ob-

scure or alter the soils so that identification is not feasible.

Typically, the Canadian soil has a surface [illegible]

Included with this unit in mapping are small areas of Canadian and Tabler soils, which make up to 10 to 20 per-



part is brown, very firm clay loam; the lower part is brown to dark brown, very firm clay loam with calcium carbonate concretions. The substratum to a depth of 60 inches is brown to dark brown clay loam with a few nests and seams of lime. In places the soil has been radically altered. Some of the low areas have been filled or leveled during construction, and other small areas have been cut, built up, or smoothed.

Included with this unit in mapping are small areas of Irwin and Tabler soils, which make up 5 to 15 percent of the unit. The well drained Irwin soils occupy higher, convex areas on the landscape. The moderately well drained Tabler soils occupy nearly level to slightly depressional areas.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches.

Water and air move through the Farnum soil at a moderately slow rate. Runoff is slow to medium. Available water capacity is high. Reaction ranges from medium acid to neutral in the surface layer and from neutral to moderately alkaline in the subsoil. The shrink-swell potential of the subsoil is moderate.

The Farnum soil, or the open part of the map unit, is used for parks, open space, building sites, lawns, and gardens. It has good potential for lawns, vegetable and flower gardens, and trees and shrubs. It has fair to good

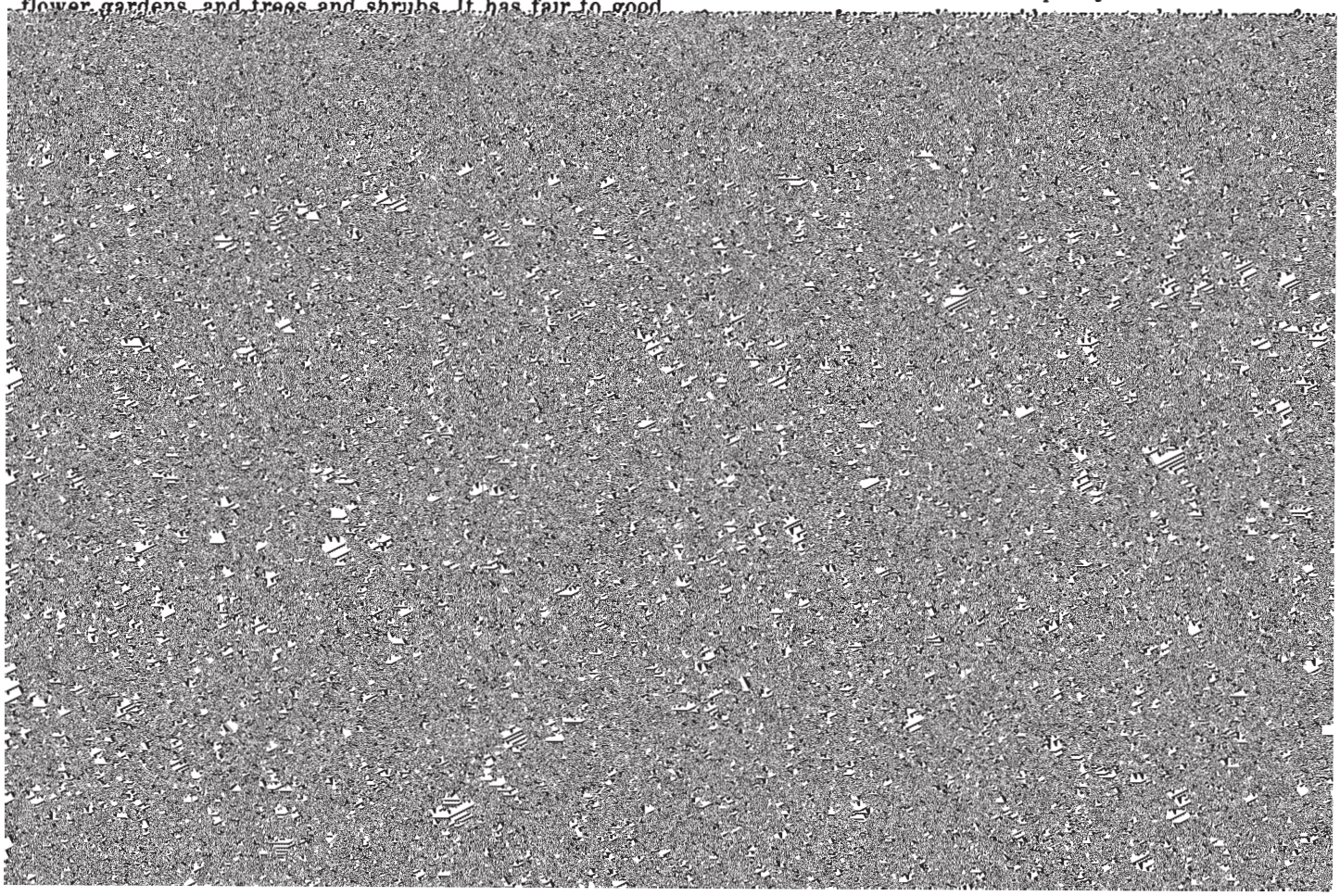
The Urban land part of the unit is covered by streets, parking lots, buildings, and sports complexes and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Irwin soil has a dark grayish brown silty clay loam surface layer about 12 inches thick. The subsoil is very firm silty clay about 40 inches thick. The upper part is dark brown to brown; the lower part is brown. The substratum to a depth of 60 inches is brown silty clay. In places the upper part of the of the subsoil is redder. In some areas the soil has been radically altered. Some of the low areas have been filled or leveled during construction, and other small areas have been cut, built up, or smoothed.

Included with this unit in mapping are small areas of Farnum, Rosehill, and Tabler soils, which make up 10 to 15 percent of the unit. The loamy Farnum soils and the moderately deep Rosehill soils occupy higher, convex areas and lower side slopes. The moderately well drained Tabler soils occupy nearly level to slightly depressional areas.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches.

Permeability is very slow in the Irwin soil, and runoff is medium. Available water capacity is moderate. Reac-



and are 60 to 75 percent Urban land and 15 to 30 percent Tabler soils. The Urban land and Tabler soils are so intricately mixed or are in areas so small in size that it is not practical to separate them in mapping.

The Urban land part of the unit is covered by streets, parking lots, industries, and buildings and other structures that obscure or alter the soils so that identification is not feasible.

Typically, the Tabler soil has a surface layer of dark gray silty clay loam about 9 inches thick. The subsoil is silty clay about 35 inches thick. The upper part is very dark gray and firm; the next part is dark grayish brown and very firm; the lower part is grayish brown and very firm. The substratum to a depth of 60 inches is grayish brown silty clay. In places the soil has been radically altered. Some of the low areas have been filled or leveled during construction, and other areas have been cut, built up, or smoothed. In places the soil is more poorly drained and contains more sand.

Included with this unit in mapping are small areas of Farnum and Naron soils, which make up 10 to 20 percent of the unit. The well drained Naron soils occupy higher, convex areas on the landscape. The well drained Farnum soils are in slightly raised positions.

Most areas of this map unit are artificially drained through sewer systems, gutters, drainage tiles, and, to a lesser extent, surface ditches. In some areas that are not drained, the water table is perched within a foot of the surface during wet periods, and some low-lying areas are ponded by runoff from adjacent areas, streets, and parking lots.

Permeability is very slow through the Tabler soil. Runoff is slow, and available water capacity is moderate. The surface layer of the Tabler soil ranges from medium acid to moderately alkaline, and the subsoil ranges from slightly acid to moderately alkaline. The shrink-swell potential is high.

The Tabler soil, or open part of the map unit, is used for parks, open space, building sites, lawns, and gardens. It has fair potential for lawns, vegetable and flower gardens, and trees and shrubs. It has poor potential for

tural damage caused by shrinking and swelling. All sanitary facilities should be connected to commercial sewers and treatment facilities. If these facilities are not available, it is possible to construct a properly designed sewage lagoon in the areas of Tabler soil. The upper layer of this soil should be replaced or covered with a suitable base material if local roads and streets are to function properly.

If possible, the small included areas of Farnum and Naron soils should be selected for developing new parks and playgrounds. Onsite investigation is essential to properly evaluate and plan the development of specific sites. Not assigned to a capability unit or range site.

Va—Vanoss silt loam, 0 to 1 percent slopes. This nearly level, well drained soil is on narrow upland divides. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 15 to 100 acres in size.

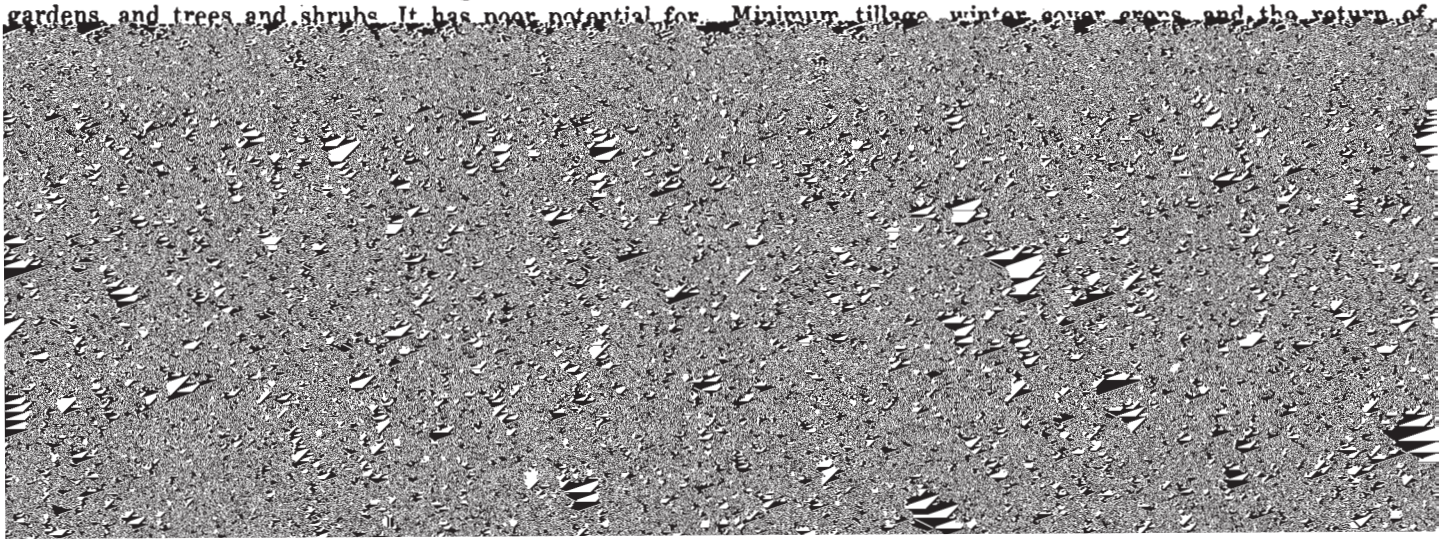
Typically, the surface layer is brown silt loam about 15 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder.

Included with this soil in mapping are small areas of well drained Blanket and Farnum soils in shallow depressions and some of the drainageways. The Blanket soils contain more clay than this Vanoss soil, and the Farnum soils contain more sand. These included areas make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, corn, and soybeans and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and the return of



can be prevented by special treatment to seal the lagoon. This soil has slight limitations if it is used for recreational purposes. Capability unit I-2; Loamy Upland range site.

Vb—Vanoss silt loam, 1 to 3 percent slopes. This gently sloping, well drained soil is on uplands and terraces. Individual areas of this unit are irregular in shape and range from 15 to 160 acres in size.

Typically, the surface layer is brown silt loam about 13 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder.

Included with this soil in mapping are small areas of well drained Farnum and Milan soils in some of the slightly raised, convex positions or on some sloping terrace breaks. These soils contain more sand than this Vanoss soil. They make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

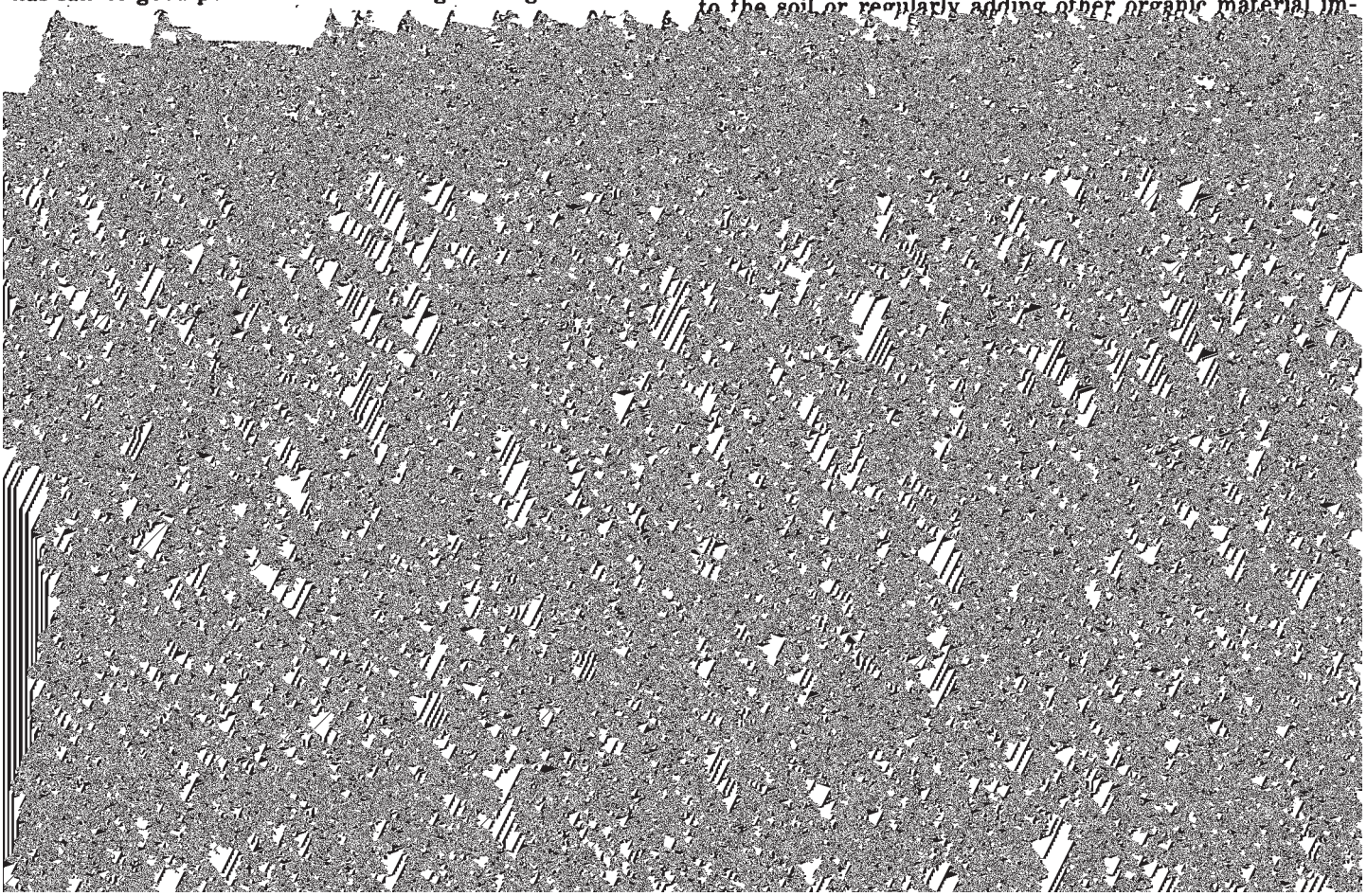
Typically, the surface layer is brown silt loam about 10 inches thick. The subsoil is brown silty clay loam about 47 inches thick. The upper part is friable; the lower part is firm and very firm. In places the subsoil is redder.

Included with this soil in mapping are small areas of well drained Farnum and Milan soils on narrow ridgetops and adjacent to some drainageways. These soils contain more sand than this Vanoss soil. They make up 10 to 20 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff on cultivated fields is medium. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, corn, trees, and soybeans and to grasses and legumes for hay and pasture. If the soil is used for cultivated crops, water erosion is a severe hazard. Minimum tillage and winter cover crops help prevent excessive soil loss. Most areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material im-



been mixed with the surface soil by plowing, the surface layer is silty clay loam.

Included with this soil in mapping are small areas of well drained Milan soils. These soils occupy narrow ridge crests and are adjacent to some drainageways. They make up 5 to 10 percent of the unit.

Water and air move through this soil at a moderate rate, and runoff is medium. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the surface layer and subsoil. Natural fertility is medium, but organic-matter content is moderately low because of the loss of surface soil through erosion. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle, however, after hard rains, especially in areas where the plow layer contains subsoil material.

Most areas of this soil are farmed. The soil has good potential for crops, hay, pasture, and trees. It has fair to good potential for most engineering uses.

This soil is suited to small grain, sorghum, and trees and to grasses and legumes for hay or pasture. To a lesser extent, it is suited to soybeans and corn. If the soil is used for cultivated crops, there is a hazard of further erosion damage. Minimum tillage and winter cover crops help prevent excessive soil loss. Most areas have slopes that are long enough and smooth enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes compaction of the surface, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and soil in good condition.

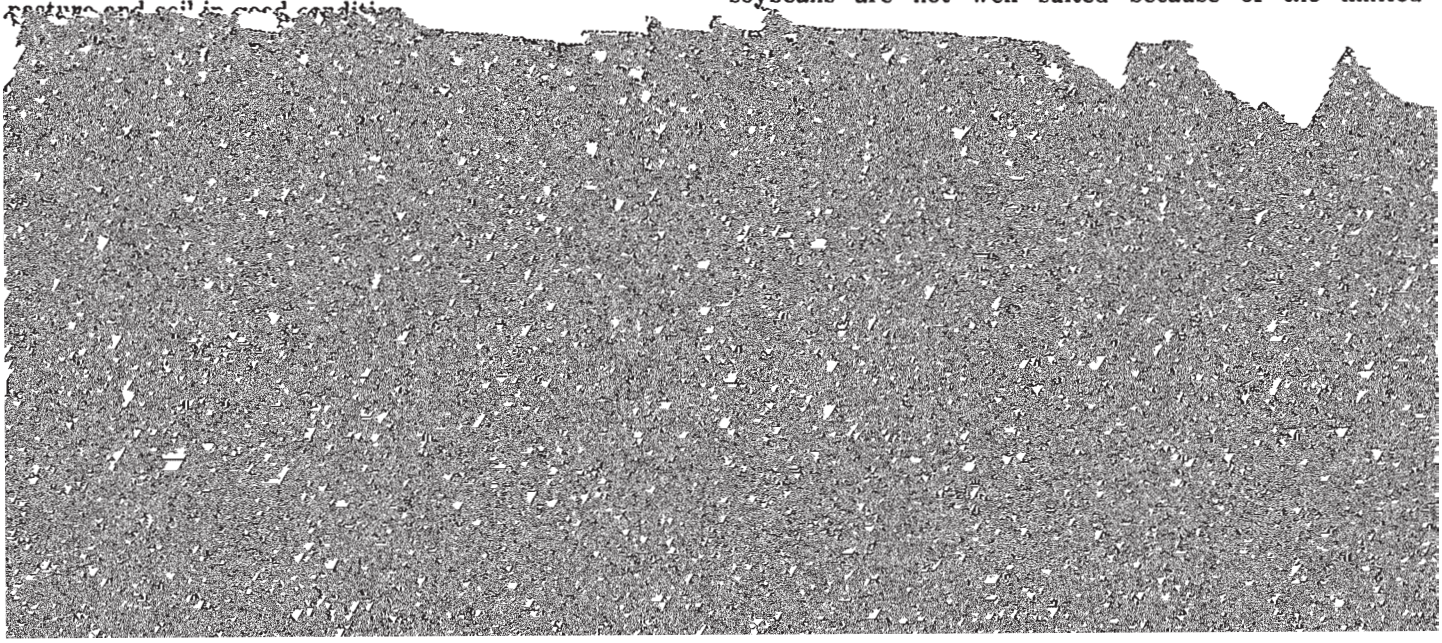
Typically, the surface layer is dark brown sandy loam about 8 inches thick. The subsoil is about 16 inches thick. The upper part is reddish brown, firm sandy clay loam; the lower part is reddish brown, very firm silty clay. The substratum to a depth of 28 inches is reddish brown clay. Below this is red clayey shale. In areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown sandy clay loam.

Included with this soil in mapping are small areas of well drained Milan, Owens, Renfrow, and Shellabarger soils. The Milan and Shellabarger soils contain more sand in the subsoil and substratum and are deeper than this Vernon soil. They occur as small, isolated areas that are remnants of former landscapes. The Owens and Renfrow soils are less sandy than this Vernon soil. They are in areas where the boundary between the shale and the clay substratum varies greatly within a short horizontal distance.

Water and air move through this soil at a very slow rate, and runoff from cultivated fields is rapid. Available water capacity is low to moderate. Reaction ranges from slightly acid to mildly alkaline in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to erode if it lacks some type of protective cover. The root zone extends to the clayey shale.

About half of the acreage of this soil remains in native grass and is used for grazing. The rest is used for small grain and sorghum. The soil has fair to good potential for cultivated crops, range, and trees and shrubs. It has poor potential for most engineering uses.

This soil is suited to small grain and sorghum and to grasses and legumes for hay and pasture. Corn and soybeans are not well suited because of the limited



graded to shed water, and suitable base material should be hauled in from outside the area. Suitable sites for lagoons generally can be located in some of the areas of deeper soil. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IIIe-7; Red Clay Prairie range site.

Vf—Vernon sandy loam, 3 to 6 percent slopes. This sloping, well drained soil is on short, uneven side slopes. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 20 to 40 acres in size.

Typically, the surface layer is dark brown sandy loam about 7 inches thick. The subsoil is about 16 inches thick. The upper part is reddish brown, firm sandy clay loam; the lower part is reddish brown, very firm silty clay. The substratum to a depth of 28 inches is reddish brown clay. Below this is red clayey shale. In some areas where the upper part of the subsoil has been mixed with the surface soil by plowing, the surface layer is reddish brown sandy clay loam.

Included with this soil in mapping are small areas of well drained Milan, Owens, Renfrow, and Shellabarger soils. The Milan and Shellabarger soils contain more sand in the subsoil and substratum than this Vernon soil. They occur as small, isolated areas that are remnants of former landscapes. The Owens and Renfrow soils are less sandy than this Vernon soil. They are in areas where the boundary between the shale and the clay substratum is wavy and depth to the substratum varies greatly within a short horizontal distance.

Water and air move through this soil at a very slow rate, and runoff from cultivated fields is rapid. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline in the surface layer and from neutral to moderately alkaline in the subsoil. Natural fertility is medium, and organic-matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to erode unless some type of mulch is on the surface. The root zone extends to the clayey shale.

About half of the acreage of this soil is in native grass and is used for grazing. The rest is used for small grain and sorghum. This soil has fair potential for cultivated crops and good potential for range and trees and shrubs. It has poor potential for most engineering uses.

This soil is suited to small grain and sorghum and to grasses and legumes for hay and pasture. Corn, soybeans, and alfalfa are not well suited because of the limited amount of available water in this soil. If the soil is used for cultivated crops, minimum tillage, winter cover crops, terraces, and contour farming are needed to help control erosion and increase water infiltration. Returning crop residue to the soil or regularly adding other organic

This soil is suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. If buildings are constructed on this soil, foundations should be designed to reduce structural damage caused by shrinking and swelling. The underlying shale beds are somewhat soft and may be slip prone. Artificial drainage should be provided around the buildings to keep the soils and shales from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Suitable sites for lagoons generally can be located in some of the areas of deeper soil. This soil has slight to moderate limitations if it is used for recreational purposes. Capability unit IVe-4; Red Clay Prairie range site.

Wa—Waldeck sandy loam. This nearly level, somewhat poorly drained soil is on flood plains and low terraces. Flooding is occasional, averaging about once every 2 or 3 years. Individual areas of this unit are generally oblong, but some are irregularly shaped. They range from 5 to 40 acres in size.

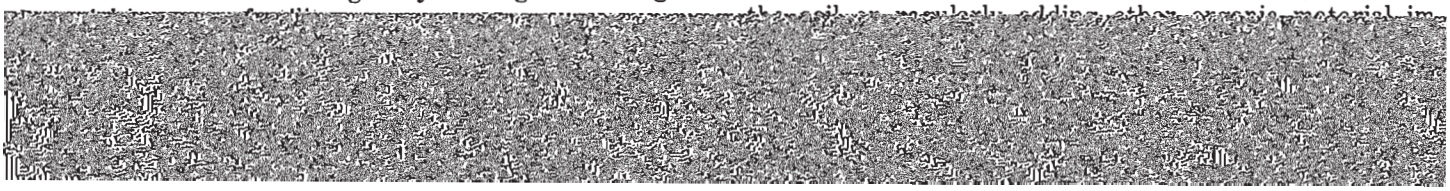
Typically, the surface layer is dark gray sandy loam about 14 inches thick. The next layer is about 13 inches thick. It is light brownish gray, very friable sandy loam that is mottled in the lower part. The substratum to a depth of 60 inches is pale brown coarse sand with common mottles.

Included with this soil in mapping are small areas of somewhat poorly drained Lesho soils and poorly drained Plevna soils. The Lesho soils are typically on the slightly higher parts of the landscape, and the Plevna soils are typically on the slightly lower parts. Included soils make up 5 to 15 percent of the unit.

Water and air move through this soil at a moderately rapid rate, and runoff is slow. Available water capacity is moderate. The soil has a fluctuating water table that in most years seasonally rises to within about 2 feet of the surface. Reaction is mildly alkaline or moderately alkaline throughout the profile. Natural fertility is medium, and organic-matter content is moderate. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. Soil blowing is a hazard where the soil is bare of vegetation. Root growth is restricted below a depth of about 27 inches by the coarse sand substratum.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor to fair potential for most engineering uses.

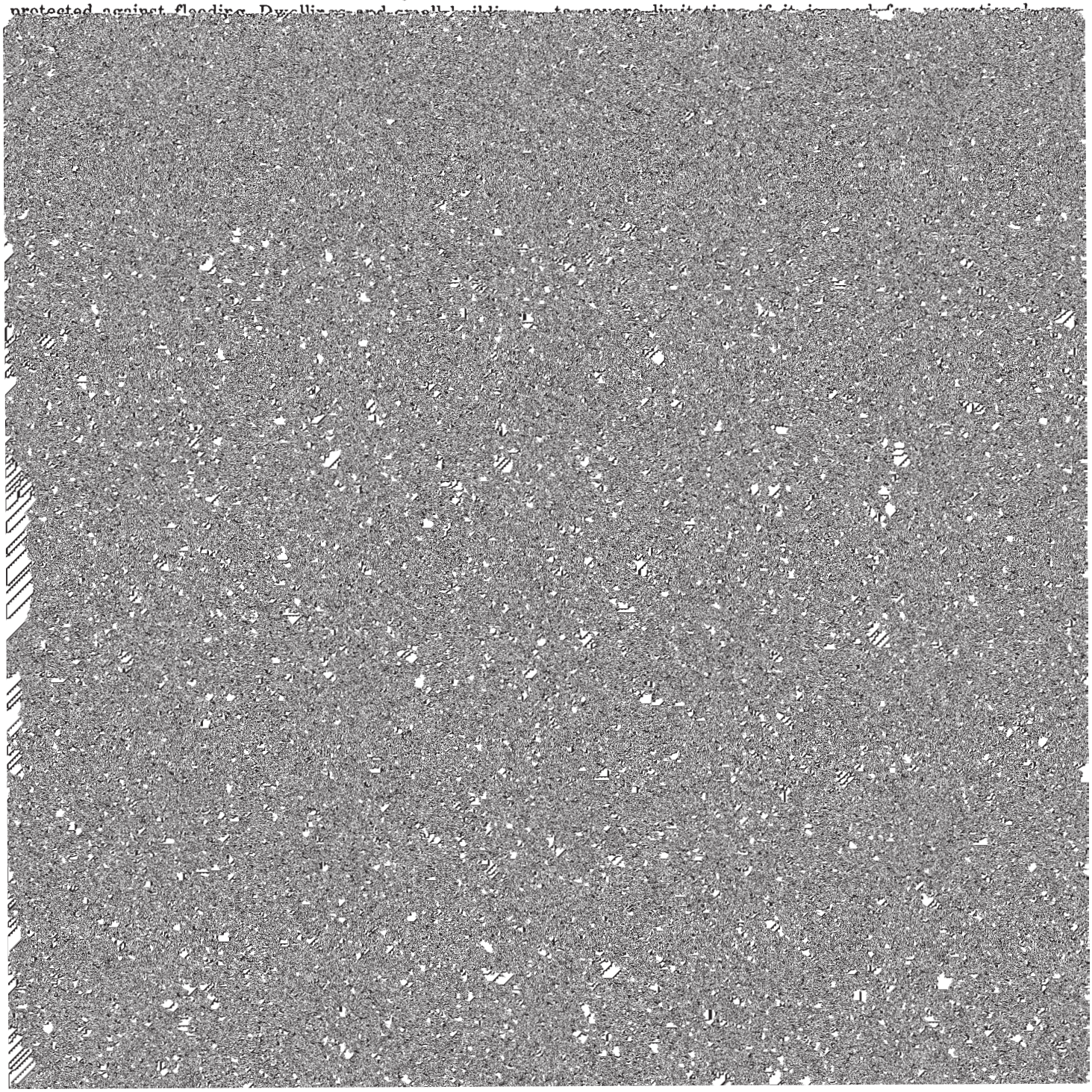
This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Minimum tillage, winter cover crops, and stubble mulch help prevent excessive soil loss. Returning crop residue to



This soil is well suited to trees grown as windbreaks and environmental plantings. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled or removed. The main problems to be concerned about when planting or harvesting trees are flooding and wetness.

This soil has severe to moderate limitations for building site development and recreational development. Areas used for these purposes must be artificially drained and protected against flooding. Dwellings and small buildi

If buildings are constructed on this soil, foundations and footings should be designed to reduce the risk of structure damage caused by shrinking and swelling. Artificial drainage should be provided around the buildings to keep the soil from becoming saturated. Local roads should be graded to shed water, and suitable base material should be hauled in from outside the area. Sewage lagoons should be used for onsite disposal unless a commercial sewer system is available. This soil has moderate



closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

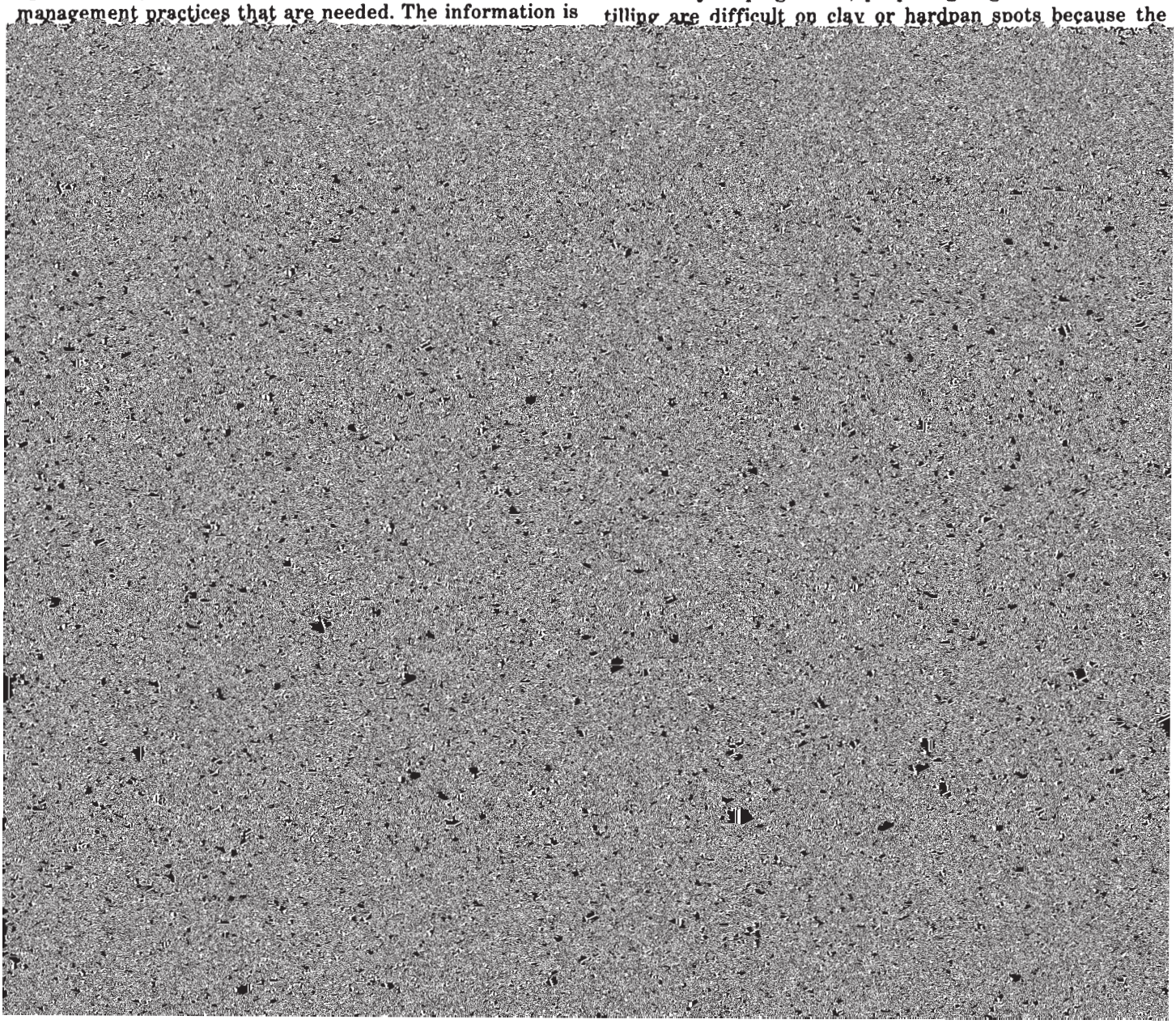
Crops and pasture

The major management concerns in the use of the soils for crops and pasture are described in this section. In addition, the crops or pasture plants best suited to the soil, including some not commonly grown in the survey area, are discussed; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are presented for each soil.

This section provides information about the overall agricultural potential of the survey area and about the management practices that are needed. The information is

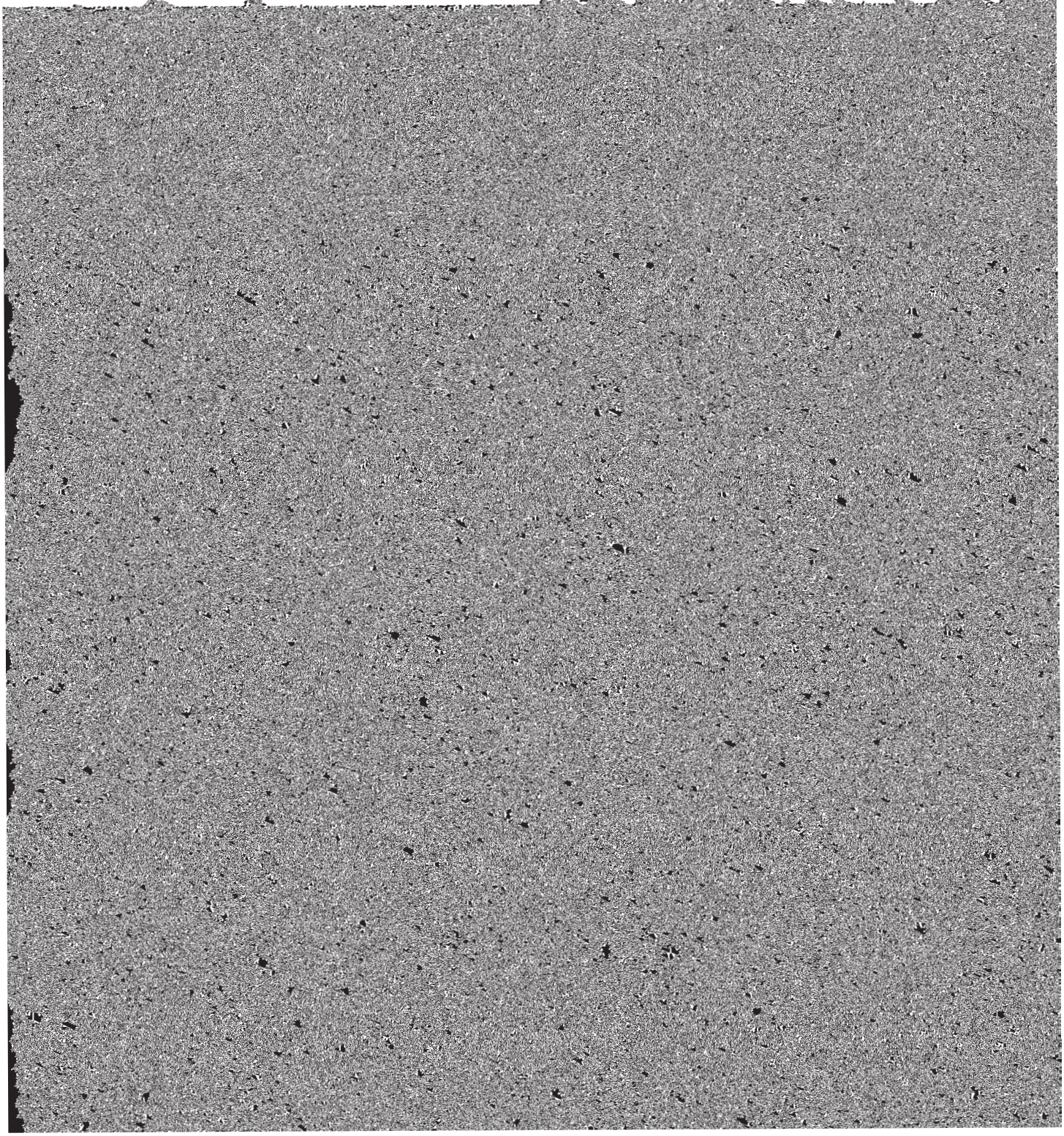
Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as Blanket, Clark, Irwin, Renfrow, and Vernon soils, and on soils with a layer in or below the subsoil that limits the depth of the root zone. Such layers include the shaly clay in Clime, Owens, Renfrow, Rosehill, and Vernon soils. Erosion also reduces productivity on soils that tend to be droughty, such as Albion, Pratt, and Shellabarger soils. Second, soil erosion on farmland results in sediment entering streams. Control of erosion minimizes the pollution of streams by sediment and improves the 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 clay or hardpan spots because the



Soil blowing is a hazard on the sandy Albion, Pratt, and Shellabarger soils. It can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. A protective plant cover, surface mulch, wind stripcropping, and rough surfaces resulting from proper tillage minimize the hazard of soil

Most of the soils used for crops in the survey area have a silt loam, loam, or silty clay loam surface layer that has a depleted organic-matter content because of years of cultivation. Generally, the surface layer of such soils is weak, and intense rainfall causes the formation of a crust on the surface. The crust is hard when dry, and it is nearly im-



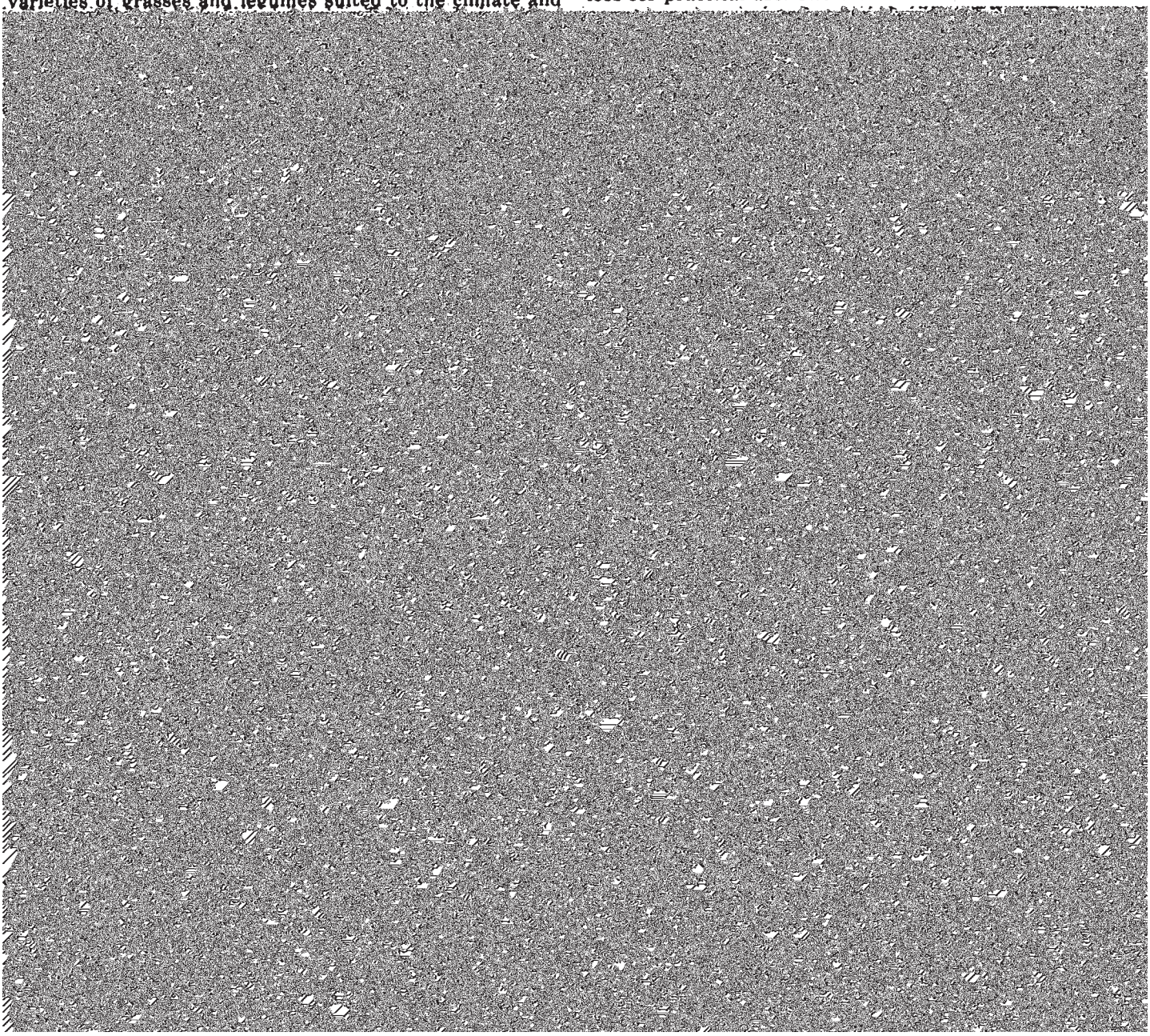
shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors. Absence of an estimated yield indicates that the crop is not suited to or not commonly grown on the soil or that a given crop is not commonly irrigated.

The estimated yields were based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The yields were estimated assuming that the latest soil and crop management practices were used. Hay and pasture yields were estimated for the most productive varieties of grasses and legumes suited to the climate and into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops that require special management. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for forest trees, or for engineering purposes.

In the capability system, all kinds of soil are grouped at three levels: capability class, subclass, and unit (*5*). These levels are defined in the following paragraphs. A survey area may not have soils of all classes.

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



for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-5.

Rangeland

About 11 percent of Sedgwick County is rangeland. Production of livestock is the second largest farm enterprise in the county. The number of cattle, including calves, is about 64,000. The number of sheep and lambs is about 18,000.

Native grasslands total about 72,000 acres. Much of the range is adjacent to the Arkansas and Ninnescah Rivers and in the Cheney area, but smaller areas are throughout the county. The soils are sandy. Some areas are hummocky and are subject to severe soil blowing if overgrazed. Many of the soils are subject to flooding and have a high water table. Under poor rangeland management, a heavy growth of brush, weeds, and trees invades in a short period.

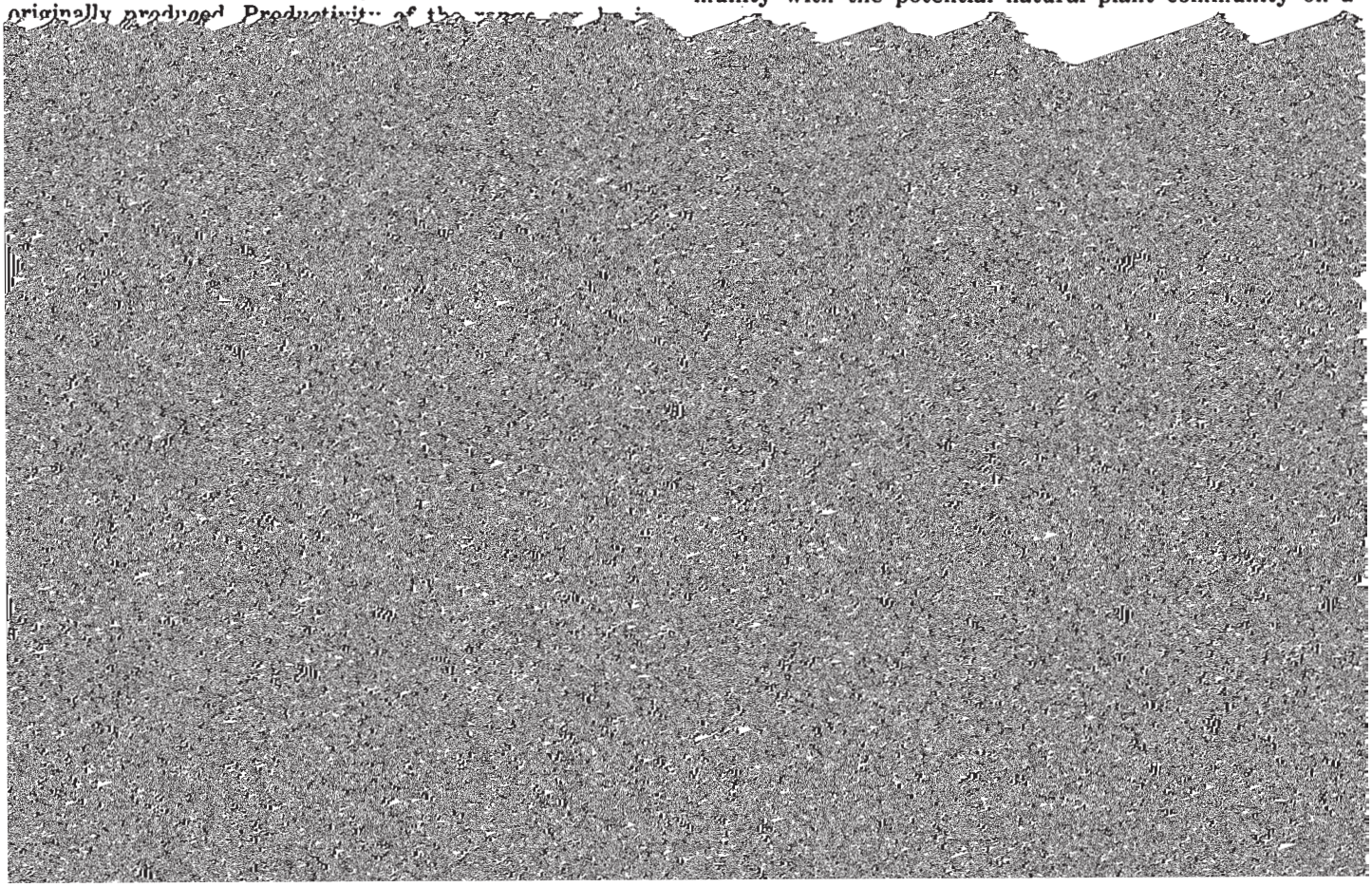
The native vegetation in many parts of the survey area has been greatly depleted by continued excessive use. Much of the acreage that was once open grassland is now covered with brush, weeds, and trees, especially in the valleys of the Arkansas and Ninnescah Rivers. The amount of forage produced may be less than half of that originally produced. Productivity of the range can be increased

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.

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. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season. Generally all of the vegetation produced is not used.

Range management requires, in addition to knowledge of the kinds of soil and the potential natural plant community, an evaluation of the present condition of the range vegetation in relation to its potential. Range condition is determined by comparing the present plant community with the potential natural plant community on a



mostly evergreen shrubs and trees, are closely spaced. A healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 7 shows the height that locally grown trees and shrubs are expected to reach on various kinds of soil in 20 years. The estimates in table 7, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from nurserymen.

Engineering

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

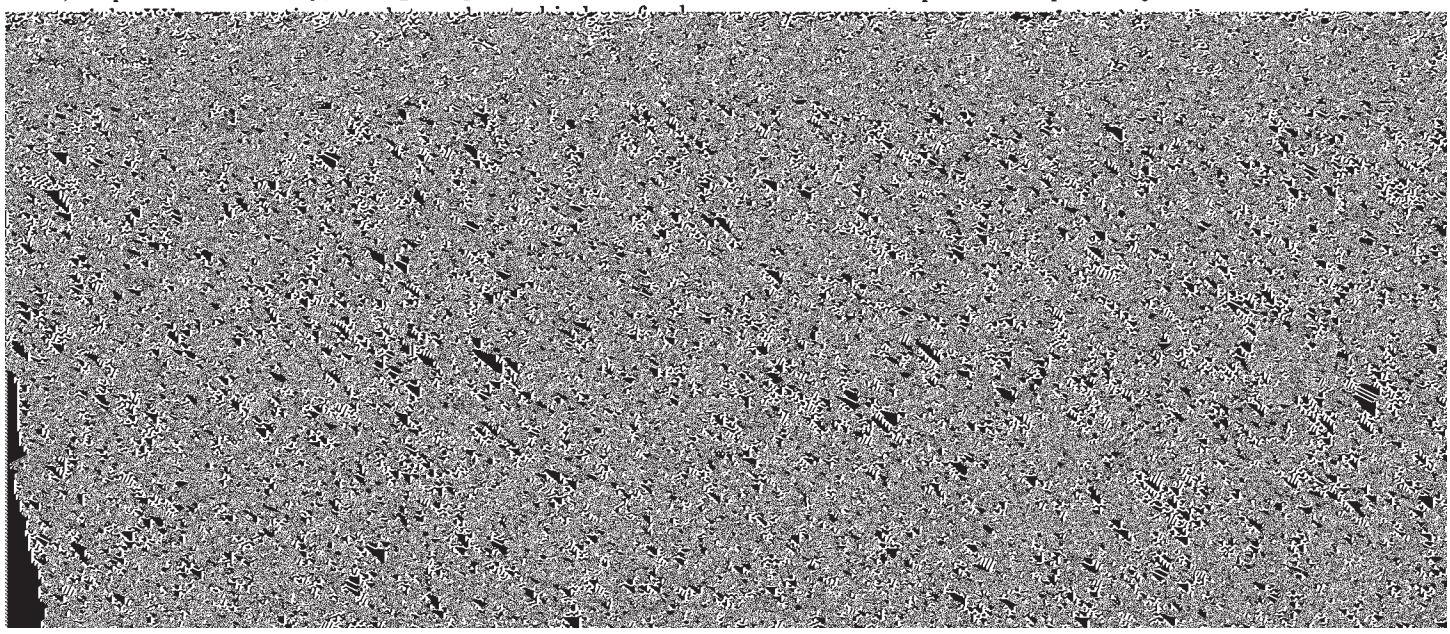
The ratings in the engineering tables are based on test data and estimated data in the "Soil properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various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

Among the soil properties and site conditions identified by a soil survey and used in determining the ratings in this section were grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock that is within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil evaluate alternative sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section 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.



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

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

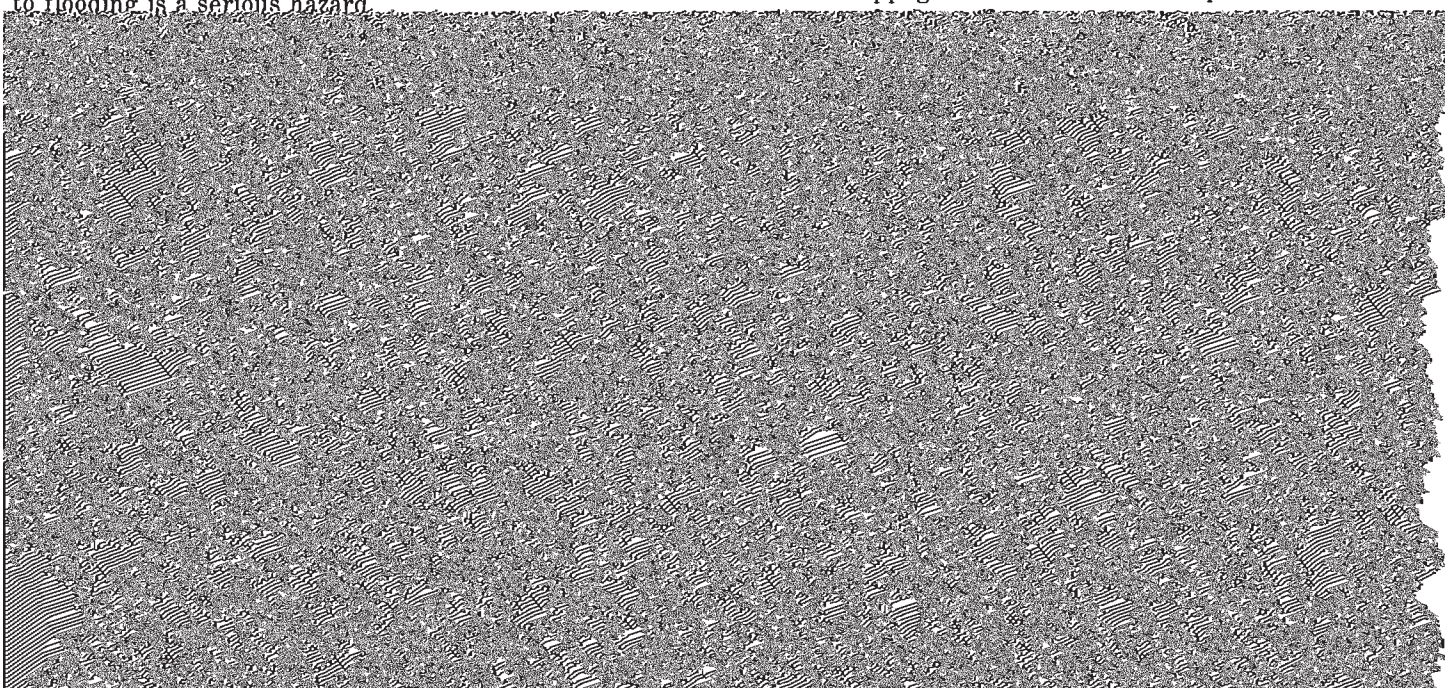
Dwellings and *small commercial buildings* referred to in table 8 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, 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 hazard.

sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 9 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

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

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

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



and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the suitability of sites for sewage lagoons or the cost of construction (fig. 11). Shear strength and permeability of compacted soil material affect the performance of embankments.

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

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

Unless otherwise stated, the limitations in table 9 apply only to the soil material within a depth of about 6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

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

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

Construction materials

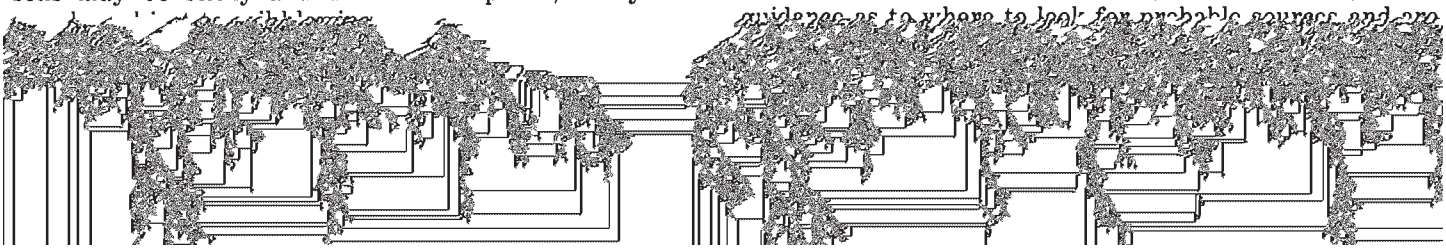
The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated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

Roadfill is soil material used in embankments for roads. Because soil survey interpretations are oriented to local roads and streets rather than highways, the 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 upper part of the roadfill is considered the subgrade, or foundation, for the road. 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 thickness of suitable material is less than 3 feet, the entire soil is rated *poor*.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide



The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

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

The ease of excavation is influenced by the thickness of suitable material, wetness, slope, and amount of stones. The ability of the soil to support plantlife is determined by texture, structure, and the amount of soluble salts or toxic substances. Organic matter in the A1 or Ap horizon greatly increases the absorption and retention of moisture and nutrients. Therefore, the soil material from these horizons should be carefully preserved for later use.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones and cobbles, are low in content of gravel, and have gentle slopes. They are low in soluble salts that can 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 salts; etc. [illegible]

and compaction characteristics. Large stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

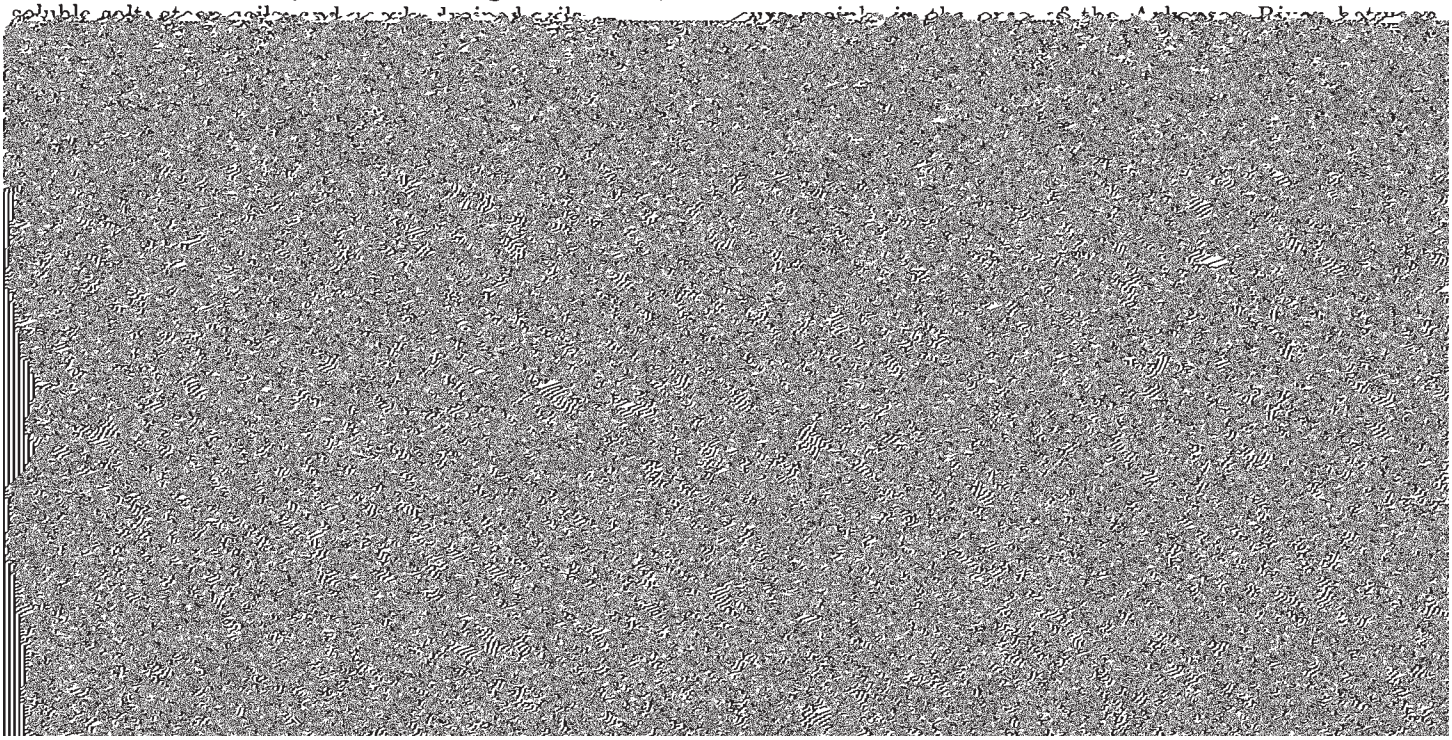
Drainage of soil is affected by such soil properties as permeability; texture; depth to bedrock, hardpan, or other layers that affect the rate of water movement; depth to the water table; slope; stability of ditchbanks; susceptibility to flooding; salinity and alkalinity; and availability of outlets for drainage.

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

Irrigation with water from drilled wells did not become widespread in Sedgwick County until the 1950's. Nearly all the irrigation wells are drilled into Pleistocene alluvium in the valley of the Arkansas River between Mount Hope and Mulvane. Water is pumped from wells that range from 60 to 200 feet in depth. The pumps are powered by natural gas, electricity, liquid gas, or diesel fuels.

Both sprinkler and surface systems are used. Water is transported to the fields by pipes or ditches. Underground pipes or grated surface pipes eliminate the need for maintenance of ditches and control of weeds and do not take up space that could be used for crops.

Irrigation of large fields is limited to the areas where enormous supplies of ground water are available. Sufficient ground water for irrigation in Sedgwick County oc- [illegible]



Recreation

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation uses. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreation use by the duration and intensity of flooding and the season when flooding occurs. Onsite assessment of height, duration, intensity, and frequency of flooding is essential in planning recreation facilities.

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

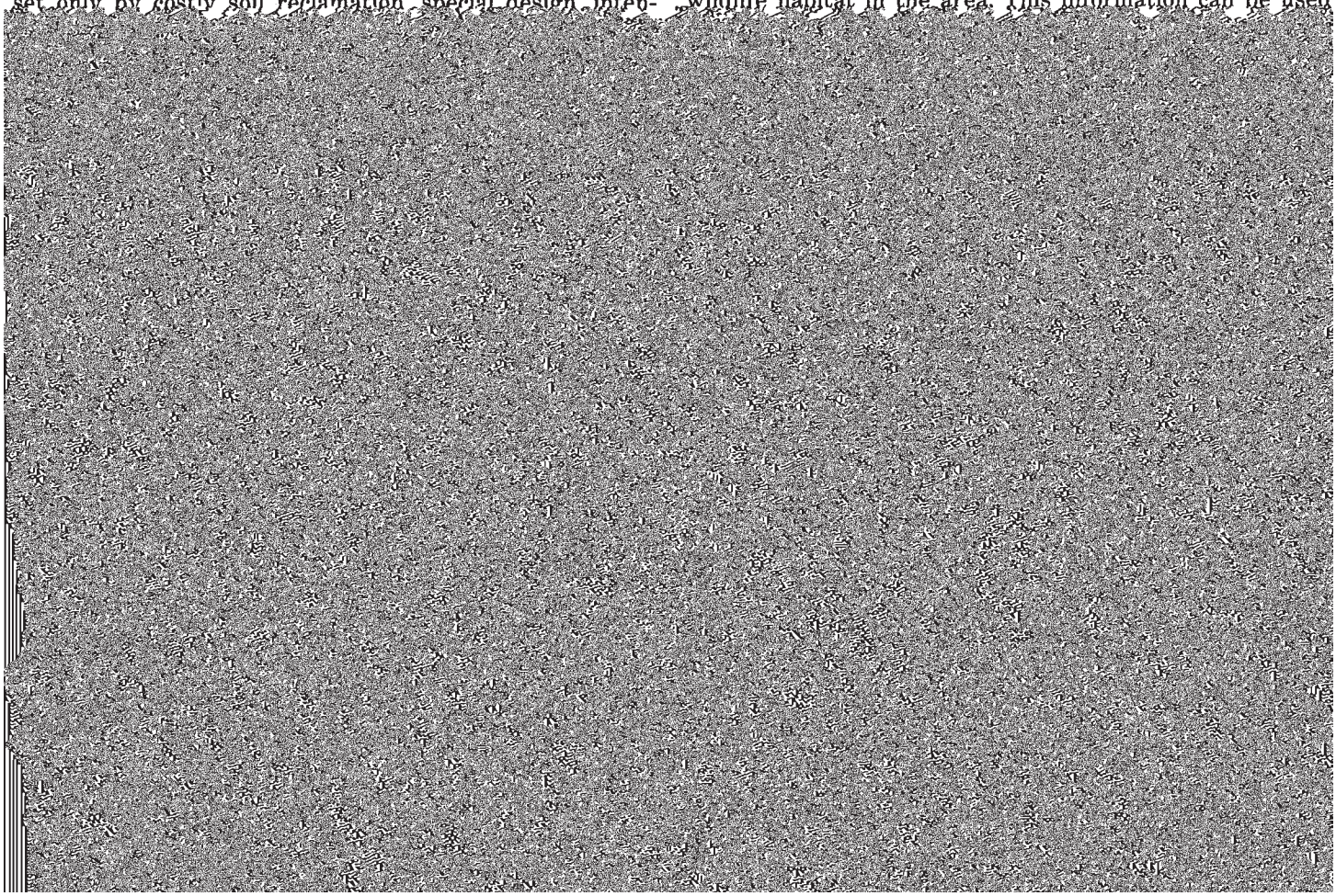
Paths and trails for walking, horseback riding, bicycling, and other uses should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the annual period of use.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

Wildlife habitat

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

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

In table 13, the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used

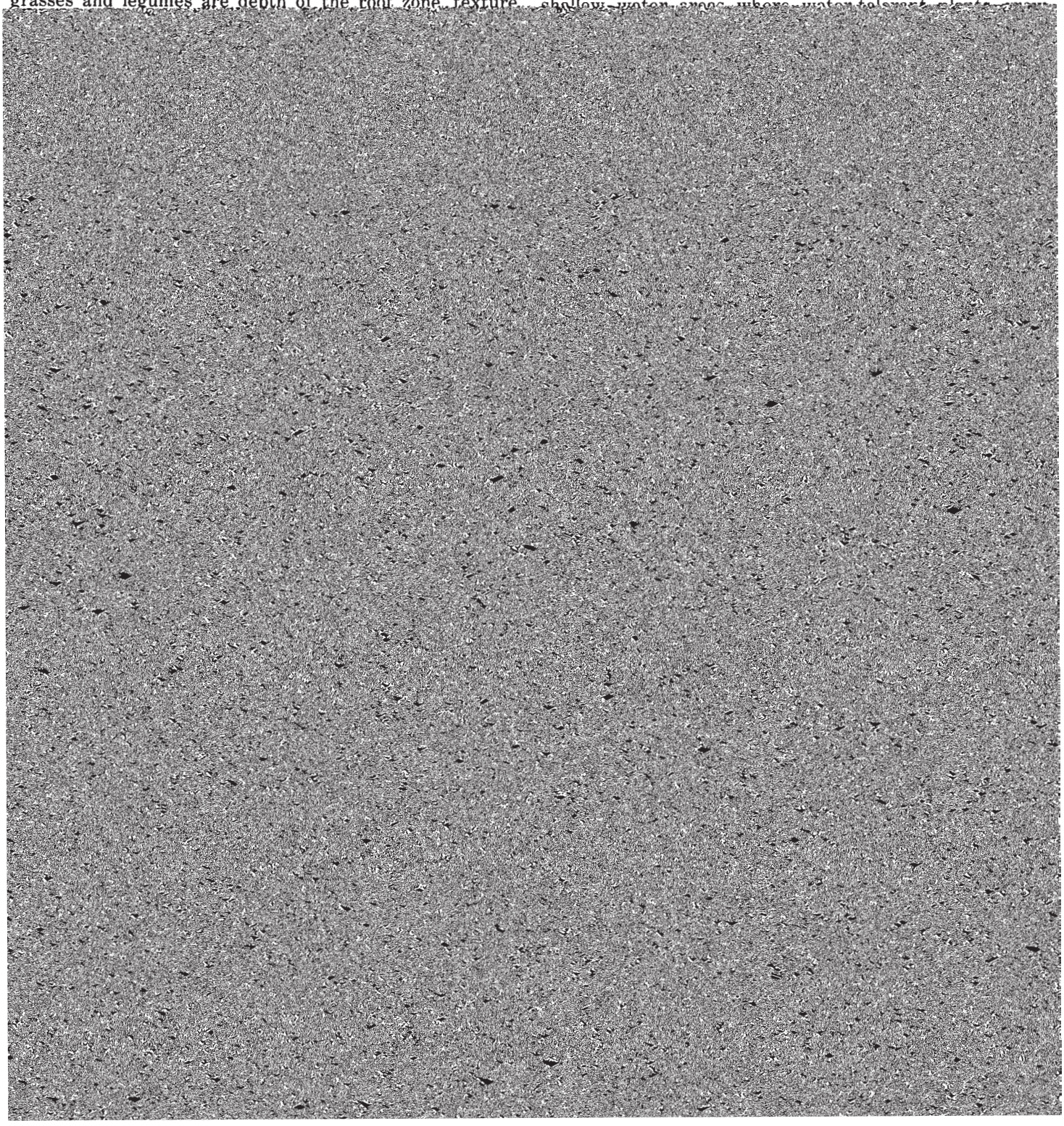


Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture,

herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, striped skunk, and red fox.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow



each of these contrasting horizons in a typical profile. *Depth* to the upper and lower boundaries of each horizon is indicated. More information about the range in depth and about other properties in each horizon is given for each soil series in the section "Soil series and morphology."

Texture is described in table 14 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

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

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

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

When laboratory data are available, the A-1, A-2, and A-7 groups are further classified as follows: A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, and A-7-6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested in the survey area, with group index numbers in parentheses, is given in table 17. The estimated classification, without group index numbers, is given in table 14. Also in table 14 the percentage, by weight, of rock fragments more than 3 inches in diameter is estimated for each major horizon. These estimates are determined mainly by observing volume percentage in the field and then converting that, by formula, to weight percentage.

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

Liquid limit and *plasticity index* indicate the effect of water on the strength and consistence of soil. These indexes are used in both the Unified and AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Range in liquid limit and 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.

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.

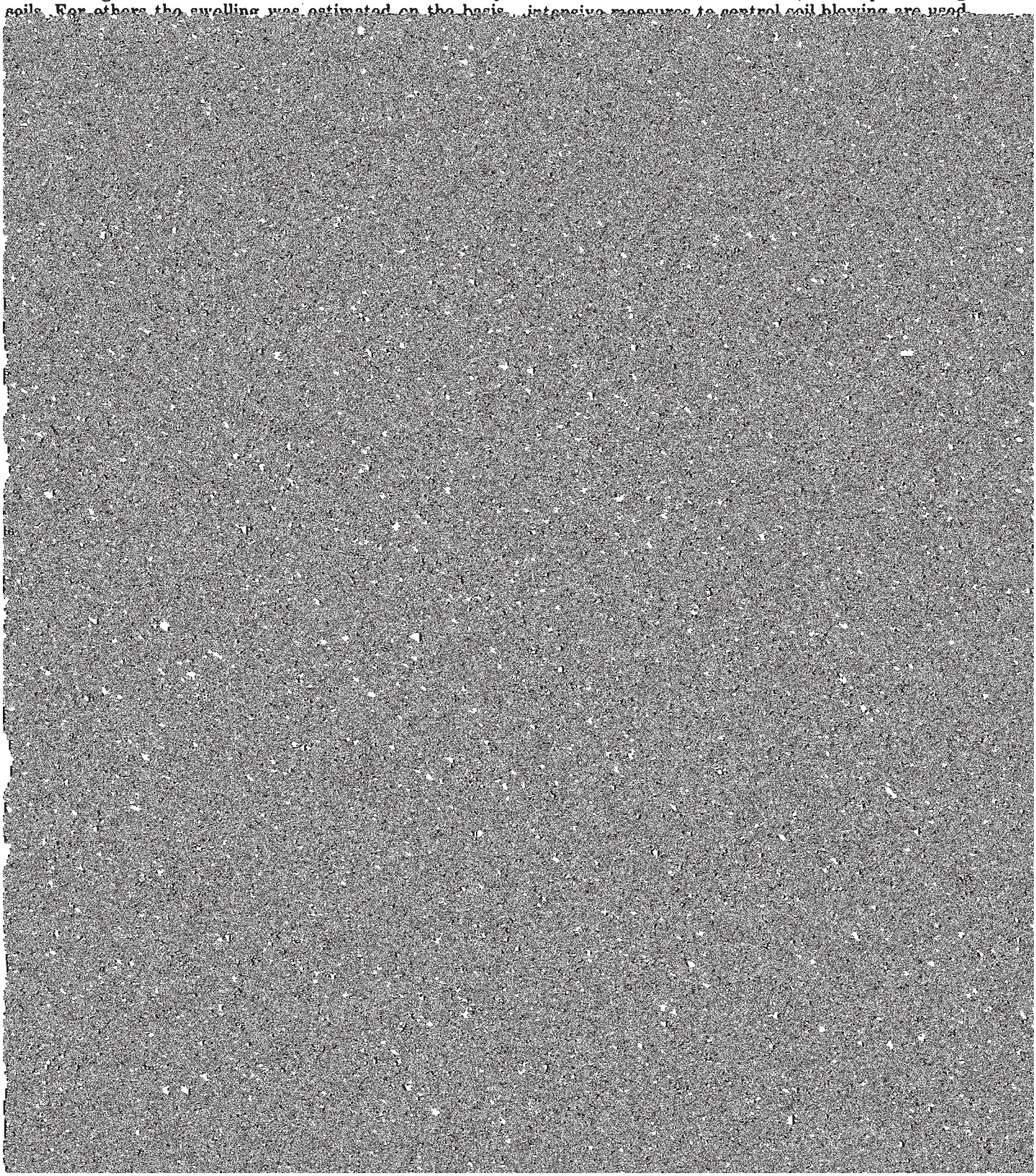
Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for vertical water movement when the soil is 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 potential of soils for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

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

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

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

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



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

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; and absence of distinctive soil horizons that form in soils of the area that are not subject to flooding. The ratings are also based on local information about floodwater levels in the area and the extent of flooding and on information that relates the position of each soil on the landscape to historic floods.

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

High water table is the highest level of a saturated zone more than 6 inches thick for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between gray-

Engineering test data

The results of analyses of engineering properties of several typical soils of the survey area are given in table 17.

The data presented are for soil samples that were collected from carefully selected sites. The soil profiles sampled are typical of the series discussed in the section "Soil series and morphology." The soil samples were analyzed by the Kansas Department of Transportation.

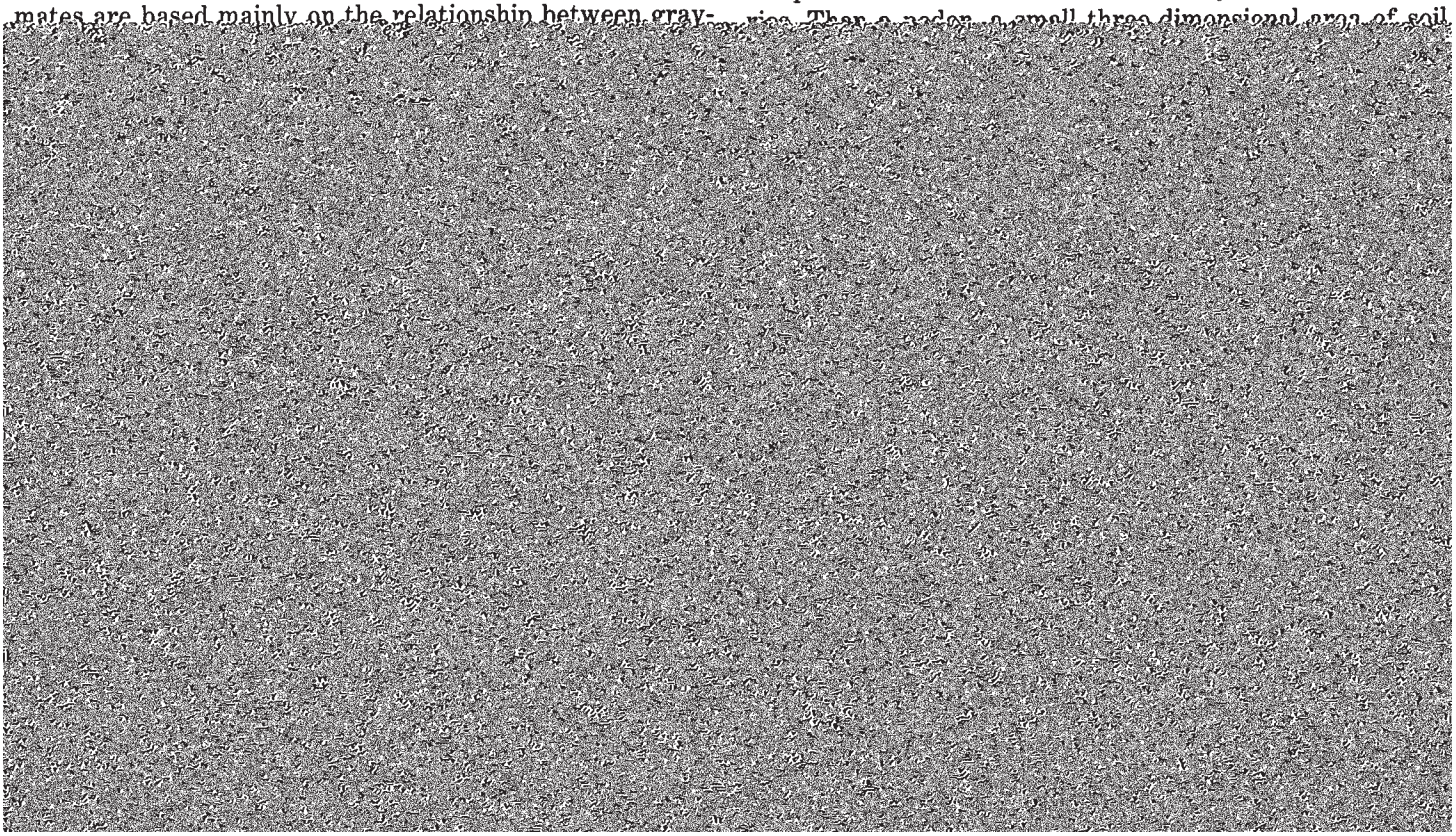
The methods used in obtaining the data are listed by code in the next paragraph. Most of the codes, in parentheses, refer to the methods assigned by the American Association of State Highway and Transportation Officials. The code for Unified classification is that assigned by the American Society for Testing and Materials.

The methods and codes are AASHTO classification (M-145-66); Unified classification (D-2487-69); mechanical analysis (T88-72); liquid limit (T89-68); plasticity index (T90-70); and moisture-density, method A (T99-74).

Soil series and morphology

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

Characteristics of the soil and the material in which it formed are discussed for each series. The soil is then compared to similar soils and to nearby soils of other se-



A1—0 to 9 inches; brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable; few coarse sand grains and fine pebbles throughout horizon; many roots; medium acid; gradual smooth boundary.

B2t—9 to 19 inches; reddish brown (5YR 4/3) heavy sandy loam, dark reddish brown (5YR 3/3) moist; moderate medium granular structure; slightly hard, friable; several coarse sand grains and fine pebbles throughout horizon; many roots; slightly acid; clear smooth boundary.

B3—19 to 26 inches; reddish brown (5YR 4/4) coarse sandy loam, dark reddish brown (5YR 3/4) moist; weak medium granular structure; slightly hard, friable; common roots; slightly acid; diffuse boundary.

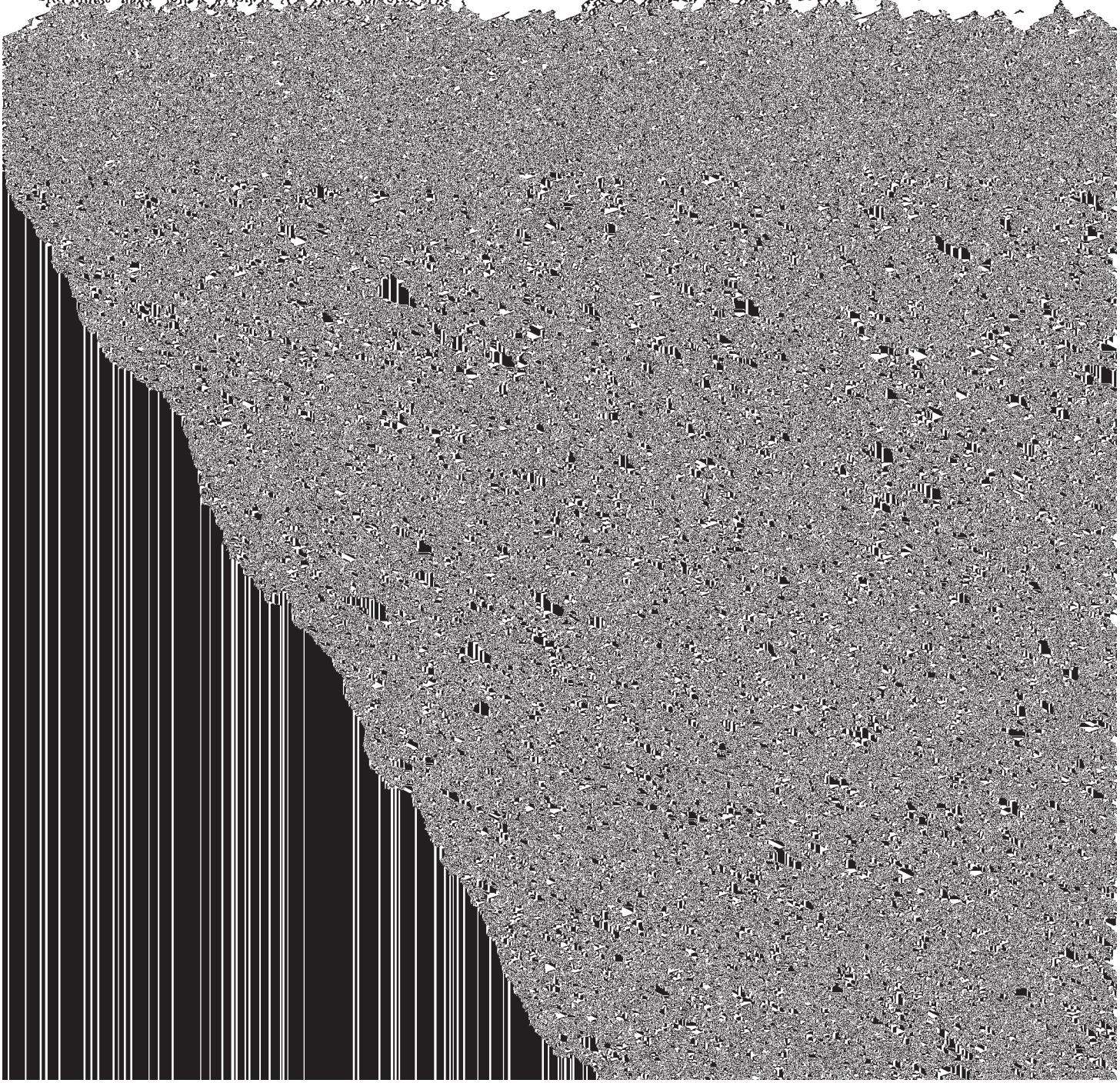
IIC—26 to 60 inches; yellowish red (5YR 5/6) sand, yellowish red (5YR 4/6) moist; loose; single grained; few roots; slightly acid.

B3ca—34 to 46 inches; brown (10YR 5/3) light silty clay, dark brown (10YR 4/3) moist; weak medium and fine blocky structure; very hard, very firm; few hard carbonate concretions; moderately alkaline; gradual smooth boundary.

C—46 to 60 inches; light brown (7.5YR 6/4) heavy silty clay loam, dark brown (7.5YR 4/3) moist; common fine faint yellowish brown (10YR 5/4) mottles; weak medium blocky structure; hard, firm; few calcium carbonate threads and soft masses; mildly calcareous; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches or more. Secondary carbonates in the form of films, threads, or soft masses are at a depth of 28 inches or more.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3



Carwile series

The Carwile series consists of deep, somewhat poorly drained, slowly permeable soils on uplands and terraces. Slopes are 0 to 1 percent.

Carwile soils are similar to Drummond and Tabler soils and are commonly adjacent to Drummond, Tabler, and Farnum soils. Drummond soils have natric horizons. Tabler soils lack the mottling in the upper part of the argillic horizon that is characteristic of Carwile soils. Tabler, Drummond, and Carwile soils occupy similar positions on the landscape. Farnum soils are typically slightly elevated, are better drained than Carwile soils, and have a fine-loamy control section.

Typical pedon of Carwile fine sandy loam 2,400 feet south and 175 feet east of the northwest corner of section 6, T. 25 S., R. 1 W.

A1—0 to 18 inches; dark brown (7.5YR 3/2) fine sandy loam, brown (7.5YR 5/2) dry; few fine distinct dark reddish brown (5YR 3/4) mottles; weak medium granular structure; hard, friable; few open pores; slightly acid; gradual smooth boundary.

B1—18 to 24 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; many medium distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, firm; distinct and patchy clay films; neutral; smooth gradual boundary.

B2t—24 to 47 inches; dark grayish brown (2.5Y 4/2) heavy clay loam, grayish brown (2.5Y 5/2) dry; common medium distinct strong brown (7.5YR 5/6) mottles; weak medium blocky structure; very hard, very firm; distinct and continuous clay films; few iron and

lack the concentrated accumulation of lime in the argillic horizons. Ost soils lack free carbonates at the surface. Blanket, Clark, and Farnum soils are in similar positions on the landscape, whereas Tabler soils are in nearly level areas.

Typical pedon of Clark clay loam, in an area of Clark-Ost clay loams, 1 to 4 percent slopes, 300 feet west and 75 feet south of the northeast corner of section 16, T. 27 S., R. 3 W.

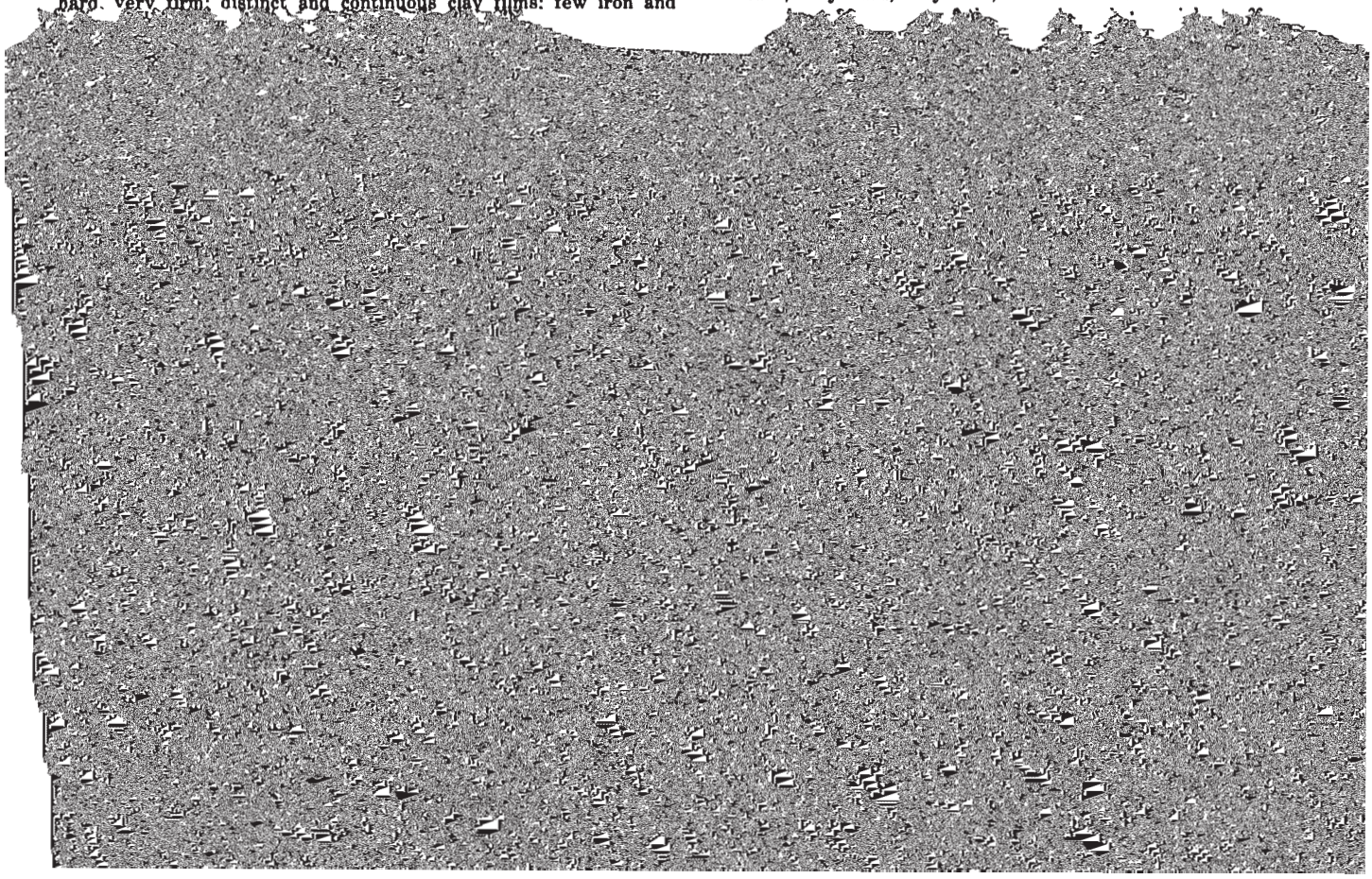
Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; weak fine granular structure; hard, firm; few very fine and fine soft masses of calcium carbonate; slight effervescence; mildly alkaline; clear wavy boundary.

A12—7 to 11 inches; very dark gray (10YR 3/1) clay loam, black (10YR 2/1) moist; moderate fine and medium granular structure; hard, firm; many roots; few fine and medium soft masses of calcium carbonate; strong effervescence; moderately alkaline; gradual wavy boundary.

AC1—11 to 17 inches; brown (10YR 5/3) clay loam, very dark grayish brown (10YR 3/2) moist; strong medium and fine subangular blocky structure; very hard, very firm; many roots; common fine and medium soft masses of calcium carbonate; violent effervescence; moderately alkaline; gradual smooth boundary.

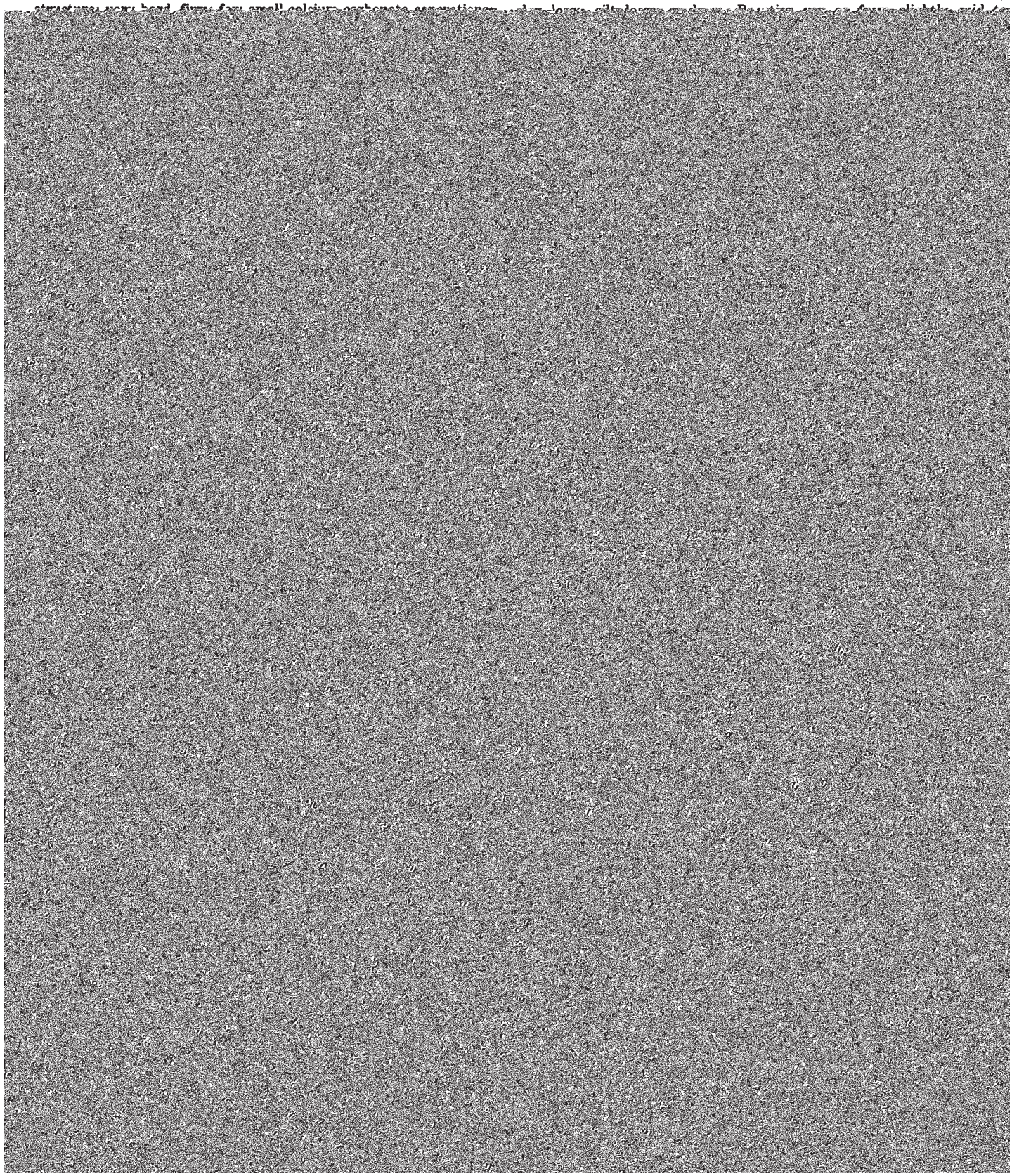
AC2—17 to 24 inches; grayish brown (10YR 5/2) clay loam, dark grayish brown (10YR 4/2) moist; moderate medium blocky structure; very hard, very firm; few roots; soft masses and concretions of calcium carbonate make up about 20 percent of mass by volume; violent effervescence; moderately alkaline; gradual smooth boundary.

C—24 to 60 inches; light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate medium and fine blocky structure; very hard, very firm; soft masses and lime concretions make



Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate fine and medium granular structure; very hard, firm; few small calcium carbonate concretions; slightly

The thickness of the solum ranges from 20 to 60 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 to 6, and chroma of 2 or 3. It is



Farnum series

The Farnum series consists of deep, well drained, moderately slowly permeable soils on terraces and uplands. These soils formed in somewhat stratified, old loamy alluvium that may have been modified by winnowing in the upper part of the solum. Slopes range from 0 to 3 percent.

Farnum soils are similar to Clark, Drummond, Milan, and Naron soils and are commonly adjacent to Blanket, Carwile, Clark, Drummond, Milan, Naron, Ost, Shellabarger, and Vanoss soils on the landscape. Clark, Drummond, Milan, and Naron soils lack mollic epipedons more than 20 inches thick. If Farnum soils are in association with Blanket, Carwile, Clark, Drummond, Ost, and Naron soils, they are on convex ridges. Milan and Shellabarger soils are typically more sloping than Farnum soils, Vanoss soils are in similar positions on the landscape.

Typical pedon of Farnum loam, 1 to 3 percent slopes, 2,000 feet west and 75 feet south of the northeast corner of section 17, T. 28 S., R. 2 W.

Ap—0 to 8 inches; brown (7.5YR 4/2) heavy loam, dark brown (7.5YR 3/2) moist; weak medium granular structure; slightly hard, friable; medium acid; clear smooth boundary.

A12—8 to 14 inches; brown (7.5YR 4/2) heavy loam, dark brown (7.5YR 3/2) moist; moderate fine granular structure; slightly hard, friable; medium acid; gradual smooth boundary.

B1—14 to 18 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; moderate fine and very fine subangular blocky structure; hard, firm; slightly acid; clear smooth boundary.

B21t—18 to 30 inches; brown (7.5YR 5/3) clay loam, dark brown (7.5YR 3/3) moist; moderate medium blocky structure; very hard, very firm; distinct and continuous clay films; few organic stains on ped faces; few coarse sand grains; mildly alkaline; gradual smooth boundary.

B22t—30 to 40 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; moderate medium blocky structure; very hard, very firm; distinct and continuous clay films; few small lime concretions; moderately alkaline; clear smooth boundary.

B3—40 to 46 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; weak medium blocky structure; very hard, very firm; thin and patchy clay films; few hard calcium carbonate concretions about 5 millimeters in diameter; few threads and nests of lime; moderately alkaline; gradual smooth boundary.

C—46 to 60 inches; brown (7.5YR 4/4) clay loam, dark brown (7.5YR 3/4) moist; very weak medium blocky structure; very hard, very firm; few nests and threads of lime; moderately alkaline.

The mollic epipedon is more than 20 inches thick. The thickness of the solum and the depth to free carbonates range from 30 to more than 60 inches.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3. It is dominantly loam, but it can also be fine sandy loam and sandy loam. Reaction is medium acid to neutral.

The B2t horizon has hue of 7.5YR, 10YR, or 2.5Y; value of 4 to 6 (3 to 5 moist); and chroma of 2 to 4. It is loam, sandy clay loam, or clay loam. Reaction ranges from neutral to moderately alkaline.

The C horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 to 6 (3 to 5 moist); and chroma of 3 or 4. It is loam, clay loam, sandy clay loam, fine sandy loam, loamy sand, or sand. Reaction ranges from neutral to moderately alkaline. In some pedons the B and C horizons have fine and medium mottles with chroma of more than 2.

Goessel series

The Goessel series consists of deep, moderately well drained, very slowly permeable soils on terraces and uplands. These soils formed in old clayey alluvial sediments. Slopes range from 0 to 2 percent.

Goessel soils are similar to Rosehill and Tabler soils and are commonly adjacent to those soils and to Clime and Irwin soils on the landscape. Clime and Rosehill soils are underlain by shale at a depth of 20 to 40 inches. Irwin and Tabler soils have a silty clay loam A horizon. Clime, Irwin, and Rosehill soils typically are more sloping than Goessel soils.

Typical pedon of Goessel silty clay, 0 to 1 percent slopes, 2,660 feet north and 50 feet east of the southwest corner of section 23, T. 25 S., R. 1 W.

Ap—0 to 5 inches; very dark gray (10YR 3/1) heavy silty clay, black (10YR 2/1) moist; moderate medium granular structure; extremely hard, very firm; few open pores; few roots; slightly acid; clear smooth boundary.

AC1—5 to 35 inches; mixed very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) heavy silty clay, black (10YR 2/1) and very dark grayish brown (10YR 3/2) moist; weak medium granular and weak fine blocky structure; common medium slickensides inclined at a 45 degree angle from horizontal; extremely hard, very firm; mildly alkaline; gradual smooth boundary.

AC2—35 to 60 inches; dark gray (10YR 4/1) heavy silty clay, very dark gray (10YR 3/1) moist; few medium faint brown (10YR 5/3) mottles; weak medium blocky structure; extremely hard, very firm; few roots; many open pores; moderately alkaline.

The thickness of the solum ranges from 40 to 60 inches. The thickness of the mollic epipedon is more than 20 inches.

The A horizon has hue of 10YR, value of 3 or 4 (2 or 3 moist), and chroma of less than 1.5 dry or moist. Typically, it is silty clay, but it is heavy silty clay loam or clay in some pedons. Reaction is slightly acid or neutral. The AC horizon has hue of 10YR or 2.5Y, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2 dry or moist. It is silty clay or clay. Vertical tongues of dark clayey surface soil extend to a depth of 35 inches in some pedons. They are less than 4 inches wide. Reaction is mildly alkaline or moderately alkaline.

The C horizon, if it occurs, has hue of 10YR or 2.5Y, value of 3 to 6 dry and 2 to 5 moist, and chroma of 1 to 4 dry or moist. It is silty clay, clay, or heavy clay loam. Reaction is mildly alkaline to moderately alkaline. In some pedons the AC and C horizons are mottled with yellowish brown or strong brown.

Irwin series

The Irwin series consists of deep, well drained, very slowly permeable soils on uplands. These soils formed in old clayey alluvial sediments. Slopes range from 1 to 6 percent.

Irwin soils are similar to Blanket and Tabler soils and are commonly adjacent to Clime, Goessel, Rosehill, and Tabler soils on the landscape. Blanket soils have a thicker A horizon and are more transitional to the argillic horizon and lighter textured in the substratum than Irwin soils. Clime and Rosehill soils have shale at a depth of 20 to 40 inches. Tabler soils have lower chroma throughout the argillic horizon than Irwin soils, and Goessel soils have a more clayey surface layer. Blanket, Goessel, and Tabler soils are typically on smoother landscapes. Clime and

Rosehill soils are typically below the Irwin soils on the landscape.

Typical pedon of Irwin silty clay loam, 1 to 3 percent slopes, 600 feet north and 75 feet east of the southwest corner of section 26, T. 28 S., R. 2 E.

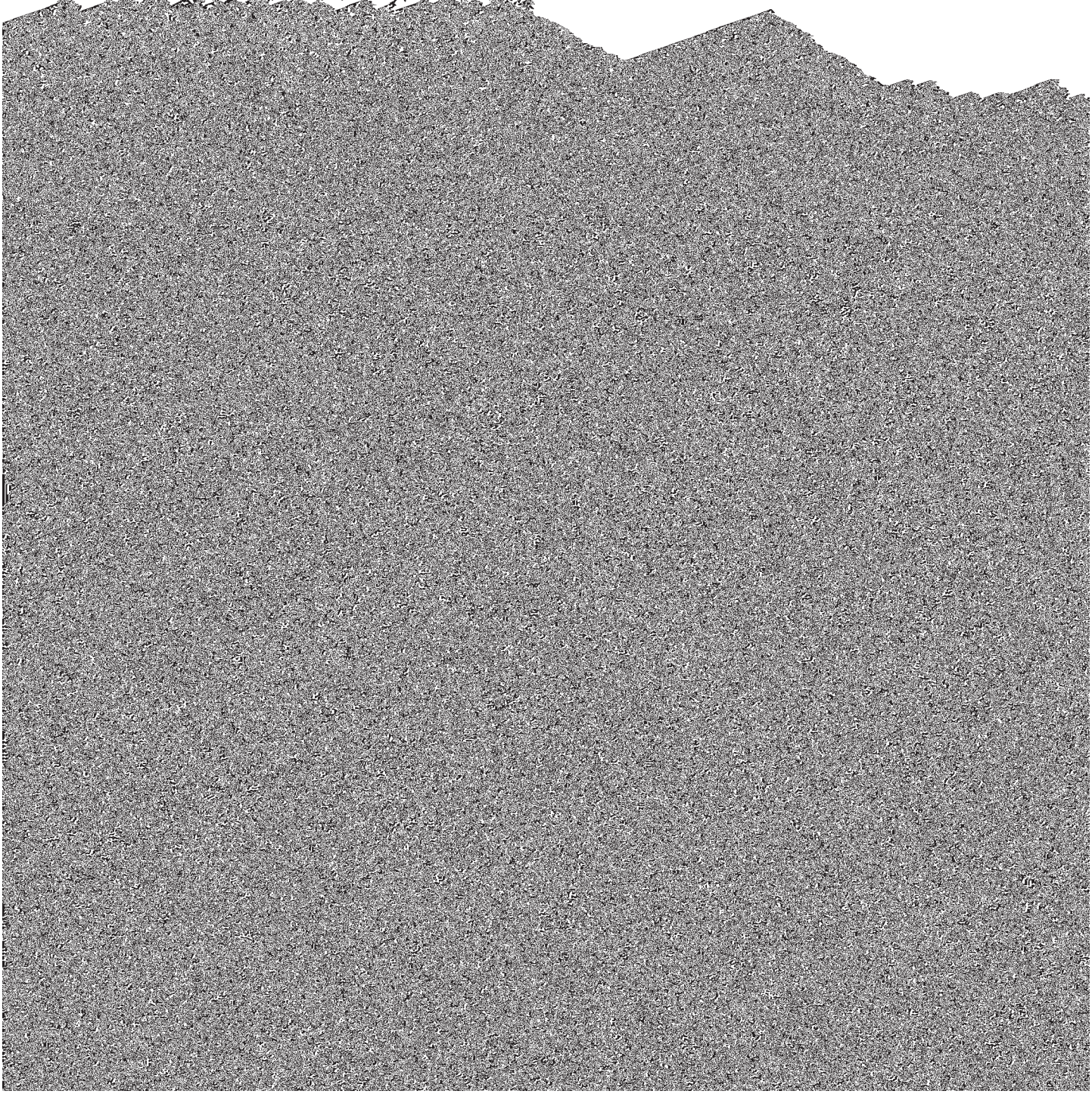
A1—0 to 12 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate medium and fine granular structure; hard, friable; slightly acid; clear smooth boundary.

B21t—12 to 28 inches; brown (7.5YR 4/2) silty clay, dark brown (7.5YR

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) loam, very dark brown (10YR 2/2) moist; weak medium granular structure; hard, friable; many open pores; moderately alkaline; calcareous; clear smooth boundary.

A12—10 to 27 inches; dark grayish brown (10YR 4/2) heavy loam, very dark grayish brown (10YR 3/2) moist; common fine distinct mottles of dark brown (7.5YR 4/4) and few fine faint grayish brown (10YR 5/2) mottles below a depth of 15 inches; moderate medium granular structure; hard, friable; many open pores; moderately alkaline; calcareous; gradual smooth boundary.

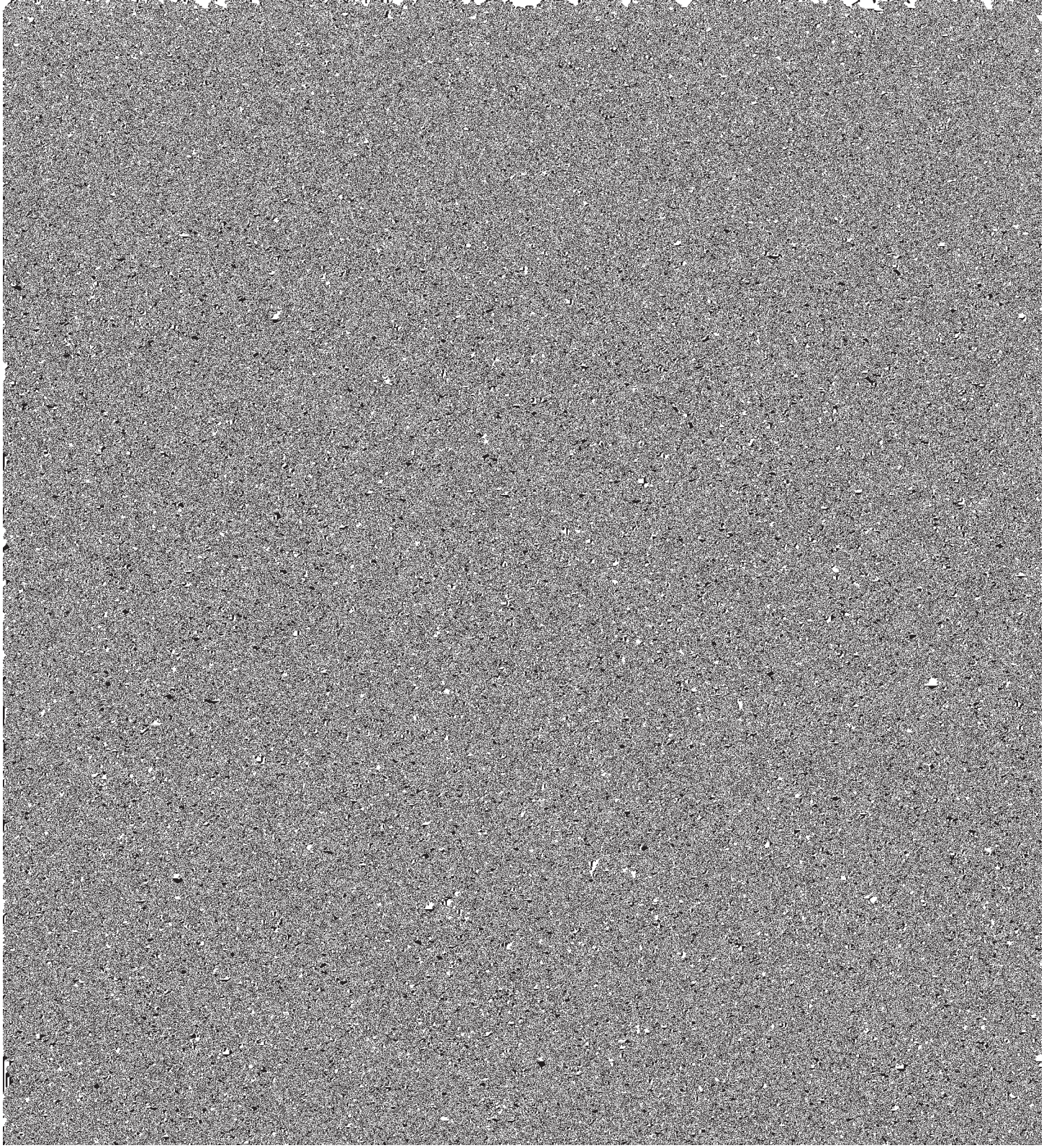
IIC—27 to 60 inches; grayish brown (10YR 5/2) fine sand, dark grayish



Milan series

The Milan series consists of deep, well drained, moderately slowly permeable soils on erosional uplands. These soils formed in loamy sediments. Slopes range from

soils and are more than 27 percent clay in the control section. Shellabarger soils have a hue redder than 7.5YR in the argillic horizon. Canadian and Elandco soils typically occur below Naron soils on the landscape. Farnum, Milan, and Shellabarger soils typically occur on about the same



B21t—7 to 15 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; moderate medium subangular blocky structure; hard, very firm; mildly alkaline; few roots; gradual wavy boundary.

B22tca—15 to 19 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; moderate medium subangular blocky structure; very hard, firm; common soft masses and fine concretions of calcium carbonate; strong effervescence; moderately alkaline; few roots; gradual wavy boundary.

Cca—19 to 60 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) moist; massive; hard, firm; about 35 percent, by volume, soft masses of calcium carbonate; few fine roots; violent effervescence; moderately alkaline.

The thickness of the solum ranges from 18 to 36 inches. Depth to free carbonates ranges from 12 to 24 inches. The mollic epipedon ranges from 8 to 18 inches in thickness and commonly includes the upper part of the B horizon.

The A horizon has hue of 10YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is typically clay loam and less commonly is loam. Reaction is slightly acid or neutral. The B2t horizon has hue of 10YR or 7.5YR, value 4 or 5 (3 or 4 moist), and chroma of 2 to 4. It is clay loam averaging between 28 and 35 percent clay. It ranges from neutral to moderately alkaline and contains free carbonates in the lower part. The Cca horizon has hue of 10YR or 7.5YR, value 5 to 7 (4 to 6 moist), and chroma of 3 or 4. It is, by volume, 20 to 40 percent soft masses of calcium carbonate.

Owens series

The Owens series consists of shallow, well drained, very slowly permeable soils on erosional uplands. These soils formed in clayey material that apparently weathered from Permian shale. Slopes range from 1 to 10 percent.

Owens soils are similar to Renfrow and Vernon soils and are commonly adjacent to those soils on the landscape. Renfrow and Vernon soils have a solum thicker than 20 inches and commonly occupy foot slopes below Owens soils.

Typical pedon of Owens clay loam, 1 to 3 percent slopes, 450 feet north and 75 feet west of the southeast corner of section 17, T. 28 S., R. 4 W.

A1—0 to 7 inches; reddish brown (2.5YR 4/4) heavy clay loam, dark reddish brown (2.5YR 3/4) moist; weak medium granular structure;

Plevna soils are similar to Lesho, Lincoln, and Waldeck soils and are commonly adjacent to those soils and to Pratt and Tivoli soils on the landscape. Lesho soils have a clay loam control section. Lincoln soils are shallow over sand, and Waldeck soils are better drained than Plevna soils. Pratt and Tivoli soils are on uplands next to Plevna soils.

Typical pedon of Plevna fine sandy loam 660 feet north and 25 feet west of the southeast corner of section 20, T. 26 S., R. 1 W.

A11—0 to 9 inches; very dark gray (10YR 3/1) fine sandy loam, black (10YR 2/1) moist; few medium faint mottles of brown (10YR 5/3) in lower part; weak medium granular structure; hard, friable; many fine roots; many open pores; moderately alkaline; gradual smooth boundary.

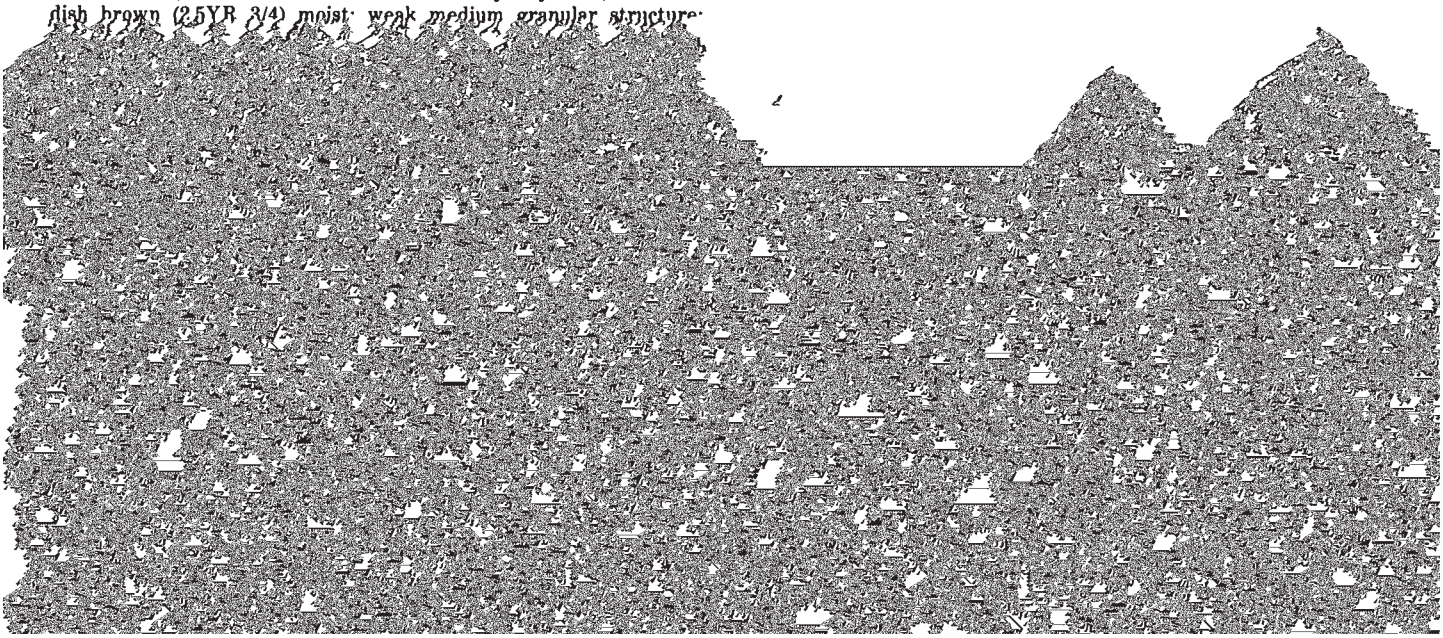
A12—9 to 20 inches; dark gray (10YR 4/1) sandy loam, very dark gray (10YR 3/1) moist; common medium distinct mottles of strong brown (7.5YR 5/6); weak medium granular structure; slightly hard, very friable; few roots; few open pores; moderately alkaline; gradual smooth boundary.

B2g—20 to 35 inches; grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; many medium and coarse distinct mottles of strong brown (7.5YR 5/6); structureless; slightly hard, very friable; few roots; few open pores; moderately alkaline; gradual smooth boundary.

IIC—35 to 60 inches; grayish brown (10YR 5/2) fine sand, grayish brown (2.5Y 5/2) moist; structureless; slightly hard, very friable; very few roots; moderately alkaline; many nests and seams of soft calcium carbonate; gravel ranges from 5 to 10 millimeters in diameter.

The thickness of the solum ranges from 30 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 24 inches. Reaction throughout the profile ranges from neutral to moderately alkaline.

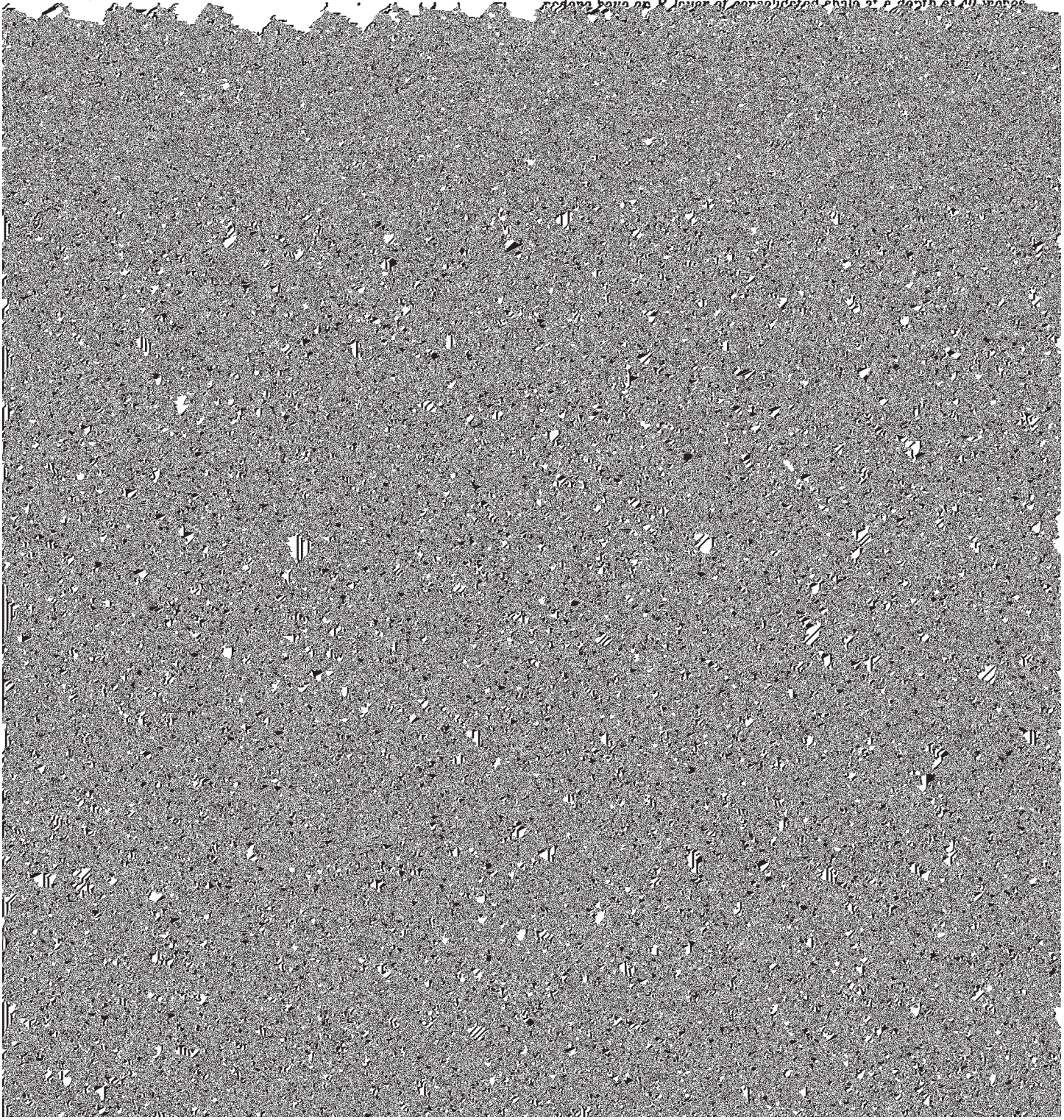
The A horizon has hue of 10YR, value of 2 or 3 (3 to 5 dry), and chroma of 1 or 2. It is typically fine sandy loam or sandy loam and less commonly is loamy fine sand. Most pedons have mottles in the lower part of the A horizon. The B2g horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 2 or less. Mottles are distinct or prominent in the upper part of the B2g horizon. This horizon is fine sandy loam or sandy loam. The IIC horizon has hue of 10YR or 2.5Y, value of 4 to 6 (5 to 7 dry), and chroma of 1 to 4. It is fine sand, sand, or loamy sand and is stratified in most areas.



C—36 to 60 inches; light brown (7.5YR 6/4) fine sand, dark brown (7.5YR 4/3) moist; single grained; loose; very few roots; slightly acid.

The thickness of the solum ranges from 24 to 50 inches. The A horizon has hue of 7.5YR or 10YR, value of 4 to 6 dry and 3 to 5 moist, and chroma of 1 to 3. It is loamy fine sand or sand. Reaction ranges from medium acid to neutral. The Bt horizon has hue of 10YR to 5YR, value of 4 to 6 dry and 4 or 5 moist, and chroma of 2 to 6. It is loamy sand or

The A horizon has hue of 10YR, 7.5YR, or 5YR; value of 4 or 5 (3 or 4 moist); and chroma of 2 or 3. It is typically silty clay loam, but it can also be clay loam and silt loam. Reaction is slightly acid or neutral. The B2t horizon has hue of 2.5YR or 5YR, value of 3 to 5, and chroma of 2 to 4. It is clay or silty clay. Reaction is slightly acid to moderately alkaline. The lower part of the B2t horizon has various amounts of shale fragments, but these fragments do not exceed 35 percent of the volume. Some pedons have lime concretions at a depth of 28 inches. Also, some pedons have an R layer of consolidated shale at a depth of 40 inches.



Shellabarger soils are similar to Albion, Milan, and Naron soils and are commonly adjacent to those soils and to Farnum and Vernon soils. Albion soils have a sand substratum at a depth of 20 to 40 inches and are typically more sloping than Shellabarger soils. Farnum and Milan soils have a clay loam argillic horizon and are less sloping than Shellabarger soils. Naron soils are less red than Shellabarger soils and typically are less sloping. Vernon soils are underlain by shale at a depth of 20 to 40 inches.

Typical pedon of Shellabarger sandy loam, 1 to 3 percent slopes (fig. 12), 300 feet south and 1,800 feet east of the northwest corner of section 2, T. 28 S., R. 2 W.

A1—0 to 10 inches; dark brown (7.5YR 3/2) sandy loam, very dark brown (7.5YR 2/2) moist; weak fine granular structure; soft, very friable; many roots; slightly acid; gradual smooth boundary.

B1—10 to 15 inches; dark reddish brown (5YR 3/2) heavy sandy loam, dark reddish brown (5YR 2/2) moist; moderate medium granular structure; slightly hard, friable; many roots; slightly acid; clear smooth boundary.

B2t—15 to 40 inches; yellowish red (5YR 4/6) sandy clay loam, yellowish red (5YR 3/6) moist; moderate coarse prismatic structure that breaks to moderate fine subangular blocky; hard, firm; clay bridges between sand particles; common roots; slightly acid; gradual smooth boundary.

C—40 to 60 inches; yellowish red (5YR 5/6) heavy sandy loam, yellowish red (5YR 4/6) moist; very weak medium blocky structure; slightly hard, very friable; few roots; slightly acid.

The thickness of the solum ranges from 36 to 60 inches. The thickness of the mollic epipedon ranges from 10 to 20 inches.

The A horizon has hue of 5YR, 7.5YR, 10YR; value of 3 to 5 (2 or 3 moist), and chroma of 2 or 3 dry or moist. It is typically sandy loam and less commonly is loamy fine sand. Reaction is medium or slightly acid.

The B2t horizon has hue of 2.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6 dry or moist. It is sandy clay loam or heavy sandy loam. It averages between 18 and 27 percent clay and more than 20 percent sand coarser than fine sand. Some pedons have a few mottles of yellow or brown in the lower part of the B horizon. Reaction ranges from slightly acid to mildly alkaline.

The C horizon has hue of 2.5YR, 5YR, or 7.5YR; value of 4 to 6 (3.5 to 6 moist); and chroma of 4 to 6 dry or moist. It is sandy loam, fine sandy loam, or loamy sand. Reaction ranges from slightly acid to moderately alkaline. Some pedons contain gravel as much as 1 inch in diameter in the upper part of the solum, but no horizon is more than 10 percent by volume.

Tabler series

The Tabler series consists of deep, moderately well drained, very slowly permeable soils on terraces and uplands. These soils formed in old clayey sediments. Slopes are 0 to 1 percent.

Tabler soils are similar to Blanket, Carwile, Drummond, Goessel, Irwin, and Waurika soils and are commonly adjacent to Blanket, Carwile, Drummond, Elandco, Goessel, Irwin, Rosehill, and Waurika soils. Blanket soils have a thicker A horizon than Tabler soils and are more gradational to the B2t horizon. Carwile soils [illegible] bler soils and are more sloping. Rosehill soils are moderately deep over shale, and Waurika soils have an albic horizon. Blanket, Irwin, and Rosehill soils are typically more undulating than Tabler soils. Elandco soils are on flood plains.

Typical pedon of Tabler silty clay loam 1,100 feet south and 900 feet west of the northeast corner of section 16, T. 25 S., R. 2 E.

Ap—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate fine granular structure; hard, friable; few roots; few open pores; medium acid; clear smooth boundary.

B21t—9 to 27 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) moist; weak fine blocky structure; very hard, firm; few roots; few open pores; slightly acid; gradual smooth boundary.

B22t—27 to 32 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; weak medium blocky structure; extremely hard, very firm; few open pores; thick continuous clay films; moderately alkaline; gradual smooth boundary.

B3—32 to 44 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; weak medium blocky structure; extremely hard, very firm; few small lime concretions; moderately alkaline; gradual smooth boundary.

C—44 to 60 inches; grayish brown (10YR 5/2) silty clay, dark grayish brown (10YR 4/2) moist; few faint medium mottles of brown (10YR 5/3); massive; very hard, very firm; few small lime concretions; moderately alkaline.

The thickness of the solum ranges from 40 to more than 60 inches. The thickness of the mollic epipedon is more than 20 inches.

The A horizon has hue of 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is silty clay loam, clay loam, or silt loam. Reaction ranges from medium acid to moderately alkaline. The Bt horizon has hue of 10YR, value of 3 to 5 (2 to 4 moist), and chroma of 1 or 2. It is silty clay or clay. Reaction ranges from slightly acid to moderately alkaline. The C horizon has hue of 10YR, value of 4 to 6 (3 to 5 moist), and chroma of 1 to 3. It is silty clay loam, silty clay, clay loam, or clay. Reaction is mildly alkaline or moderately alkaline. This horizon is mottled in shades of gray, brown, or red. It is calcareous or noncalcareous.

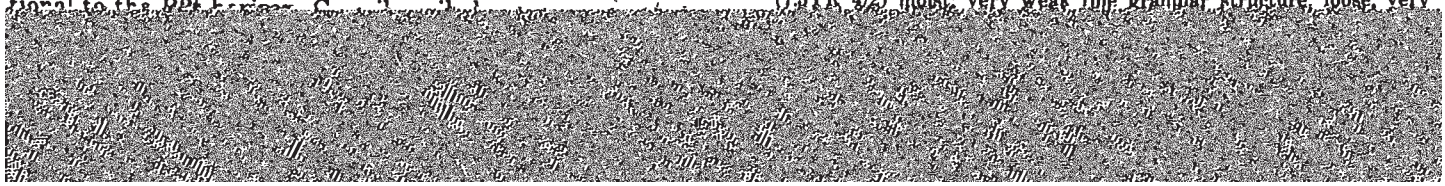
Tivoli series

The Tivoli series consists of deep, excessively drained, rapidly permeable soils on eolian uplands. These soils formed in eolian sandy sediments. Slopes range from 5 to 30 percent.

Tivoli soils are similar to Lincoln and Pratt soils and are commonly adjacent to Plevna, Pratt, and Lincoln soils on the landscape. Pratt soils are on smoother parts of the landscape and have an argillic horizon. Plevna soils are on flood plains, have a fine sandy loam solum, and are poorly drained. Lincoln soils are on flood plains and contain strata finer than loamy fine sand in the control section.

Typical pedon of Tivoli loamy fine sand, in an area of Pratt-Tivoli complex, rolling, 400 feet north and 1,000 feet west of the southeast corner of section 6, T. 29 S., R. 3 W.

A1—0 to 10 inches; brown (7.5YR 5/2) loamy fine sand, dark brown (7.5YR 4/2) moist; very weak fine granular structure; loose, very



mildly alkaline. The C horizon has hue of 7.5YR or 10YR, value of 5 to 7, and chroma of 3 to 6. It is slightly acid to mildly alkaline in the upper part and neutral to moderately alkaline in the lower part. The C horizon is fine sand or sand.

Vanoss series

The Vanoss series consists of deep, well drained, moderately permeable soils on loess-covered uplands. These soils formed in loamy or silty sediments. Slopes range from 0 to 6 percent.

Vanoss soils are similar to Blanket and Elandco soils and are commonly adjacent to Blanket, Farnum, and Waurika soils on the landscape. Blanket, Elandco, and Farnum soils have a mollic epipedon thicker than 20 inches. Also, Elandco soils also lack an argillic horizon. Blanket and Farnum soils typically are less sloping than Vanoss soils and are above those soils on the landscape. Elandco soils are on flood plains. Waurika soils have an albic horizon and are in depressional areas.

[illegible]

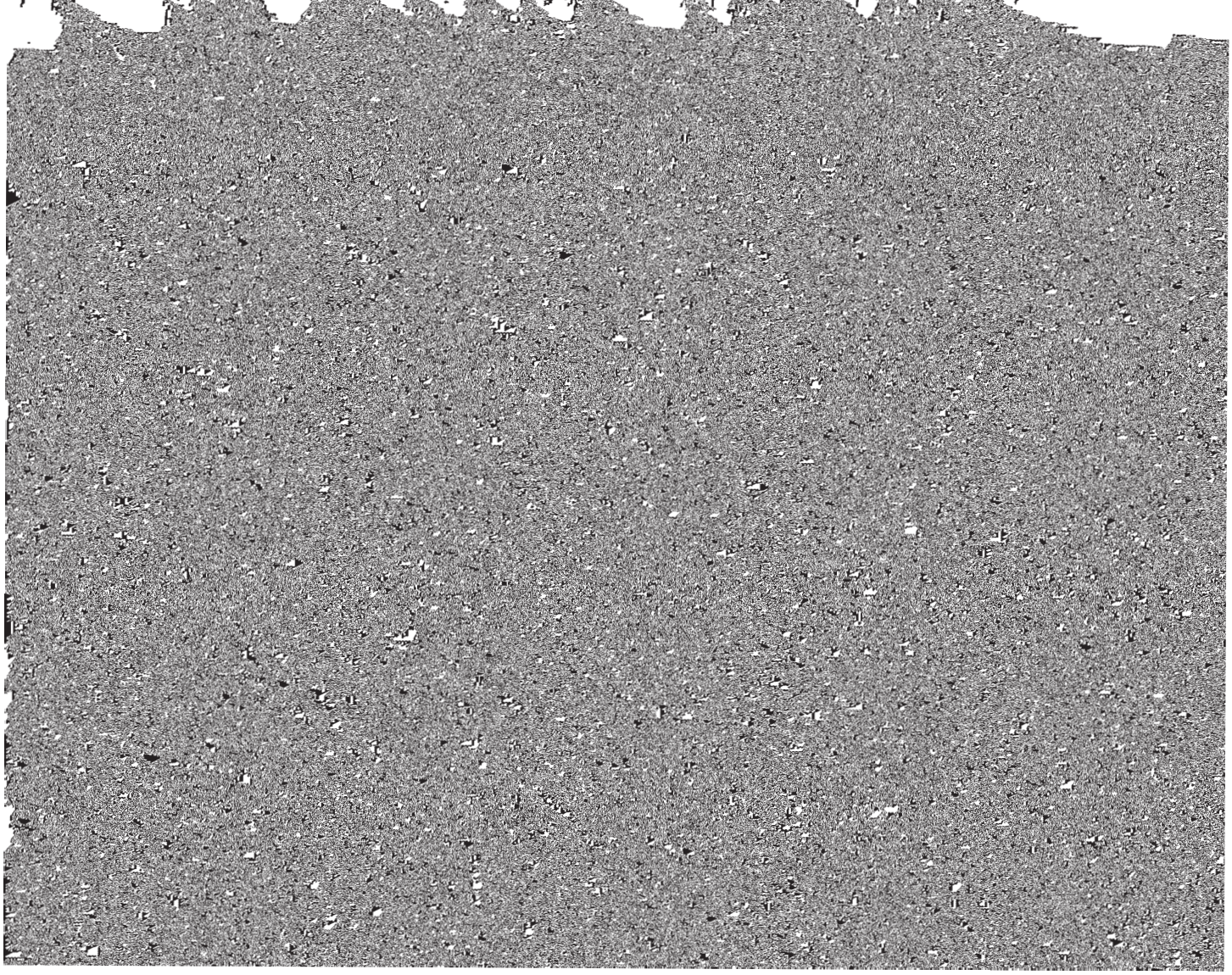
Vernon soils are similar to Owens and Renfrow soils and are commonly adjacent to those soils and to Milan and Shellabarger soils on the landscape. Owens soils have a solum that is less than 20 inches thick. Renfrow soils have a solum that is more than 40 inches thick. Shellabarger and Milan soils have fine loamy control sections and are on narrow, convex ridgetops.

Typical pedon of Vernon sandy loam, 1 to 3 percent slopes (fig. 13), 800 feet north and 100 feet west of the southeast corner of section 31, T. 27 S., R. 4 W.

Ap—0 to 8 inches; dark brown (7.5YR 4/2) sandy loam, dark brown (7.5YR 3/2) moist; weak medium granular structure; slightly hard, friable; neutral; gradual smooth boundary.

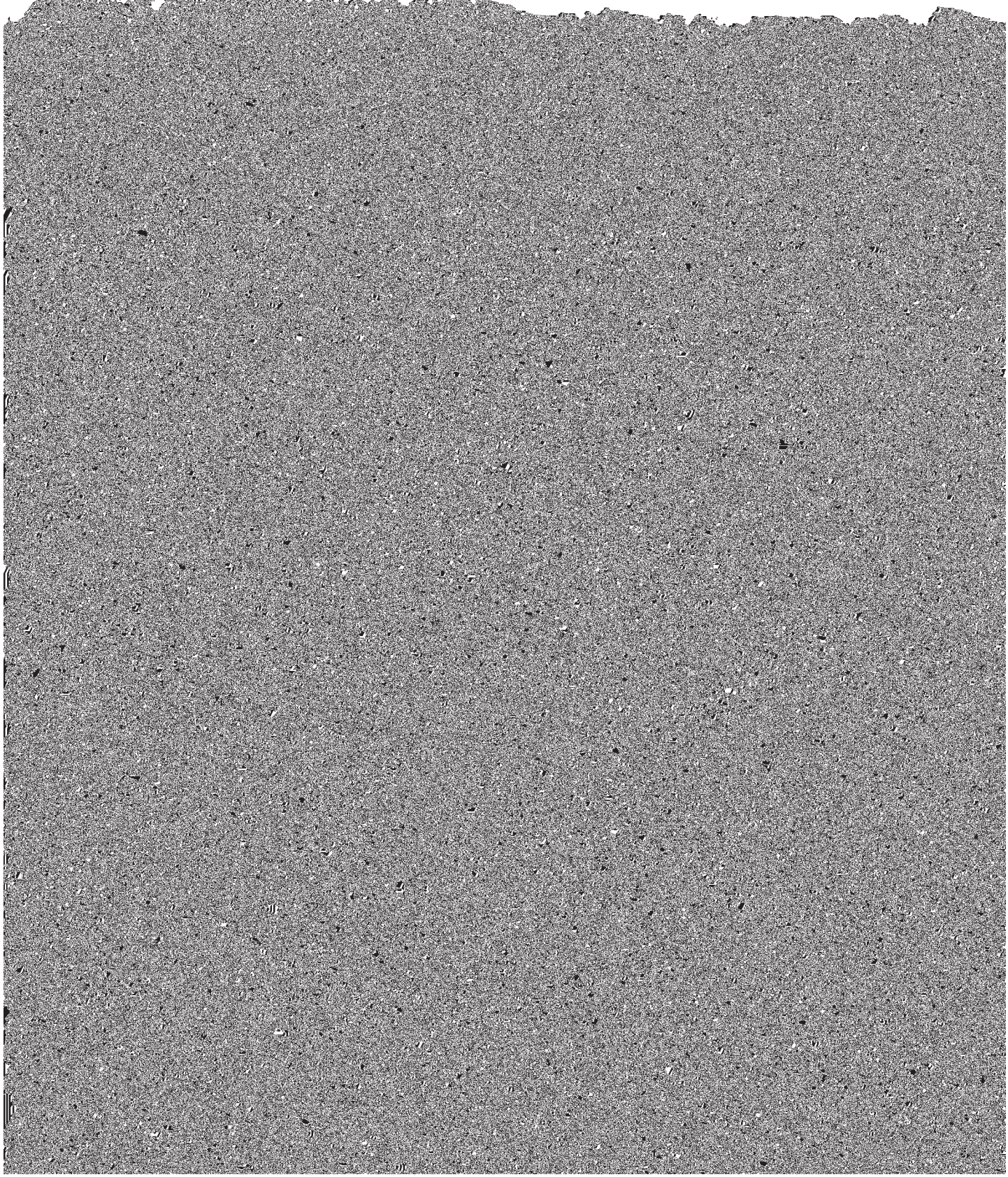
B1—8 to 13 inches; reddish brown (5YR 4/3) sandy clay loam, dark reddish brown (5YR 3/3) moist; weak medium subangular blocky structure; hard, firm; many open pores; few roots; neutral; gradual smooth boundary.

IIB2—13 to 24 inches; reddish brown (5YR 4/3) silty clay, dark reddish brown (5YR 3/3) moist; moderate fine blocky structure; thick and continuous clay films; extremely hard, very firm; many open pores; few roots; neutral; gradual smooth boundary.



AC—14 to 27 inches; light brownish gray (10YR 6/2) sandy loam, grayish brown (10YR 5/2) moist; common medium distinct yellowish

Classification of the soils



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 Pachic Argiustolls.

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

This section describes the factors of soil formation, relates them to the formation of soils in the survey area, and explains the processes of soil formation.

The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material formed and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or topography of the land, and (5) the length of time that the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly bring about the development of genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Typically, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be

Permian System (*8*), which crops out in the eastern part of the county. It is soft, calcareous, gray and bluish gray shale that contains several thin beds of limestone and gypsum. Rosehill and Clime soils probably formed in material weathered from this shale. In the western part of the county are outcrops of Ninnescah shale, which is also part of the Permian System. Renfrow, Vernon, and Owens soils probably formed in material weathered from this shale.

During the Pleistocene epoch, streams deposited sediments ranging from sand to clay. Some of these outwash sediments were reworked by wind before vegetation became established. Other areas were covered by windblown material. The thickness of this material varies. Blanket, Carwile, Farnum, Milan, Vanoss, and Irwin soils formed in this material.

Eolian sand is the parent material of some of the soils in the county. The sand is probably derived from sediments in the Arkansas Valley and from older Pleistocene stream deposits southwest of this area (*8*). Pratt and Tivoli soils formed in these sandy deposits. Naron, Farnum, Milan, and Shellabarger soils formed partly in eolian deposits.

Alluvium of late Quaternary age is in stream valleys (*6*). Lesho, Lincoln, and Elandco soils formed in these sediments.

Climate

Climate has played an improtant role in the formation of soils in Sedgwick County. Precipitation, temperature, and wind affect the type of soil profile that forms.

Moisture from rainfall and other sources enters the soil, dissolves soluble materials, and transports them downward. It permits plants to grow and contributes organic matter to the soil. As moisture moves downward, it carries clay particles and minerals with it and deposits them in the subsoil, or B horizon. Moisture also allows soil organisms to increase in number and activity. These organisms help to darken the soil by changing plant material to organic matter.

Alternate wetting and drying of soils that are high in content of clay results in shrinking and swelling of soil

Wind also affects soil formation. Most of the precipitation in Sedgwick County falls in summer. The hot summer wind, however, evaporates moisture rapidly. It blows the fine particles from the plow layer and thus decreases soil fertility and, in time, changes soil texture. This winnowing is evident in Naron, Canadian, Pratt, and Shellabarger soils.

Plant and animal life

Animal life and vegetation are indispensable in soil formation. Burrowing animals, fungi, and other micro-organisms help to weather rock and decompose organic material. Plant and animal life also influences the chemical and biological processes that take place in the soil.

Plants are the main source or organic matter. The soils in Sedgwick County formed under tall and mid grasses, which supply enormous amounts of roots that decay and

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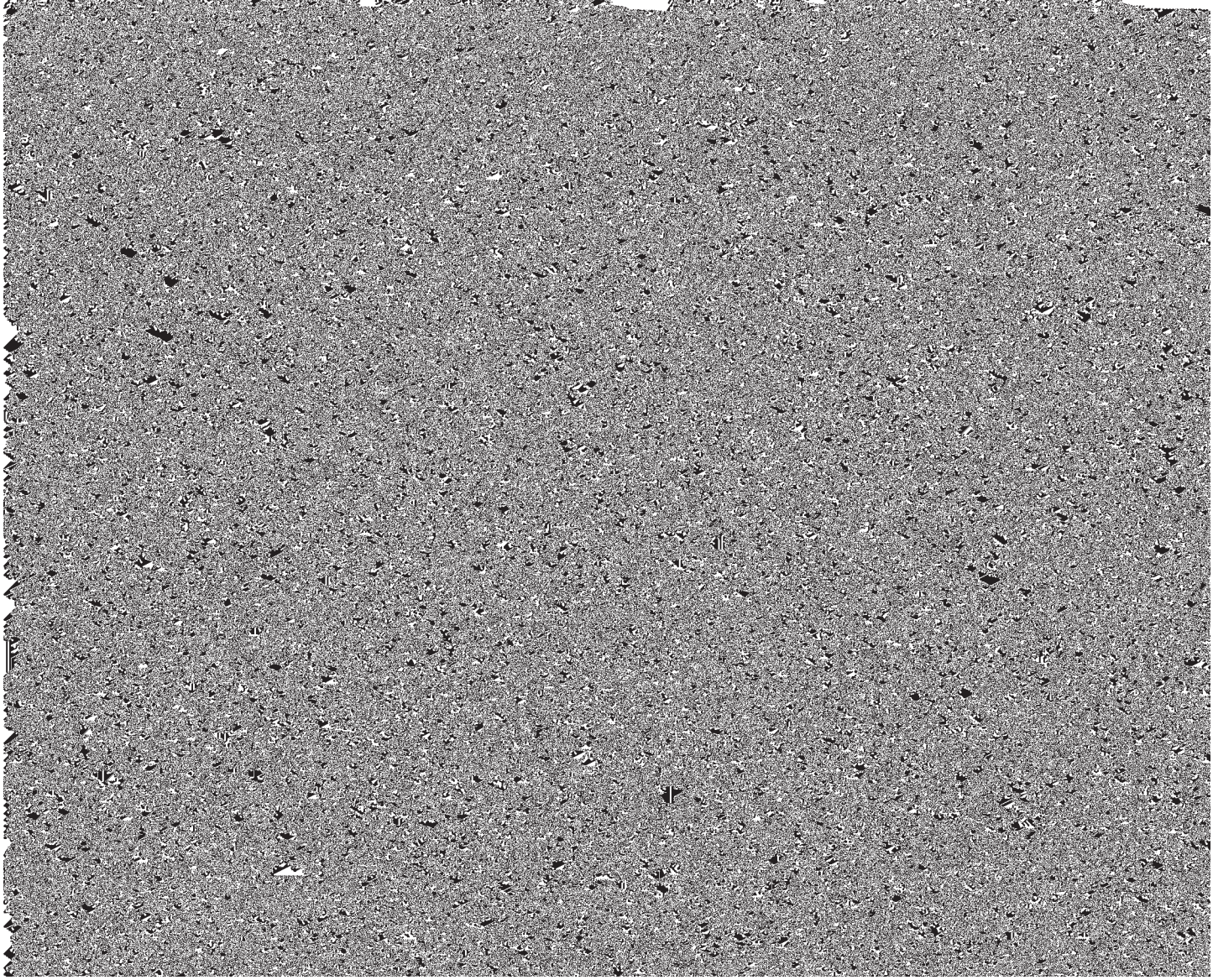
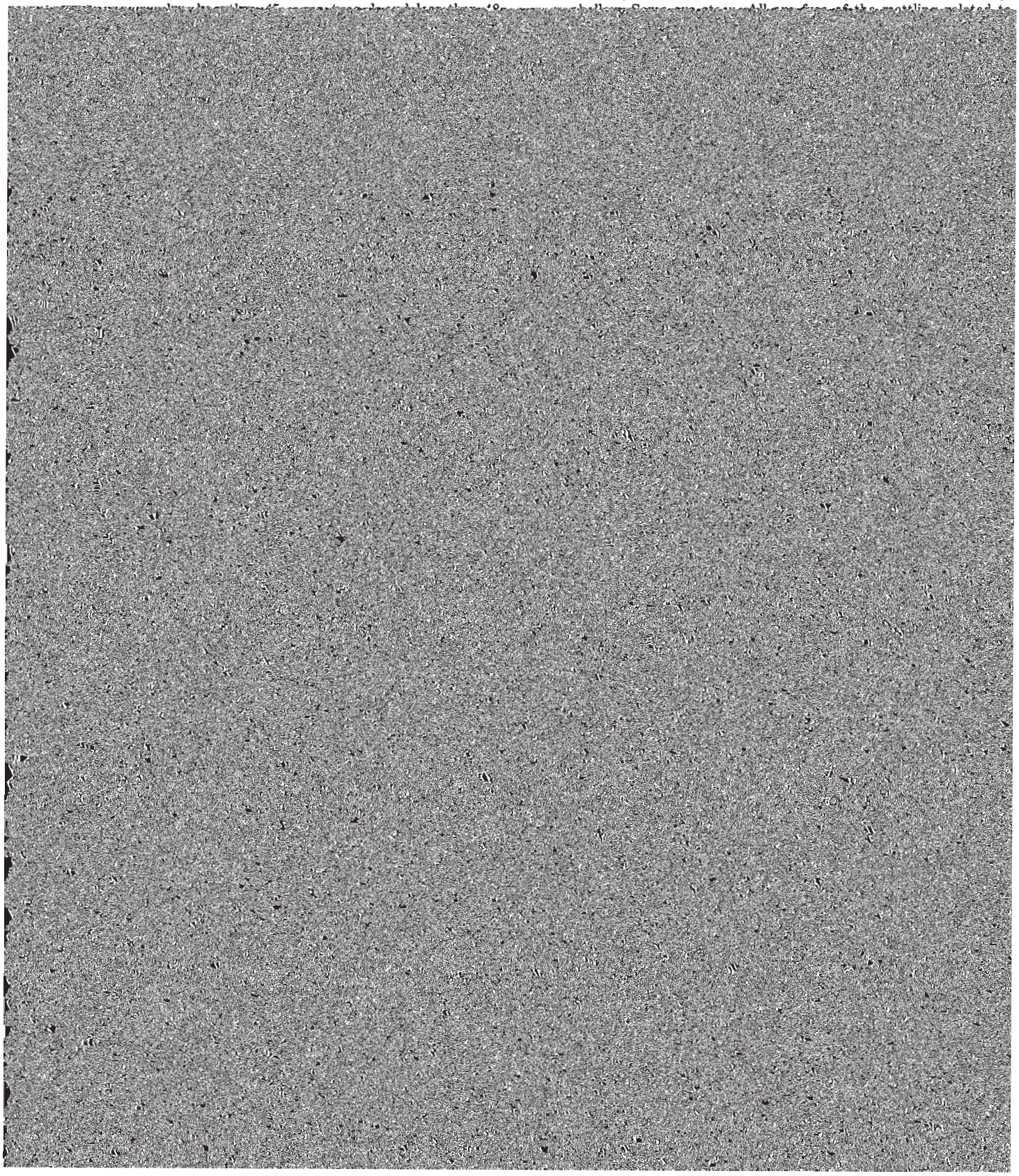


Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky,



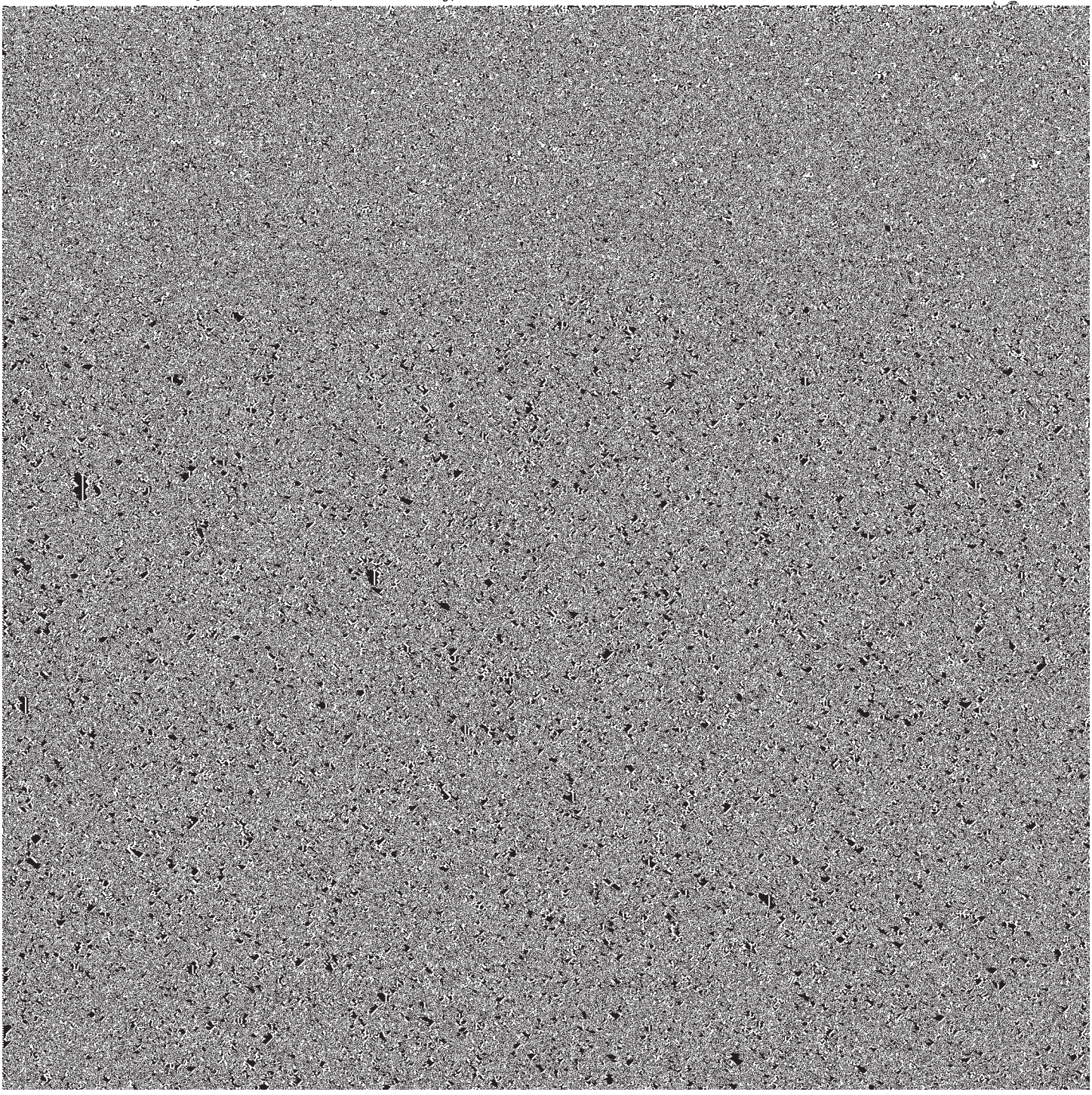
First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flooding. The temporary covering of soil with water from overflowing streams, runoff from adjacent slopes, and tides. Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; *November-May*, for exam-

not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hummocky. Refers to a landscape of hillocks, separated by low sags, having sharply rounded tops and steep sides. Hummocky relief resembles rolling or undulating relief, but the tops of ridges are narrower and the sides are shorter and less even.



Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is greater than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil, are too nearly inaccessible for orderly examination, or cannot otherwise be feasibly classified.

Moderately coarse textured (moderately light textured) soil. Sandy loam and fine sandy loam.

Moderately fine textured (moderately heavy textured) soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few*, *common*, and *many*; size—*fine*, *medium*, and *coarse*; and contrast—*faint*, *distinct*, and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Pan. A compact, dense layer in a soil. A pan impedes the movement of water and the growth of roots. The word "pan" is commonly combined with other words that more explicitly indicate the nature of the layer; for example, *hardpan*, *fragipan*, *claypan*, *plowpan*, and *traffic pan*.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly. The slow movement of water through the soil adversely

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

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Poorly graded. Refers to soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under a specified system of management. Productivity is measured in terms of output, or harvest, in relation to input.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Range (or rangeland). Land that, for the most part, produces native plants suitable for grazing by livestock; includes land supporting some forest trees.

Range condition. The health or productivity of forage plants on a given range, in terms of the potential productivity under normal climate and the best practical management. Condition classes generally recognized are—*excellent*, *good*, *fair*, and *poor*. The classification is based on the percentage of original, or assumed climax vegetation on a site, as compared to what has been observed to grow on it when well managed.

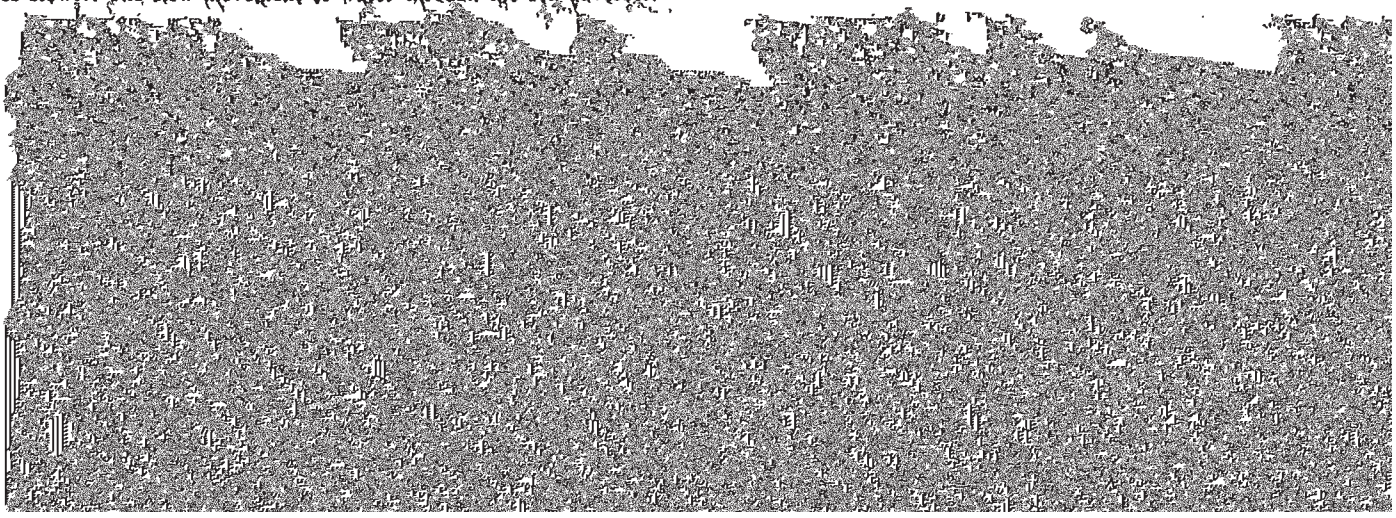
Range site. An area of range where climate, soil, and relief are sufficiently uniform to produce a distinct kind and amount of native vegetation.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock. Soil scientists regard as soil only the part of the regolith that is modified by organisms and other soil-building forces. Most engineers describe the whole regolith, even to a great depth, as "soil."

Relief. The elevations or inequalities of a land surface, considered col-



reaction are in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils, formed from a particular type of parent material, having horizons that, except for the texture of the A or surface horizon, are similar in all profile characteristics and in arrangement in the soil profile. Among these characteristics are color, texture, structure, reaction, consistence, and mineralogical and chemical composition.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slick spot. Locally, a small area of soil having a puddled, crusted, or smooth surface and an excess of exchangeable sodium. The soil is generally silty or clayey, is slippery when wet, and is low in productivity.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

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

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows: *very coarse sand* (2.0 millimeters to 1.0 millimeter); *coarse sand* (1.0

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter a hardpan or claypan.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use or management.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand*, *loamy sand*, *sandy loam*, *loam*, *silt*, *silt loam*, *sandy clay loam*, *clay loam*, *silty clay loam*, *sandy clay*, *silty clay*, and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Topsoil (engineering). Presumably a fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to dress roadbanks, lawns, and gardens.

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.

Well graded. Refers to a soil or soil material consisting of particles well distributed over a wide range in size or diameter. Such a soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Illustrations

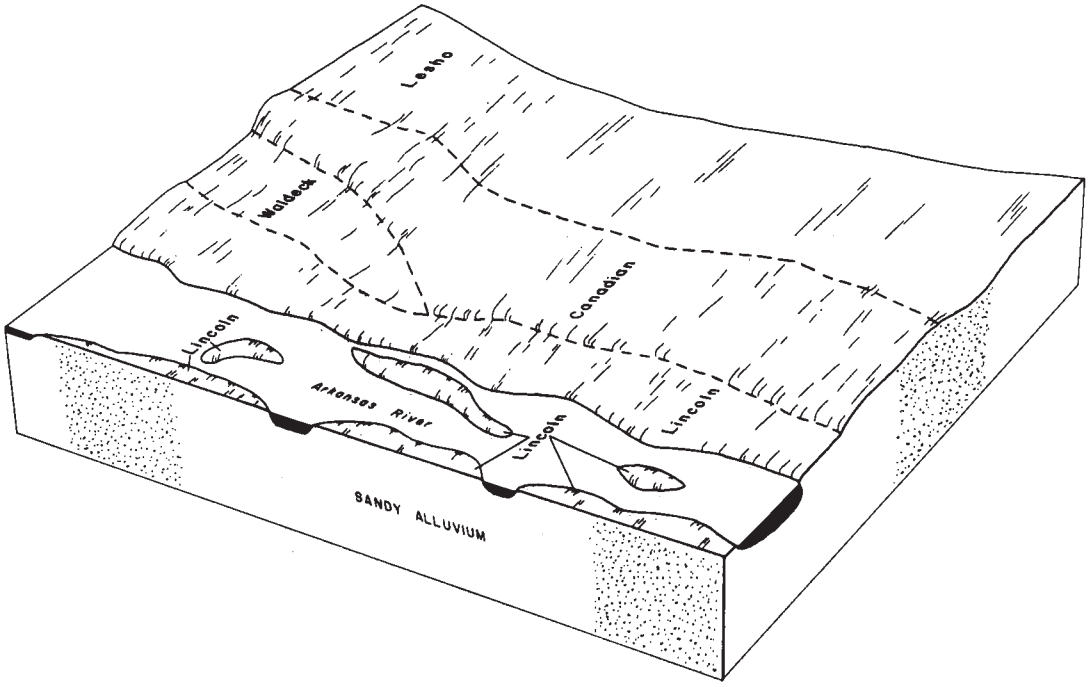


Figure 1.—Typical pattern of soils and underlying material in the Lesho-Lincoln-Canadian map unit.

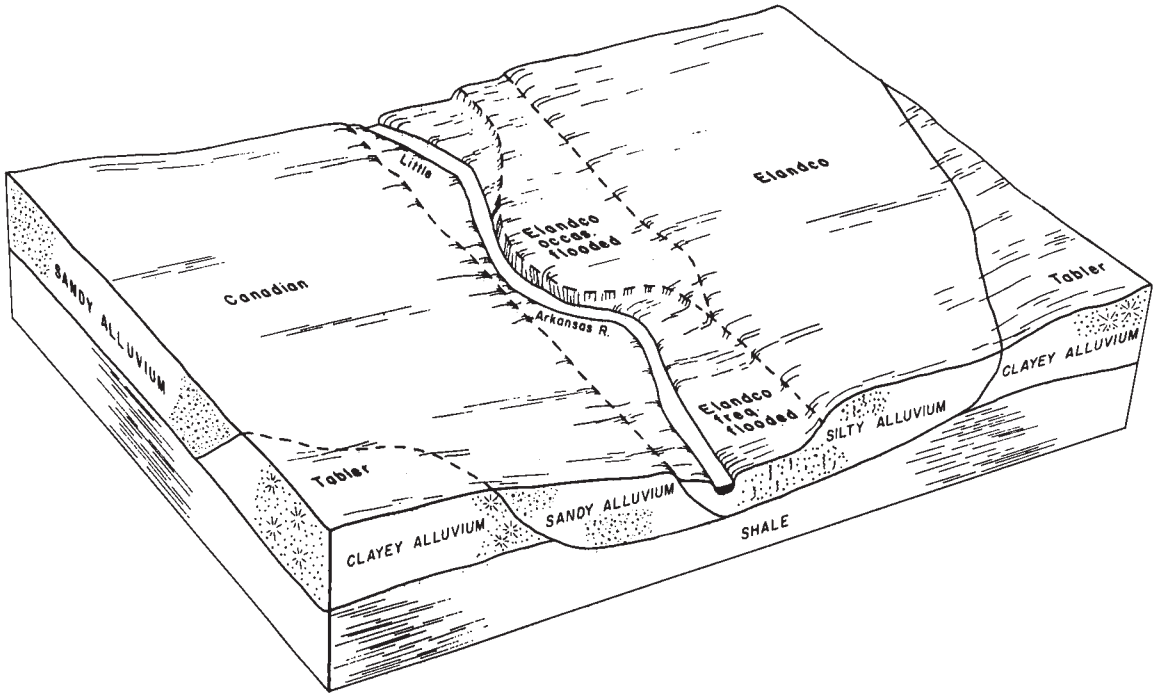


Figure 2.—Typical pattern of soils and underlying material in the Elandco-Canadian map unit.

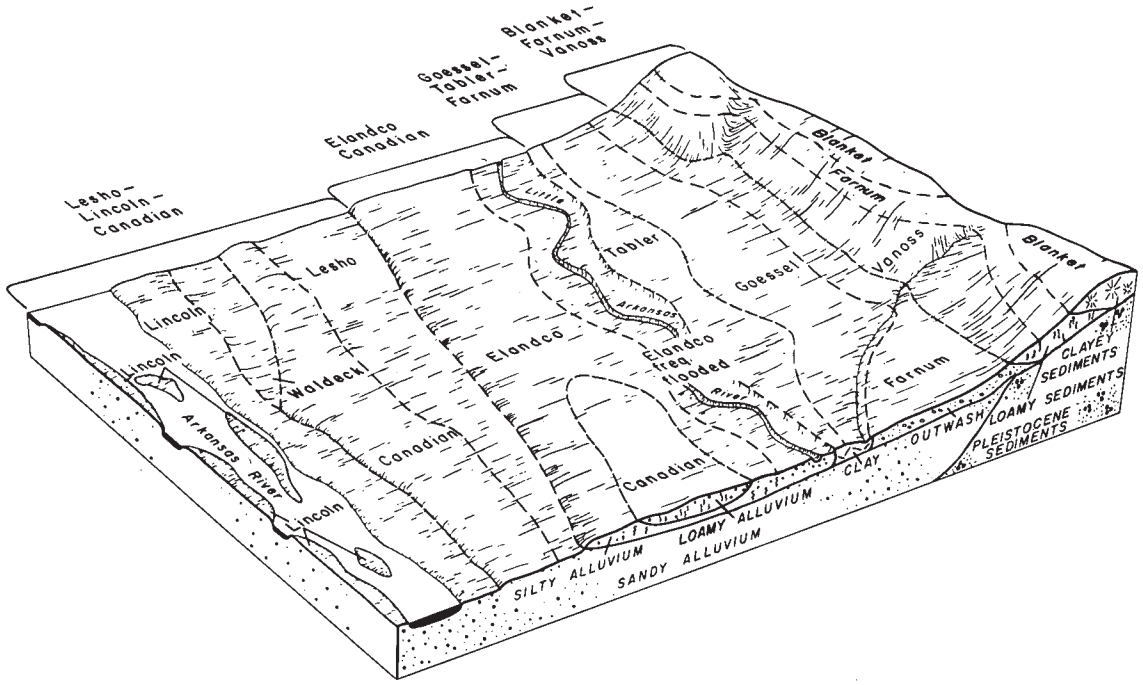


Figure 3.—Typical pattern of soils and underlying material in the valley of the Arkansas River and adjacent uplands.

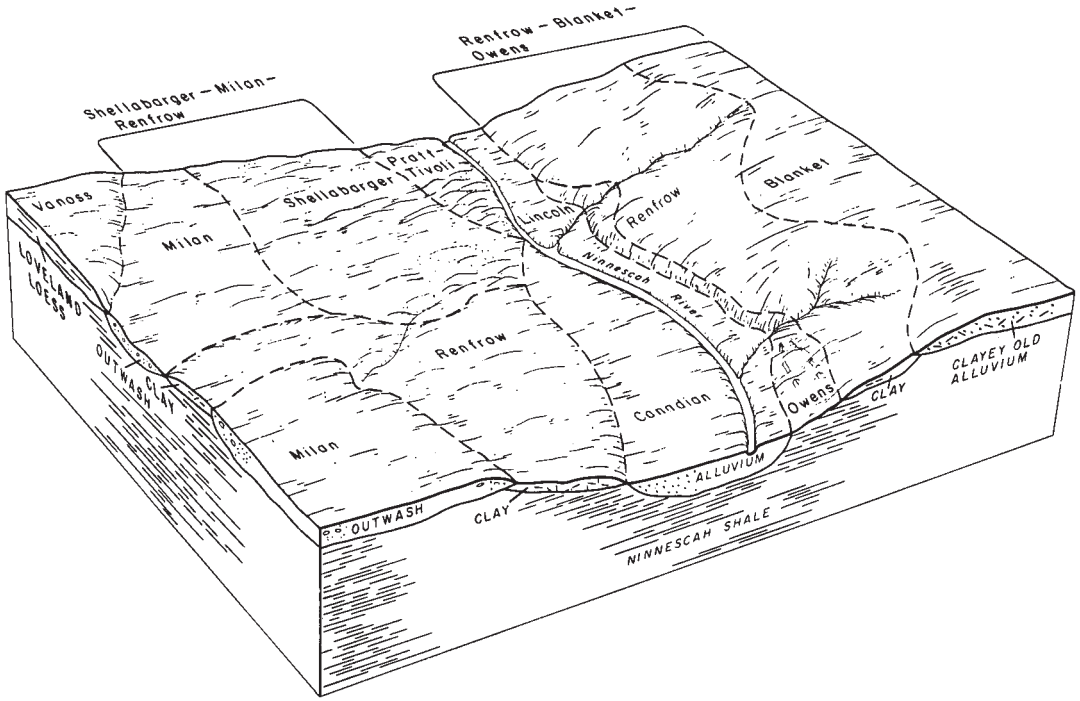
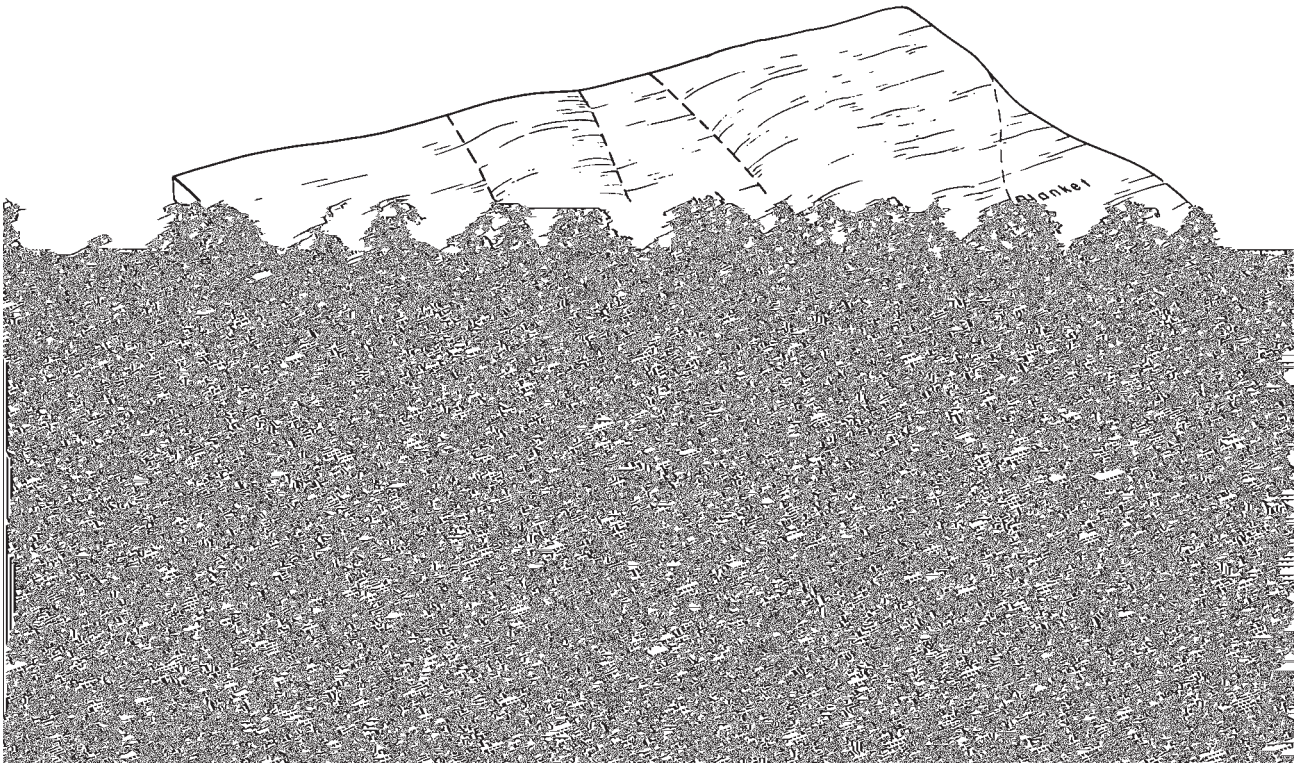


Figure 5.—Typical pattern of soils and underlying material in the Shellabarger-Milan-Renfrow and the Renfrow-Blanket-Owens map units.



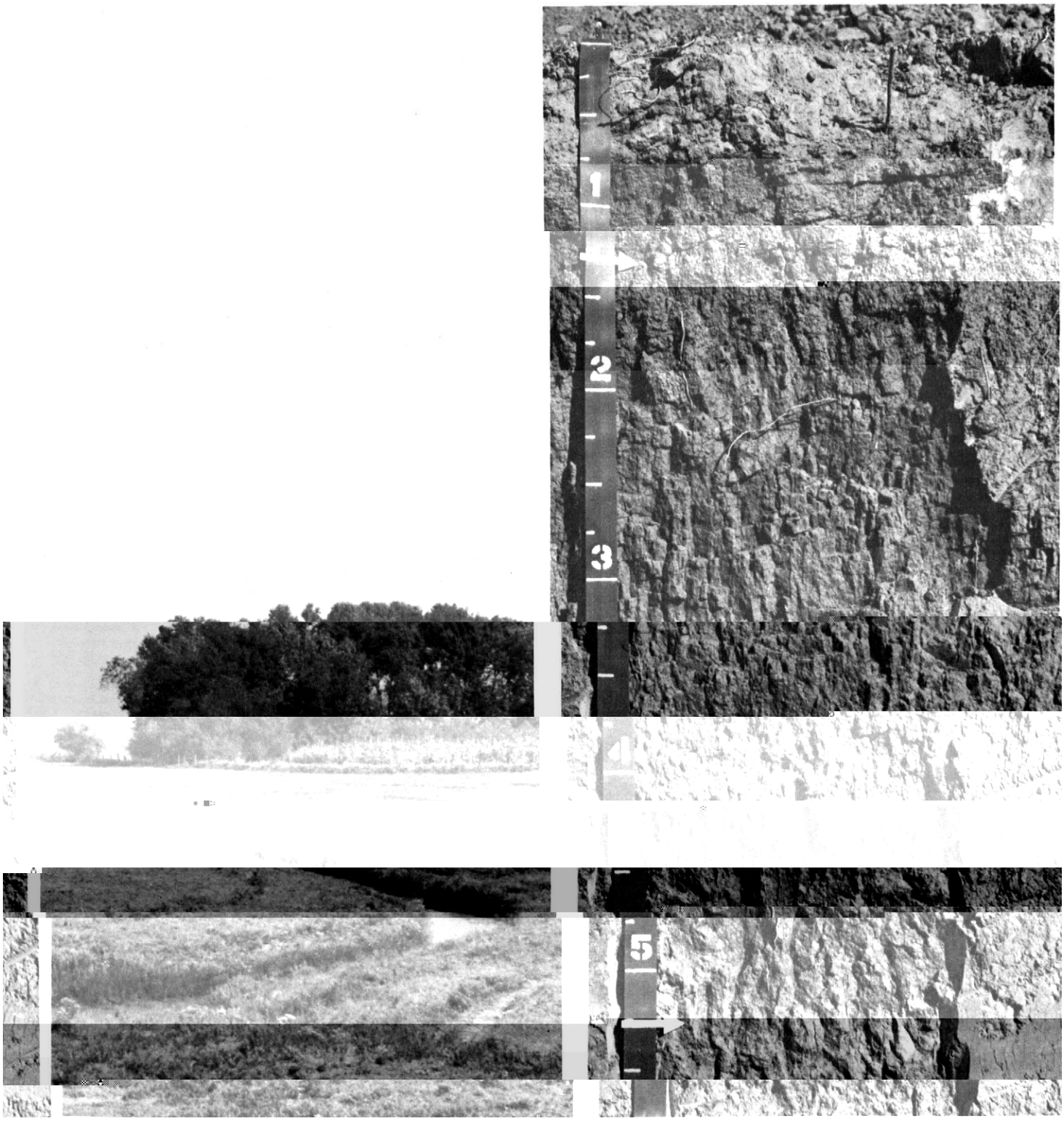


Figure 7.—Range on Elandco silt loam, frequently flooded.

Figure 8.—Typical profile of Farnum loam, 0 to 1 percent slopes.

Figure 9.—Abundant prairie cordgrass on Plevna fine sandy loam.

Figure 10.—Housing development on Tabler-Drummond complex. The white, crusty surface is practically void of vegetation.

Figure 11.—Pollution abatement facility on Elandco silt loam, occasionally flooded.

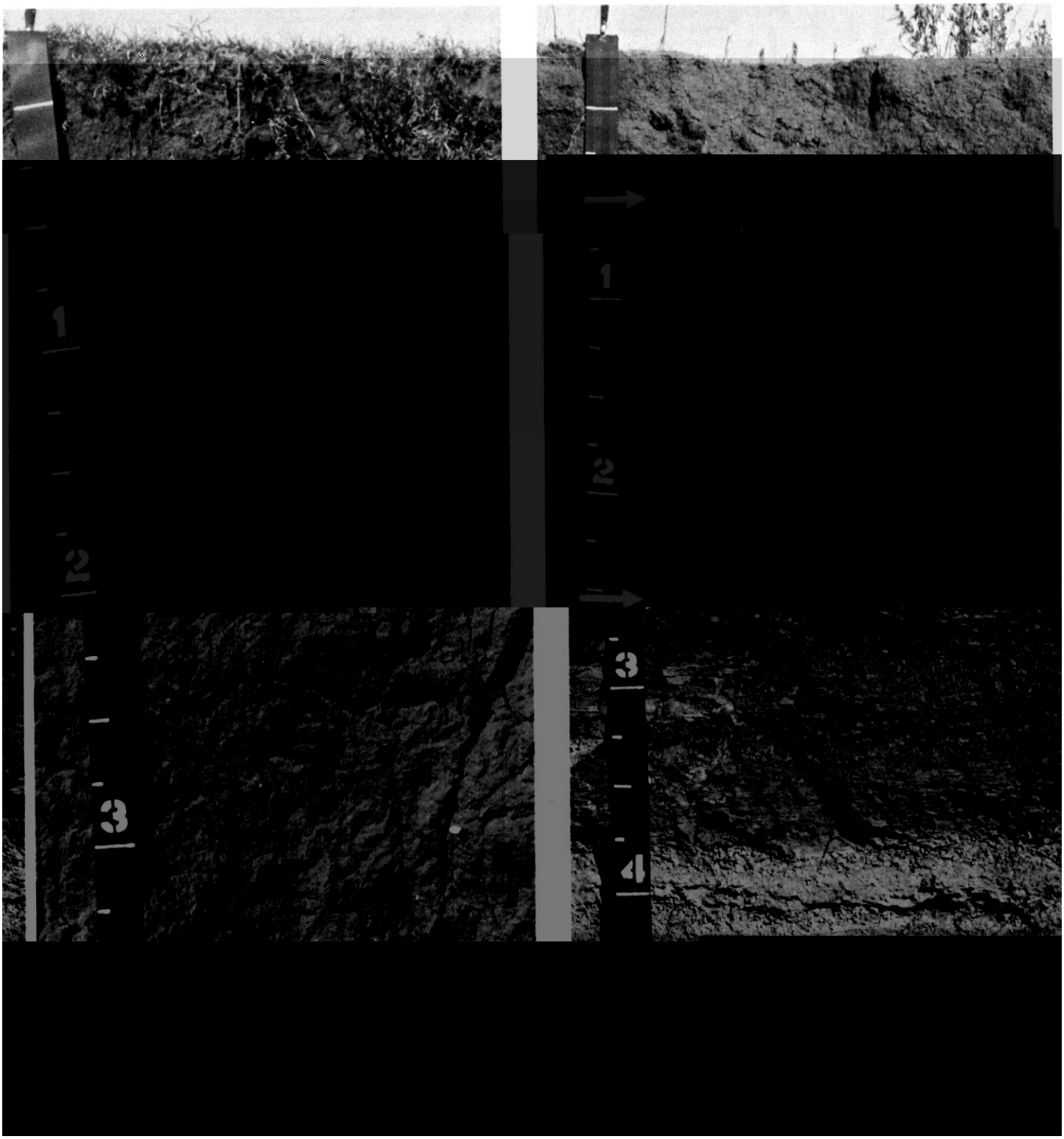


Figure 12.—Typical profile of Shellabarger sandy loam, 1 to 3 percent slopes.

Figure 13.—Typical profile of Vernon sandy loam, 1 to 3 percent slopes. Red clayey shale is at a depth of about 28 inches.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION DATA

Month	Temperature[1]					Precipitation[1]				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	In	In	In		In
January----	40.6	20.2	30.4	69	- 5	0.53	0.17	0.91	2	3.9
February---	46.5	24.7	35.6	77	2	0.79	0.21	1.42	2	3.2
March------	54.9	31.5	43.2	86	4	1.55	0.53	2.64	3	3.7
April------	69.0	45.2	57.1	92	26	2.06	1.15	3.11	4	0.1
May--------	78.0	55.6	66.8	98	35	3.80	1.41	5.96	6	0
June-------	86.4	64.6	75.5	102	47	4.38	2.37	6.76	7	0
July-------	92.6	70.2	81.4	106	55	3.30	1.59	6.81	6	0
August-----	91.1	68.1	79.6	107	52	3.05	1.02	5.39	4	0
September--	81.4	59.5	70.5	101	42	4.04	1.79	5.99	6	0

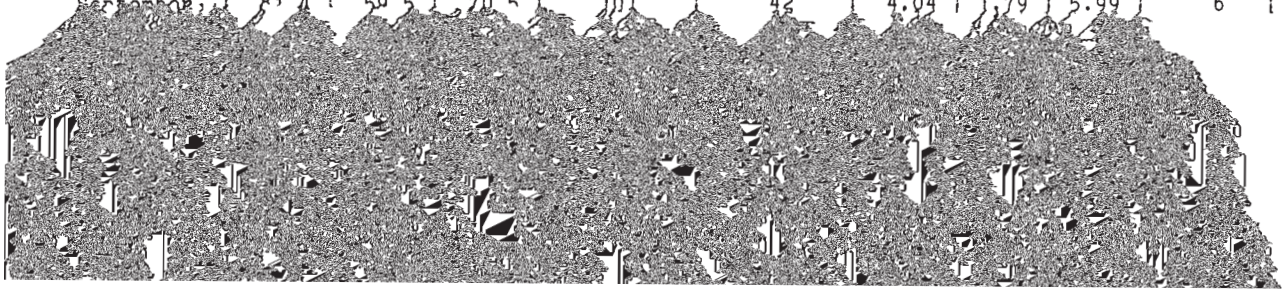


TABLE 2.--FREEZE DATES IN SPRING AND FALL

Probability	Minimum 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 8	April 19	April 30
2 years in 10 later than--	April 3	April 14	April 25
5 years in 10 later than--	March 25	April 4	April 15
First freezing temperature in fall:			
1 year in 10 earlier than--	November 2	October 22	October 10
2 years in 10 earlier than--	November 6	October 27	October 14
5 years in 10 earlier than--	November 16	November 5	October 24

[1]Recorded in the period 1931-60 at Wichita.

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	222	204	191
8 years in 10	231	211	197
5 years in 10	248	223	210
2 years in 10	265	235	222
1 year in 10	273	241	229

[1]Recorded in the period 1931-60 at Wichita.

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

Map symbol	Soil name	Acres	Percent
Aa	Albion-Shellabarger sandy loams, 1 to 4 percent slopes	2,346	0.4
Ab	Albion and Shellabarger sandy loams, 7 to 15 percent slopes	783	0.1
Ba	Blanket silt loam, 0 to 1 percent slopes	52,961	8.3
Bb	Blanket silt loam, 1 to 3 percent slopes	49,997	7.9
Ca	Canadian fine sandy loam	17,779	2.8
Cb	Canadian-Waldeck fine sandy loams	4,352	0.7
Cc	Carwile fine sandy loam	13,696	2.1
Cd	Clark-Ost clay loams, 1 to 4 percent slopes	2,887	0.4
Ce	Clime silty clay, 3 to 6 percent slopes	9,775	1.5
Ea	Elandco silt loam	21,049	3.3
Eb	Elandco silt loam, occasionally flooded	8,658	1.3
Ec	Elandco silt loam, frequently flooded	9,867	1.5
Fa	Farnum loam, 0 to 1 percent slopes	12,693	2.0
Fb	Farnum loam, 1 to 3 percent slopes	54,537	8.6
Fc	Farnum loam, sandy substratum, 0 to 1 percent slopes	13,199	2.0
Ga	Goessel silty clay, 0 to 1 percent slopes	3,161	0.5
Gb	Goessel silty clay, 1 to 2 percent slope	9,994	1.5
Ia	Irwin silty clay loam, 1 to 3 percent slopes	40,456	6.3
Ib	Irwin silty clay loam, 3 to 6 percent slopes	1,231	0.2
Ic	Irwin silty clay loam, 2 to 6 percent slopes, eroded	1,700	0.3
La	Lesho loam	8,845	1.4
Lb	Lincoln soils	5,910	0.9
Ma	Milan loam, 1 to 3 percent slopes	24,169	3.7
Mb	Milan loam, 3 to 6 percent slopes	5,870	0.9
Mc	Milan clay loam, 2 to 6 percent slopes, eroded	2,554	0.4
Na	Naron fine sandy loam	21,558	3.3
Oc	Owens clay loam, 1 to 3 percent slopes	1,408	0.2
Od	Owens-Rock outcrop complex, 3 to 10 percent slopes	1,128	0.2
Pa	Pits	1,188	0.2
Pb	Plevna fine sandy loam	4,808	0.7
Pc	Pratt loamy fine sand, undulating	6,710	1.0
Pd	Pratt-Tivoli complex, rolling	2,302	0.4
Ra	Renfrow silty clay loam, 1 to 3 percent slopes	15,749	2.4
Rb	Renfrow silty clay loam, 3 to 6 percent slopes	1,462	0.2
Rc	Renfrow-Owens clay loams, 1 to 4 percent slopes	1,152	0.2
Rd	Rosehill silty clay, 1 to 3 percent slopes	29,584	4.6

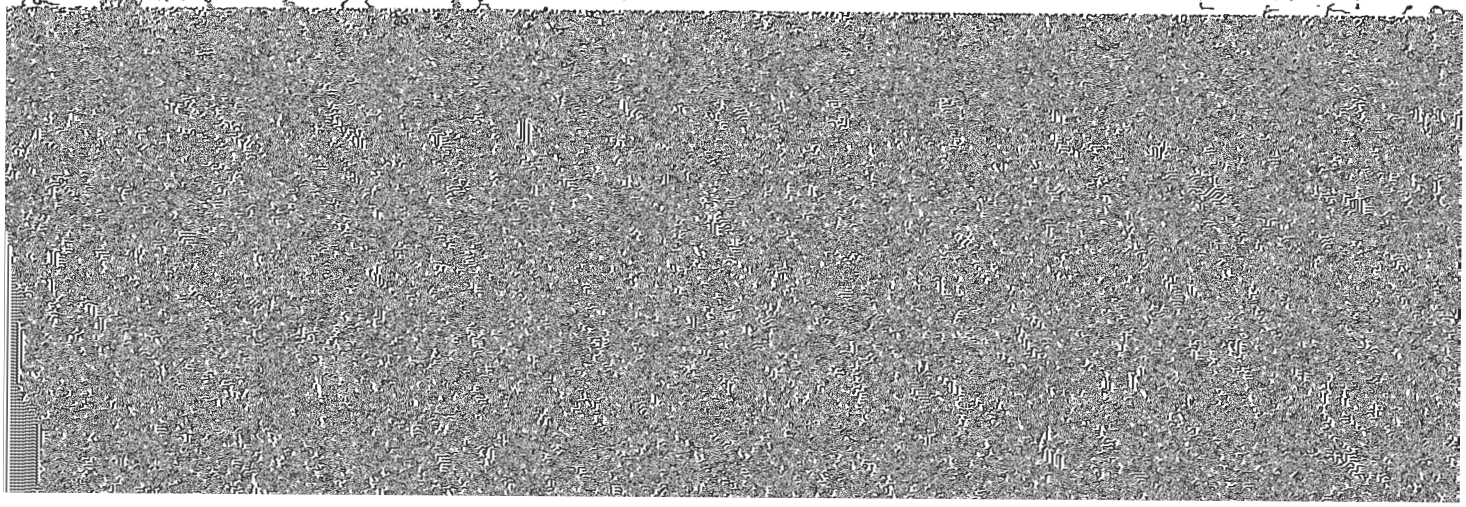


TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

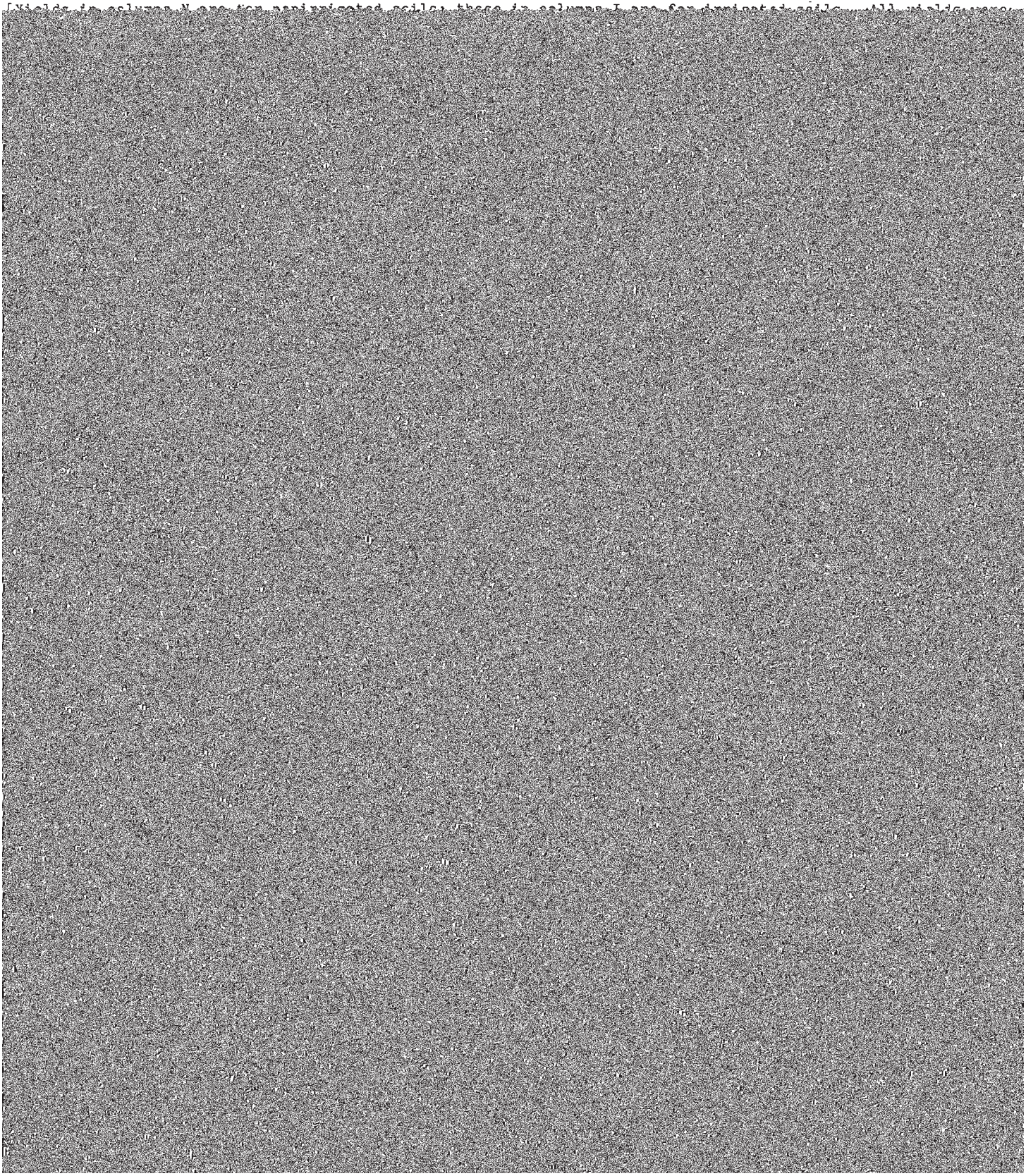


TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Wheat, winter		Grain sorghum		Alfalfa hay	
	N	I	N	I	N	I
	Bu	Bu	Bu	Bu	Ton	Ton
Pratt:						
Pc	26	---	46	90	2.5	5.5
Renfrow:						
Ra	25	---	32	---	2.5	---
Rb	20	---	25	---	2.5	---
[1]Rc	23	---	29	---	2.5	---
Rosehill:						
Rd	28	---	40	---	1.8	---

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		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Albion:					
[1]Aa:					
Albion part	Sandy	Favorable	4,000	Sand bluestem	35

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

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Canadian:					
Waldeck part	Subirrigated	Favorable	9,000	Big bluestem	20
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Maximilian sunflower	5
				Alkali sacaton	5
				Meadow dropseed	5
				Western wheatgrass	5
				Sedge	5
				Wholeleaf rosinweed	5
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
Clark:					
[1]Cd:					
Clark part	Limy Upland	Favorable	5,000	Sand bluestem	30
		Normal	4,000	Big bluestem	20
		Unfavorable	3,000	Side-oats grama	10
				Indiangrass	5
				Switchgrass	5
				Leadplant	5
				Tall dropseed	5
				Western wheatgrass	5
Ost part	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,000	Little bluestem	25
		Unfavorable	2,000	Switchgrass	10
				Indiangrass	10
				Side-oats grama	5
Clime:					
Ce	Limy Upland	Favorable	5,000	Little bluestem	30
		Normal	3,500	Big bluestem	20
		Unfavorable	2,500	Side-oats grama	15
				Indiangrass	5
				Switchgrass	5
				Blue grama	5
				Jersey-tea	5
				Leadplant	5
Elandco:					
Ea, Eb, Ec	Loamy Lowland	Favorable	8,500	Indiangrass	15
		Normal	6,000	Switchgrass	15
		Unfavorable	4,500	Little bluestem	10
				Big bluestem	25
				Eastern gamagrass	5
				Prairie cordgrass	5
				Compassplant	5
				Tall dropseed	5
Farnum:					
Fa, Fb, Fc	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	5,000	Little bluestem	25
		Unfavorable	4,000	Indiangrass	10
				Switchgrass	10
				Side-oats grama	5

See footnote at end of table.

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

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Goessel:					
Ga, Gb	Clay Upland	Favorable	5,500	Big bluestem	30
		Normal	44,500	Little bluestem	15
		Unfavorable	3,000	Switchgrass	10
				Indiangrass	5
				Side-oats grama	5
				Tall dropseed	5
				Western wheatgrass	5
				Canada wildrye	5
				Leadplant	5
				Blue grama	5
Irwin:					
Ia, Ib, Ic	Clay Upland	Favorable	6,000	Big bluestem	25
		Normal	4,200	Little bluestem	20
		Unfavorable	2,000	Indiangrass	15
				Switchgrass	15
				Tall dropseed	5
				Side-oats grama	5
Lesho:					
La	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
				Sedge	5
				Texas bluegrass	5
				Maximilian sunflower	5
Lincoln:					
Lb	Sandy Lowland	Favorable	4,000	Switchgrass	30
		Normal	3,000	Sand bluestem	15
		Unfavorable	2,000	Indiangrass	15
				Little bluestem	5
				Purpletop	5
				Maximilian sunflower	5
				Goldenrod	5
Milan:					
Ma, Mb, Mc	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
Naron:					
Na	Sandy	Favorable	4,000	Sand bluestem	35
		Normal	3,000	Big bluestem	20
		Unfavorable	2,000	Indiangrass	10
				Switchgrass	10
				Leadplant	5
				Sand lovegrass	5

See footnote at end of table.

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

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Owens:					
Oc	Red Clay Prairie	Favorable	3,000	Big bluestem	15
		Normal	2,500	Switchgrass	20
		Unfavorable	1,500	Little bluestem	20
				Compassplant	15
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
[1]Od:					
Owens part	Red Clay Prairie	Favorable	3,000	Big bluestem	15
		Normal	2,500	Switchgrass	20
		Unfavorable	1,500	Little bluestem	15
				Compassplant	15
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5
Rock outcrop part	Not assigned to a range site.				
Plevna:					
Pb	Subirrigated	Favorable	9,000	Big bluestem	20
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Prairie cordgrass	10
				Switchgrass	10
				Eastern gamagrass	10
				Western wheatgrass	5
				Little bluestem	5
				Alkali sacaton	5
				Meadow dropseed	5
				Sedge	5
				Maximilian sunflower	5
				Wholeleaf rosinweed	5
Pratt:					
Pc	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
[1]Pd:					
Pratt part	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
Tivoli part	Sands	Favorable	4,000	Little bluestem	25
		Normal	3,000	Sand bluestem	20
		Unfavorable	2,000	Big sandreed	10
				Switchgrass	10
				Sand lovegrass	5
				Scribner panicum	5
				Sand dropseed	5
				Lespedeza	5

See footnote at end of table.

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

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Renfrow:					
Ra, Rb	Red Clay Prairie	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
				Indiancurrant coralberry	5
[1]Rc:					
Renfrow part	Red Clay Prairie	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
				Indiancurrant coralberry	5
Owens part	Red Clay Prairie	Favorable	3,000	Big bluestem	15
		Normal	2,500	Switchgrass	20
		Unfavorable	1,500	Little bluestem	20
				Compassplant	15
				Indiangrass	5
				Side-oats grama	5
				Maximilian sunflower	5
				Leadplant	5

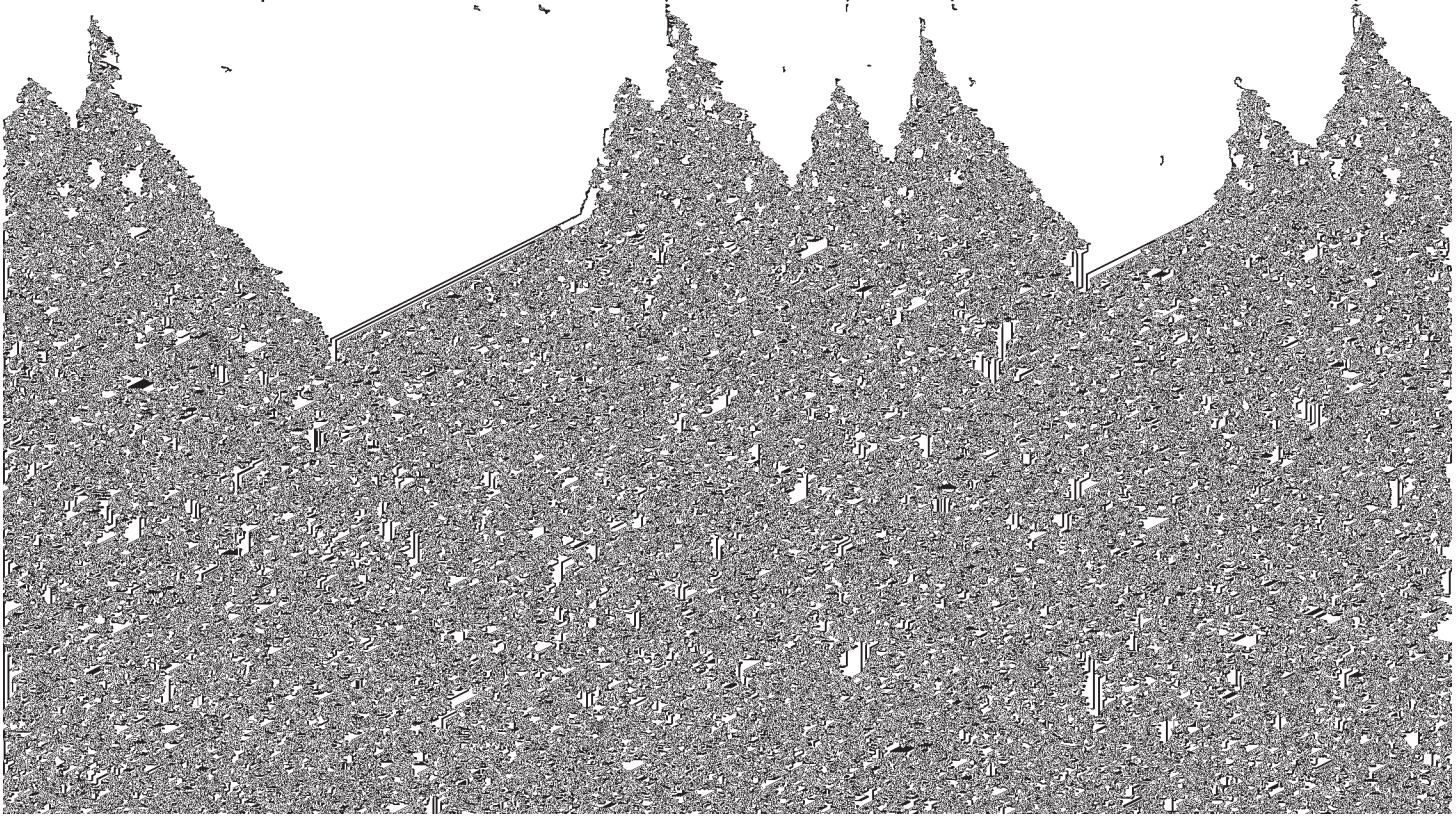


TABLE 6.--RANGE PRODUCTIVITY AND COMPOSITION--Continued

Soil name and map symbol	Range site name	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Tabler:					
Drummond part	Saline Lowland	Favorable	7,000	Prairie cordgrass	30
		Normal	5,800	Switchgrass	10
		Unfavorable	5,000	Indiangrass	10
				Inland saltgrass	10
				Little bluestem	5
				Vine-mesquite	5
				Western wheatgrass	5
				Alkali sacaton	5
				Sunflower	5
				Illinois bundleflower	5
				Sedge	5
Vanoss:					
Va, Vb, Vc, Vd	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
Vernon:					
Ve, Vf	Red Clay Prairie	Favorable	1,750	Side-oats grama	5
		Normal	1,350	Indiangrasss	15
		Unfavorable	900	Big bluestem	10
				Switchgrass	15
				Little bluestem	25
				Leadplant	5
				Sand bluestem	15
				Blue grama	5
Waldeck:					
Wa	Subirrigated	Favorable	9,000	Big bluestem	20
		Normal	8,000	Indiangrass	15
		Unfavorable	7,000	Switchgrass	10
				Eastern gamagrass	10
				Prairie cordgrass	10
				Little bluestem	5
				Maximilian sunflower	5
				Alkali sacaton	5
				Meadow dropseed	5
				Western wheatgrass	5
				Sedge	5
				Wholeleaf rosinweed	
Waurika:					
Wb	Clay Upland	Favorable	3,500	Little bluestem	25
		Normal	2,300	Big bluestem	20
		Unfavorable	1,500	Switchgrass	15
				Indiangrass	10
				Side-oats grama	5
				Blue grama	5
				Buffalograss	5

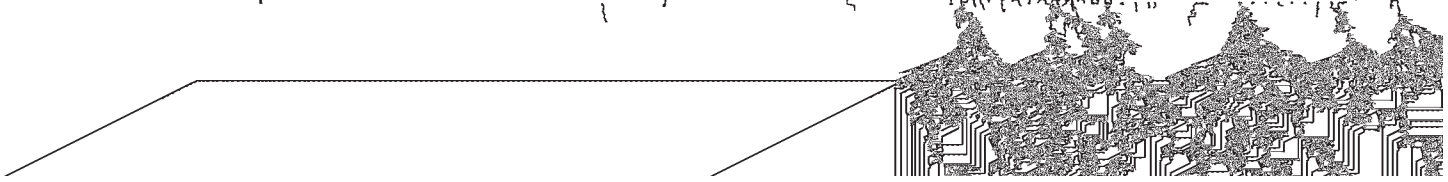


TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[Only soils suited to windbreaks are listed. Absence of an entry means the species does not grow well in

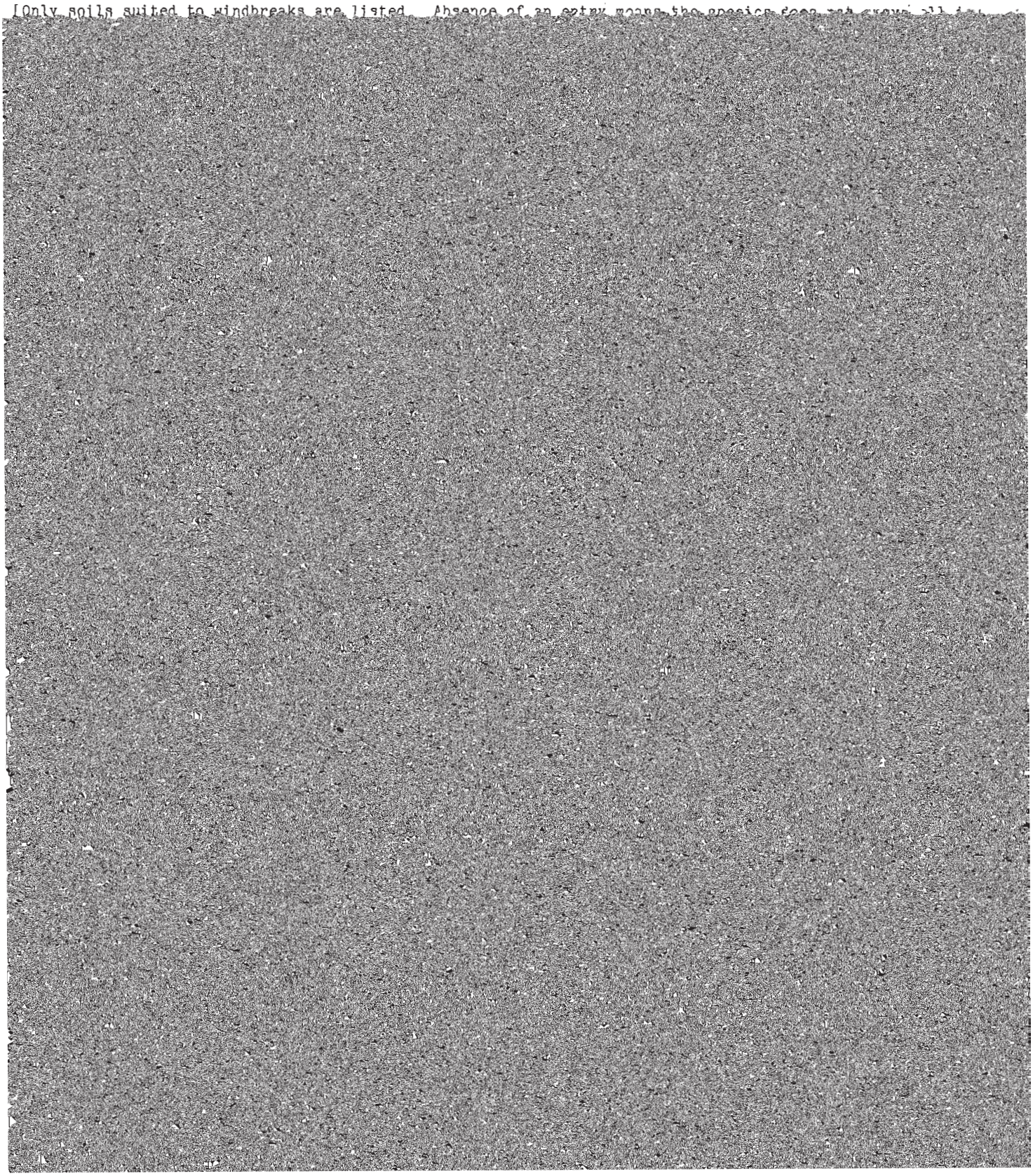


TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Expected heights of specified trees at 20 years of age							
	Eastern cottonwood	Eastern redcedar	Hackberry	Honey-locust	Ponderosa pine	Russian-olive	Siberian elm	Osage-orange
	Ft	Ft	Ft	Ft	Ft	Ft	Ft	Ft
Pratt:								
[1]Pd:								
Pratt part	45	16	18	28	20	15	36	10
Tivoli part	--	18	--	--	20	--	--	--
Renfrow:								
Ra, Rb	--	20	26	24	16	--	23	16
[1]Rc:								
Renfrow part	--	20	26	24	16	--	23	16
Owens part.								
Rosehill:								
Rd	--	17	25	--	16	--	23	15
Shellabarger:								
Sa, Sb, Sc	40	18	27	26	24	--	25	24
Tabler:								
Ta	--	20	--	--	17	--	25	17
[1]Tb:								
Tabler part	--	20	--	--	17	--	25	17

TABLE 8.--BUILDING SITE DEVELOPMENT

["Depth to rock" 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." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Albion:					
[1]Aa:					
Albion part	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Shellabarger part	Slight	Slight	Slight	Slight	Moderate: low strength.
[1]Ab:					
Albion part	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Shellabarger part	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength.
Blanket:					
Ba, Bb	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Canadian:					
Ca	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
[1]Cb:					
Canadian part	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
Waldeck part	Severe: floods, wetness, cutbanks cave.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Severe: floods.
Carwile:					
Cc	Severe: wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: low strength, shrink-swell.
Clark:					
[1]Cd:					
Clark part	Slight	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.
Ost part	Moderate:	Moderate:	Moderate:	Moderate:	Severe:

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
Elandco:					
Eb	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.
Ec	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods, low strength.
Farnum:					
Fa, Fb	Moderate: too clayey.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Severe: low strength.
Fc	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Goessel:					
Ga, Gb	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Irwin:					
Ia, Ib, Ic	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Lesho:					
La	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Moderate: low strength, wetness, shrink-swell.
Lincoln:					
Lb	Severe: floods, cutbanks cave.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.
Milan:					
Ma	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
Mb, Mc	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength, slope.	Severe: low strength.
Naron:					
Na	Slight	Slight	Slight	Slight	Moderate: low strength.
Owens:					
Oc	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
[1]Od:					
Owens part	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Rock outcrop part.					
Pits:					
Pa.					
Plevna:					
Pb	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.

See footnote at end of table.

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
Pratt:					
Pc	Severe: too sandy, cutbanks cave.	Slight	Slight	Moderate: slope.	Slight.
[1]Pd:					
Pratt part	Severe: too sandy, cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Tivoli part	Severe: cutbanks cave, too sandy.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.
Renfrow:					
Ra, Rb	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
[1]Rc:					
Renfrow part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Owens part	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Rosehill:					
Rd	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.
[1]Tb:					
Tabler part	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Drummond part	Severe: too clayey, wetness.	Severe: floods, shrink-swell, low strength.	Severe: wetness, floods, shrink-swell.	Severe: floods, shrink-swell, low strength.	Severe: low strength, shrink-swell.
Urban land:					
[1]Ua:					
Urban land part.					
Canadian part	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Moderate: floods, low strength.
[1]Ub:					
Urban land part.					
Elandco part	Moderate: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Severe: low strength.

See footnote at end of table.

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
Urban land: [1]Uc: Urban land part.					
Farnum part----	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.
[1]Ud: Urban land part.					
Irwin part-----	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
[1]Ue: Urban land part.					
Tabler part----	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.
Vanoss: Va, Vb, Vc, Vd---	Moderate: too clayey.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength, shrink-swell.
Vernon: Ve, Vf----------	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
Waldeck: Wa----------	Severe: floods, wetness, cutbanks cave.	Severe: floods.	Severe: floods, wetness.	Severe: floods.	Severe: floods.
Waurika: Wb----------	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

["Depth to rock" and some of the other terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Albion:					
[1]Aa:					
Albion part	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: thin layer, too sandy.
Shellabarger part	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
[1]Ab:					
Albion part	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: thin layer, slope, too sandy.
Shellabarger part	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: slope.
Blanket:					
Ba	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Bb	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Canadian:					
Ca	Moderate: floods.	Severe: seepage, floods.	Severe: seepage.	Severe: seepage.	Good.
[1]Cb:					
Canadian part	Moderate: floods.	Severe: seepage, floods.	Severe: seepage.	Severe: seepage.	Good.
Waldeck part	Severe: floods, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Good.
Carwile:					
Cc	Severe: percs slowly, wetness, floods.	Severe: wetness, floods.	Severe: floods, too clayey.	Severe: wetness, floods.	Poor: thin layer.
Clark:					
[1]Cd:					
Clark part	Moderate: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Good.
Ost part	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Clime:					
Ce	Severe: percs slowly, depth to rock.	Severe: depth to rock.	Severe: too clayey, depth to rock.	Slight	Poor: too clayey.
Elandco:					
Ea	Moderate: percs slowly.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Fair: too clayey.

See footnote at end of table.

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
Elandco:					
Eb	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Ec	Severe: floods.	Severe: floods.	Severe: floods.	Severe: floods.	Fair: too clayey.
Farnum:					
Fa	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Fair: too clayey.
Fb	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Fc	Severe: percs slowly.	Severe: seepage.	Severe: wetness, seepage.	Slight	Fair: thin layer.
Goessel:					
Ga, Gb	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
Irwin:					
Ia, Ib, Ic	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Lesho:					
La	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Fair: thin layer, area reclaim.
Lincoln:					
Lb	Severe: floods.	Severe: seepage, floods.	Severe: floods, seepage.	Severe: floods, seepage.	Fair: too sandy.
Milan:					
Ma, Mb, Mc	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Naron:					
Na	Slight	Moderate: seepage.	Moderate: seepage.	Moderate: seepage.	Good.
Owens:					
Oc	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, area reclaim.
[1]Od:					
Owens part	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, area reclaim.
Rock outcrop part.					
Pits:					
Pa.					
Plevna:					
Pb	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Pratt:					
Pc	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: too sandy.

See footnote at end of table.

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
Pratt:					
[1]Pd:					
Pratt part	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: too sandy, slope.
Tivoli part	Moderate: slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: thin layer, too sandy.
Renfrow:					
Ra, Rb	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: thin layer.
[1]Rc:					
Renfrow part	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: thin layer.
Owens part	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, area reclaim.
Rosehill:					
Rd	Severe: percs slowly, depth to rock.	Severe: depth to rock.	Severe: too clayey.	Slight	Poor: too clayey.
Shellabarger:					
Sa, Sb, Sc	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Tabler:					
Ta	Severe: percs slowly, wetness.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: hard to pack, too clayey.
[1]Tb:					
Tabler part	Severe: percs slowly, wetness.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: hard to pack, too clayey.
Drummond part	Severe: percs slowly, wetness.	Severe: wetness.	Severe: too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
Urban land:					
[1]Ua:					
Urban land part.					
Canadian part	Moderate: floods.	Severe: seepage, floods.	Severe: seepage.	Severe: seepage.	Good.
[1]Ub:					
Urban land part.					
Elandco part	Moderate: percs slowly.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Fair: too clayey.
[1]Uc:					
Urban land part.					
Farnum part	Severe: percs slowly.	Severe: seepage.	Severe: wetness, seepage.	Slight	Fair: thin layer.

See footnote at end of table.

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
Urban land:					
[1]Ud:					
Urban land part.					
Irwin part	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
[1]Ue:					
Urban land part.					
Tabler part	Severe: percs slowly, wetness.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: hard to pack, too clayey.
Vanoss:					
Va, Vb, Vc, Vd	Slight	Moderate: seepage.	Moderate: too clayey.	Slight	Fair: too clayey.
Vernon:					
Ve, Vf	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
Waldeck:					
Wa	Severe: floods, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Good.
Waurika:					
Wb	Severe: percs slowly, wetness.	Slight	Severe: too clayey.	Severe: wetness.	Poor: thin layer.

[illegible] See map unit description for the [illegible]

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." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Albion:				
[1]Aa:				
Albion part	Good	Fair: excess fines.	Fair: excess fines.	Good.
Shellabarger part	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
[1]Ab:				
Albion part	Good	Fair: excess fines.	Fair: excess fines.	Fair: slope.
Shellabarger part	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Blanket:				
Ba, Bb	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Canadian:				
Ca	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
[1]Cb:				
Canadian part	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Waldeck part	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Good.
Carwile:				
Cc	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
Clark:				
[1]Cd:				
Clark part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Ost part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Clime:				
Ce	Poor: low strength, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.
Elandco:				
Ea, Eb, Ec	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Farnum:				
Fa, Fb	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
Fc	Poor: low strength.	Fair: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Goessel:				
Ga, Gb	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

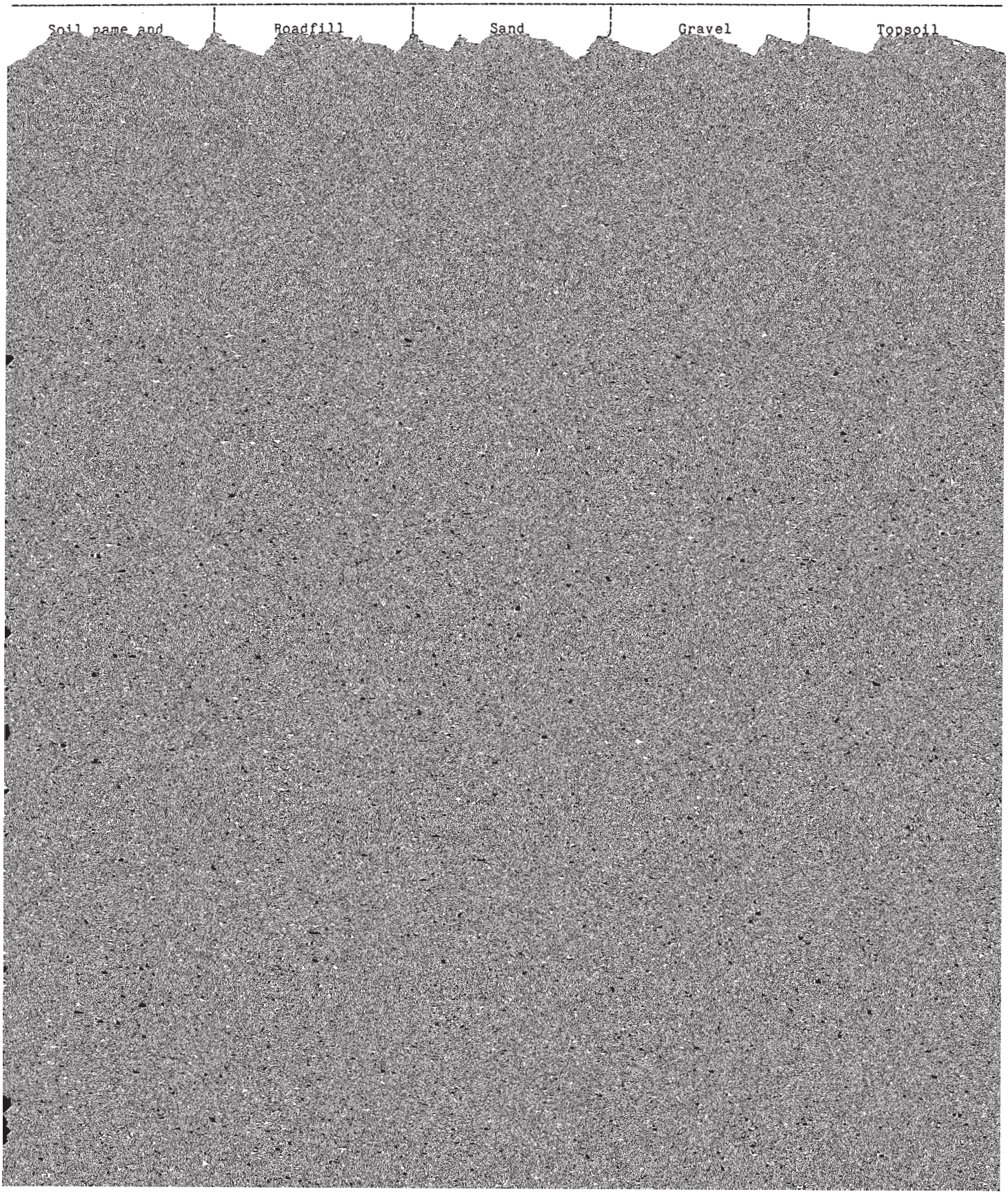


TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Shellabarger:				
Sa, Sb, Sc	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Tabler:				
Ta	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
[1]Tb:				
Tabler part	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Drummond part	Poor: low strength, shrink-swell, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim.
Urban land:				
[1]Ua:				
Urban land part.				
Canadian part	Fair: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Good.
[1]Ub:				
Urban land part.				
Elandco part	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: clayey.
[1]Uc:				
Urban land part.				
Farnum part	Poor: low strength.	Fair: excess fines.	Unsuited: excess fines.	Fair: thin layer.
[1]Ud:				
Urban land part.				
Irwin part	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
[1]Ue:				
Urban land part.				
Tabler part	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Vanoss:				
Va, Vb, Vc, Vd	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Vernon:				
Ve	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Vf	Poor: shrink-swell, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
Waldeck:				
Wa	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Good.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Waurika: Wb	Poor: low strength	Unsuited: excess fines	Unsuited: excess fines	Fair: thin layer

TABLE 11.--WATER MANAGEMENT

["Seepage" and some of the other terms that describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Albion:						
[1]Aa:						
Albion part	Seepage	Seepage	Not needed	Soil blowing	Too sandy, soil blowing.	Droughty, rooting depth.
Shellabarger part	Seepage	Low strength, piping.	Not needed	Soil blowing	Too sandy, soil blowing.	Favorable.
[1]Ab:						
Albion part	Seepage	Seepage	Not needed	Soil blowing, slope.	Too sandy, soil blowing.	Droughty, rooting depth.
Shellabarger part	Seepage	Low strength, piping.	Not needed	Soil blowing, slope.	Too sandy, soil blowing.	Favorable.
Blanket:						
Ba, Bb	Seepage	Piping	Not needed	Favorable	Favorable	Favorable.
Canadian:						
Ca	Seepage	Favorable	Not needed	Soil blowing	Not needed	Erodes easily.
[1]Cb:						
Canadian part	Seepage	Favorable	Not needed	Soil blowing	Not needed	Erodes easily.
Waldeck part	Seepage	Seepage	Floods	Floods,	Not needed	Favorable.

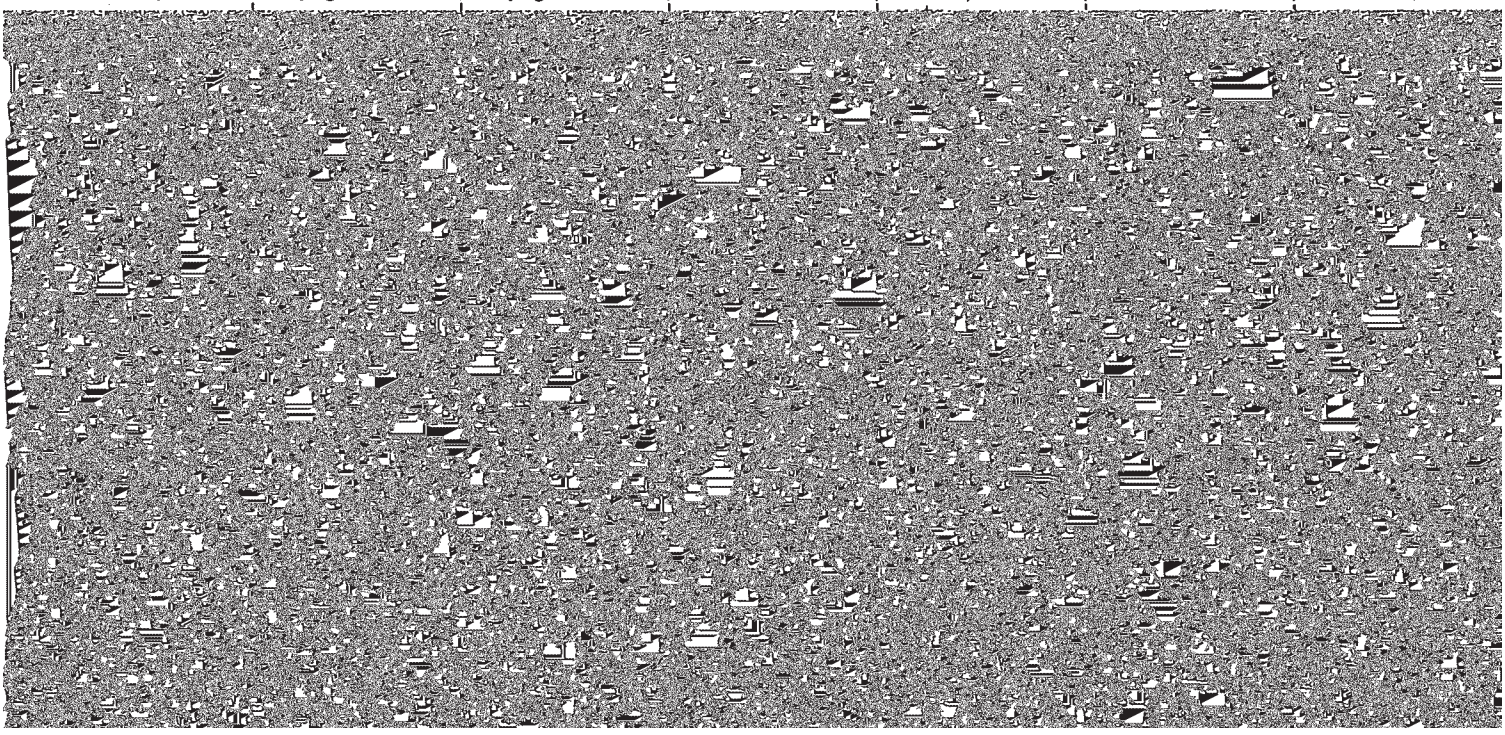


TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Farnum:						
Fb	Favorable	Favorable	Not needed	Favorable	Favorable	Favorable.
Fc	Seepage	Favorable	Not needed	Favorable	Not needed	Favorable.
Goessel:						
Ga, Gb	Favorable	Hard to pack	Percs slowly	Slow intake	Not needed	Percs slowly.
Irwin:						
Ia, Ib, Ic	Depth to rock	Hark to pack	Favorable	Slow intake erodes easily.	Percs slowly	Favorable.
Lesho:						
La	Favorable	Seepage	Floods	Floods	Not needed	Favorable.
Lincoln:						
Lb	Seepage	Seepage	Floods	Seepage, fast intake.	Not needed	Favorable.
Milan:						
Ma, Mb, Mc	Favorable	Favorable	Not needed	Slow intake, slope.	Favorable	Favorable.
Naron:						
Na	Seepage	Piping	Not needed	Soil blowing	Not needed	Erodes easily.
Owens:						
Oc	Favorable	Hark to pack	Not needed	Droughty, percs slowly.	Rooting depth, percs slowly.	Droughty, erodes easily.
[1]Od:						
Owens part	Favorable	Hard to pack	Not needed	Droughty, percs slowly	Percs slowly, rooting depth	Droughty, erodes easily

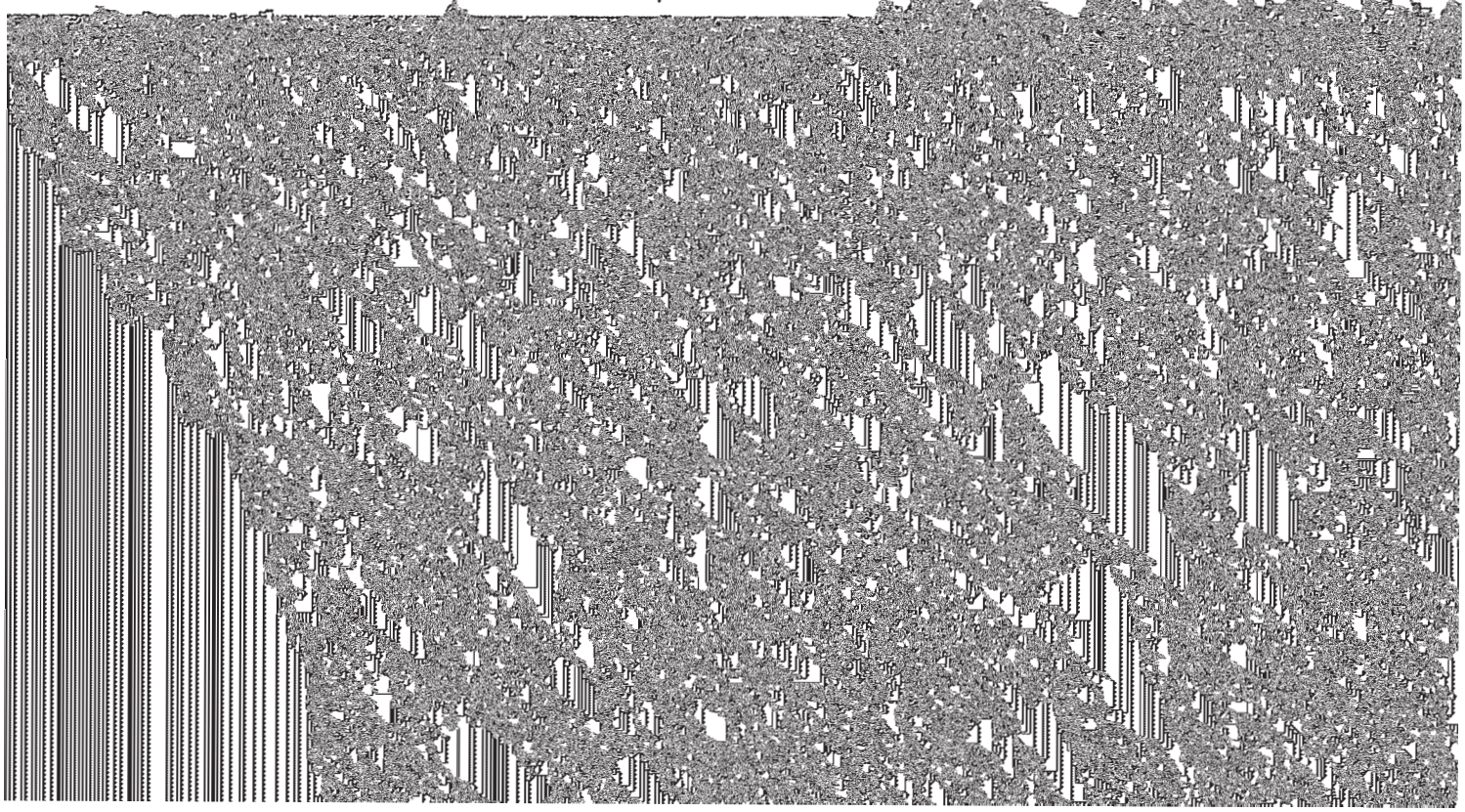


TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Rosehill: Rd	Depth to rock	Thin layer, hard to pack.	Not needed	Slow intake, rooting depth.	Depth to rock	Rooting depth.
Shellabarger: Sa, Sb, Sc	Seepage	Piping	Not needed	Soil blowing	Soil blowing	Favorable.
Tabler: Ta	Favorable	Hard to pack	Percs slowly	Slow intake, percs slowly.	Not needed	Percs slowly.
[1]Tb: Tabler part	Favorable	Hard to pack	Percs slowly	Slow intake, percs slowly.	Not needed	Percs slowly.
Drummond part	Favorable	Piping, hard to pack.	Percs slowly, floods.	Slow intake, excess sodium.	Not needed	Droughty, erodes easily, excess salt.
Urban land: [1]Ua: Urban land part.						
Canadian part	Seepage	Favorable	Not needed	Fast intake, soil blowing.	Not needed	Favorable.
[1]Ub: Urban land part.						
Elandco part	Seepage	Piping	Not needed	Favorable	Not needed	Favorable.
[1]Uc: Urban land part.						
Farnum part	Seepage	Favorable	Not needed	Slow intake	Favorable	Favorable.
[1]Ud: Urban land part.						
Irwin part	Depth to rock	Hard to pack	Favorable	Slow intake, erodes easily.	Percs slowly	Favorable.
[1]Ue: Urban land part.						
Tabler part	Favorable	Hard to pack	Percs slowly	Slow intake, percs slowly.	Not needed	Percs slowly.
Vanoss: Va, Vb, Vc, Vd	Seepage	Piping	Not needed	Favorable	Favorable	Favorable.
Vernon: Ve, Vf	Favorable	Hard to pack	Not needed	Droughty, percs slowly.	Percs slowly	Droughty, percs slowly.
Waldeck: Wa	Seepage	Seepage	Floods	Floods, wetness.	Not needed	Favorable.
Waurika: Wb	Favorable	Hard to pack, wetness.	Percs slowly	Wetness, slow intake, percs slowly.	Not needed	Wetness, percs slowly.

[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." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Albion:				
[1]Aa:				
Albion part	Slight	Slight	Moderate: slope.	Slight.
Shellabarger part	Slight	Slight	Moderate: slope.	Slight.
[1]Ab:				
Albion part	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Shellabarger part	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Blanket:				
Ba	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Bb	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight.
Canadian:				
Ca	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
[1]Cb:				
Canadian part	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
Waldeck part	Severe: floods.	Moderate: wetness.	Moderate: floods, wetness.	Slight.
Carwile:				
Cc	Severe: wetness, floods.	Severe: wetness.	Severe: wetness.	Severe: wetness.
Clark:				
[1]Cd:				
Clark part	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope.	Moderate: too clayey.
Ost part	Moderate: too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey, percs slowly, slope.	Moderate: too clayey.
Clime:				
Ce	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
Elandco:				
Ea	Moderate: floods.	Moderate: dusty.	Moderate: dusty, too clayey.	Slight.
Eb	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
Ec	Severe: floods.	Moderate: floods.	Severe: floods.	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Farnum:				
Fa	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Fb	Moderate: percs slowly.	Slight	Moderate: percs slowly, slope.	Slight.
Fc	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Goessel:				
Ga, Gb	Severe:	Severe:	Severe:	Severe:

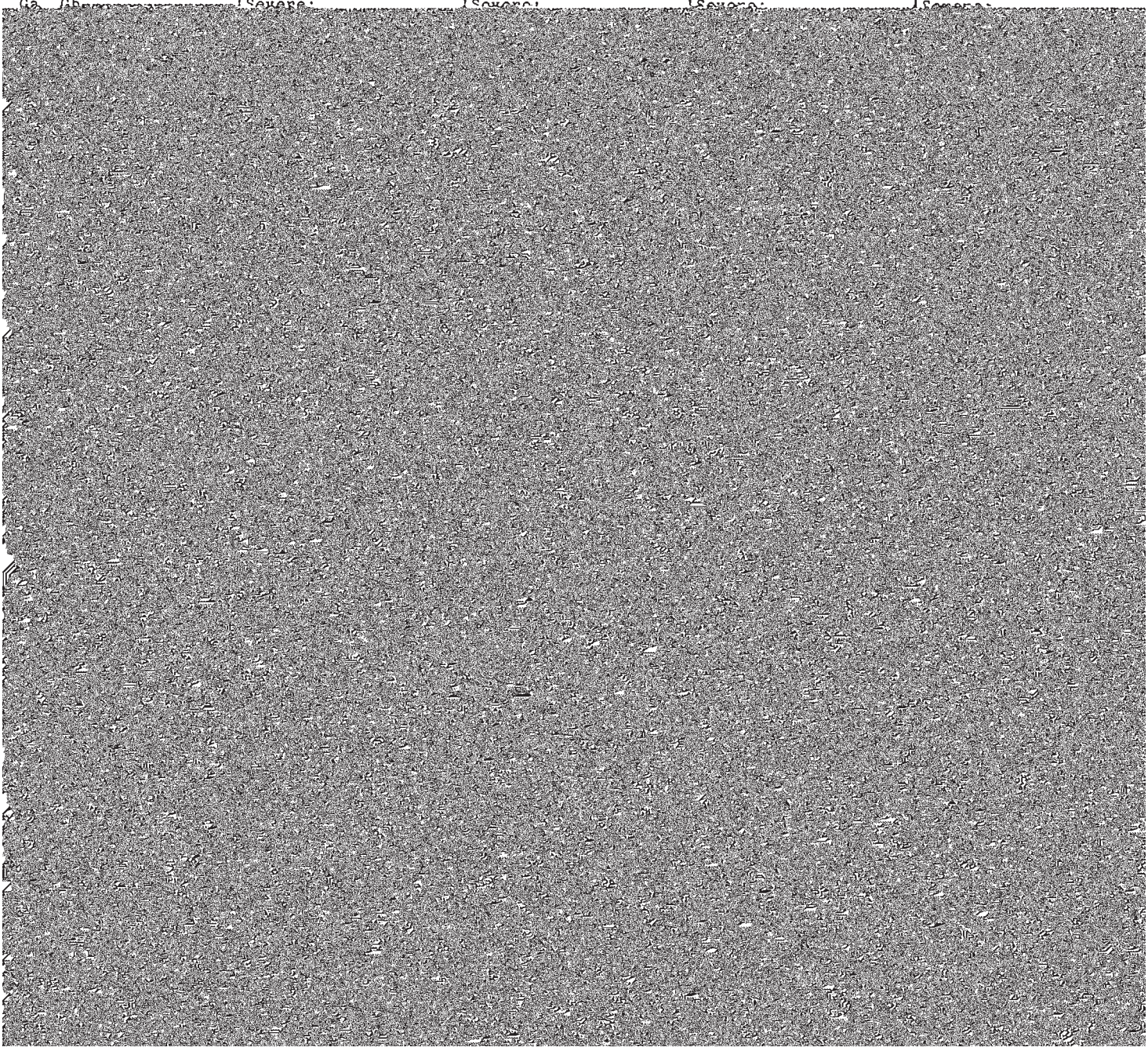


TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Renfrow:				
Ra, Rb	Severe: percs slowly, too clayey.	Moderate: too clayey.	Severe: percs slowly, slope.	Moderate: too clayey.
[1]Rc:				
Renfrow part	Severe: percs slowly, too clayey.	Moderate: too clayey.	Severe: percs slowly, slope.	Moderate: too clayey.
Owens part	Severe: too clayey, percs slowly.	Severe: too clayey.	Severe: too clayey, percs slowly.	Severe: too clayey.
Rosehill:				
Rd	Severe: percs slowly, too clayey.	Severe: too clayey.	Severe: percs slowly, too clayey.	Severe: 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.
[1]Tb:				
Tabler part	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Drummond part	Severe: percs slowly.	Moderate: wetness.	Severe: percs slowly.	Moderate: wetness.
Urban land:				
[1]Ua:				
Urban land part.				
Canadian part	Severe: floods.	Moderate: floods.	Moderate: floods.	Slight.
[1]Ub:				
Urban land part.				
Elandco part	Moderate: floods.	Moderate: dusty.	Moderate: dusty, too clayey.	Slight.
[1]Uc:				
Urban land part.				
Farnum part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
[1]Ud:				
Urban land part.				
Irwin part	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
[1]Ue:				
Urban land part.				
Tabler part	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.
Vanoss:				
Va	Slight	Slight	Slight	Slight.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Vanoss: Vb, Vc, Vd	Slight	Slight	Moderate: slope.	Slight.
Vernon: Ve	Severe: percs slowly.	Slight	Severe: percs slowly, too clayey.	Slight.
Vf	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly, too clayey.	Moderate: too clayey.
Waldeck: Wa	Severe: floods.	Moderate: wetness.	Moderate: floods, wetness.	Slight.
Waurika: Wb	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." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Albion:										
[1]Aa:										
Albion part	Fair	Good	Fair	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Shellabarger part	Good	Good	Good	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
[1]Ab:										
Albion part	Poor	Fair	Fair	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Shellabarger part	Poor	Fair	Good	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Blanket:										
Ba, Bb	Good	Good	Fair	Good	Good	Poor	Very poor.	Good	Very poor.	Fair.
Canadian:										
Ca	Good	Good	Good	---	Good	Poor	Very poor.	Good	Very poor.	Good.
[1]Cb:										
Canadian part	Good	Good	Good	---	Good	Poor	Very poor.	Good	Very poor.	Good.
Waldeck part	Fair	Good	Good	---	Good	Fair	Fair	Good	Fair	Good.
Carwile:										
Cc	Fair	Good	Good	---	Good	Good	Fair	Good	Fair	Good.
Clark:										
[1]Cd:										
Clark part	Fair	Good	Fair	---	Poor	Poor	Very poor.	Fair	Very poor.	Poor.
Ost part	Good	Good	Fair	---	Fair	Poor	Poor	Good	Poor	Fair.
Clime:										
Ce	Fair	Fair	Fair	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Elandco:										
Ea	Good	Good	Fair	---	Good	Poor	Very poor.	Good	Very poor.	Fair.
Eb	Good	Good	Fair	---	Good	Poor	Very poor.	Good	Very poor.	Fair.
Ec	Very poor	Poor	Fair	---	Good	Poor	Very poor.	Poor	Very poor.	Fair.
Farnum:										
Fa, Fb, Fc	Good	Good	Good	---	Fair	Fair	Poor	Good	Poor	Fair.
Goessel:										
Ga, Gb	Fair	Fair	Fair	---	Fair	Poor	Fair	Fair	Poor	Fair.

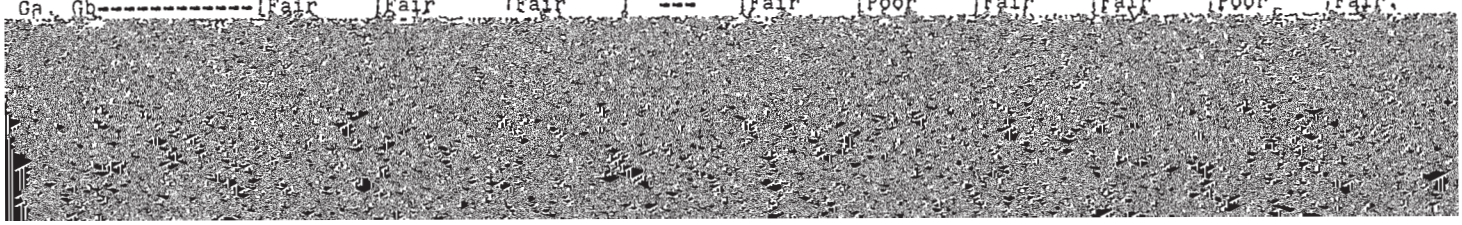


TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Lincoln:										
Lb	Poor	Fair	Fair	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Milan:										
Ma	Good	Good	Good	---	Fair	Fair	Poor	Good	Poor	Fair.
Mb, Mc	Fair	Good	Good	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Naron:										
Na	Good	Good	Good	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Owens:										
Oc	Fair	Fair	Fair	---	Poor	Very poor.	Very poor.	Fair	Very poor.	Poor.
[1]Od:										
Owens part	Poor	Fair	Fair	---	Poor	Very poor.	Very poor.	Fair	Very poor.	Poor.
Rock outcrop part										
Pits:										
Pa.										
Plevna:										
Pb	Poor	Fair	Fair	---	Fair	Good	Good	Fair	Good	Fair.
Pratt:										
Pc	Fair	Good	Fair	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
[1]Pd:										
Pratt part	Fair	Good	Fair	---	Fair	Very poor.	Very poor.	Fair	Very poor.	Fair.
Tivoli part	Poor	Poor	Fair	---	Poor	Very poor.	Very poor.	Poor	Very poor.	Poor.
Renfrow:										
Ra, Rb	Good	Good	Fair	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
[1]Rc:										
Renfrow part	Good	Good	Fair	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Owens part	Fair	Fair	Fair	---	Poor	Very poor.	Very poor.	Fair	Very poor.	Poor.
Rosehill:										
Rd	Fair	Good	Fair	---	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
Shellabarger:										
Sa	Good	Good	Good	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Sb, Sc	Fair	Good	Good	---	Fair	Poor	Very poor.	Good	Very poor.	Fair.
Tabler:										
Ta	Good	Good	Fair	---	Fair	Poor	Poor	Good	Poor	Fair.
[1]Tb:										
Tabler part	Good	Good	Fair	---	Fair	Poor	Poor	Good	Poor	Fair.
Drummond part	Poor	Fair	Fair	Poor	Poor	Fair	Fair	Fair	Fair	Poor.

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	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Wetland wildlife	Rangeland wildlife
Urban land:										
[1]Ua:										
Urban land part.										
Canadian part----	Good	Good	Good	---	Good	Poor	Very poor.	Good	Very poor.	Good.
[1]Ub:										
Urban land part.										
Elandco part-----	Good	Good	Fair	---	Good	Poor	Very poor.	Good	Very poor.	Fair.
[1]Uc:										
Urban land part.										
Farnum part.										
[1]Ud:										
Urban land part.										
Irwin part-------	Good	Good	Good	---	Fair	Poor	Poor	Good	Poor	Fair.
[1]Ue:										
Urban land part.										
Tabler part------	Good	Good	Fair	---	Fair	Poor	Poor	Good	Poor	Fair.
Vanoss:										
Va, Vb, Vc, Vd----	Good	Good	Good	---	Good	Poor	Very poor.	Good	Very poor.	Good.
Vernon:										
Ve.										
Vf----------	Fair	Fair	Fair	---	Fair	Poor	Very poor.	Fair	Very poor.	Fair.
Waldeck:										
Wa----------	Fair	Good	Good	---	Good	Fair	Fair	Good	Fair	Good.
Waurika:										
Wb----------	Fair	Good	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 identities and proportion of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Albion:											
[1]Aa:											
Albion part-----	0-9	Sandy loam------	SM, ML	A-2, A-4	0	100	70-100	60-90	25-55	<30	[2]NP-5
	9-19	Sandy loam, loam	SM, ML, GM, GC	A-2, A-4	0	50-100	45-100	45-90	30-55	20-35	NP-10
	19-26	Coarse sandy loam, loamy sand.	SM, GM	A-2, A-1	0	50-100	45-90	40-70	15-30	<30	NP-5
	26-60	Loamy sand, gravelly sandy loam, gravelly sand.	SP-SM, GP-GM, SM, GM	A-2, A-1, A-3	0-5	40-100	40-90	30-70	5-30	<30	NP-5
Shellabarger part----------	0-15	Sandy loam------	SM, ML	A-4, A-2	0	95-100	95-100	75-100	30-55	<30	NP-5
	15-40	Sandy clay loam, sandy loam, fine sandy loam.	SC, CL	A-4, A-6	0	95-100	95-100	70-90	36-55	25-40	8-20
	40-60	Coarse sandy loam, fine sandy loam, sand.	SC, SM	A-2, A-4	0	70-100	70-100	50-80	10-40	<30	NP-10
[1]Ab:											
Albion part-----	0-9	Sandy loam------	SM, ML	A-2, A-4	0	100	70-100	60-90	25-55	<30	NP-5
	9-19	Sandy loam, loam	SM, ML, GM, GC	A-2, A-4	0	50-100	45-100	45-90	30-55	20-35	NP-10
	19-26	Coarse sandy loam, loamy sand.	SM, GM	A-2, A-1	0	50-100	45-90	40-70	15-30	<30	NP-5
	26-60	Loamy sand, gravelly sandy loam, gravelly sand.	SP-SM, GP-GM, SM, GM	A-2, A-1, A-3	0-5	40-100	40-90	30-70	5-30	<30	NP-5
Shellabarger part----------	0-15	Sandy loam------	SM, ML	A-4, A-2	0	95-100	95-100	75-100	30-55	<30	NP-5
	15-40	Sandy clay loam, sandy loam, fine sandy loam.	SC, CL	A-4, A-6	0	95-100	95-100	70-90	35-55	25-40	8-20
	40-60	Coarse sandy loam, fine sandy loam, sand.	SC, SM	A-2, A-4	0	70-100	70-100	50-80	10-40	<30	NP-10
Blanket:											
Ba, Bb----------	0-14	Silt loam-------	CL	A-6	0	95-100	95-100	90-100	60-80	28-40	12-24
	14-34	Clay loam, clay, silty clay.	CL, CH	A-7	0	95-100	95-100	85-100	70-90	41-55	20-35
	34-60	Clay loam, clay, silty clay loam.	CL	A-6, A-7	0	85-100	80-100	70-90	51-85	30-45	15-30
Canadian:											
Ca----------	0-20	Fine sandy loam	SM, ML, SC, CL	A-4	0	100	98-100	94-100	36-85	<31	NP-10
	20-60	Fine sandy loam, loam, sandy loam.	SM, ML, SC, CL	A-4, A-2	0	100	98-100	90-100	15-85	<31	NP-10
[1]Cb:											
Canadian part---	0-20	Fine sandy loam	SM, ML, SC, CL	A-4	0	100	98-100	94-100	36-85	<31	NP-10
	20-60	Fine sandy loam, loam, sandy loam.	SM, ML, SC, CL	A-4, A-2	0	100	98-100	90-100	15-85	<31	NP-10

See footnotes at end of table.

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

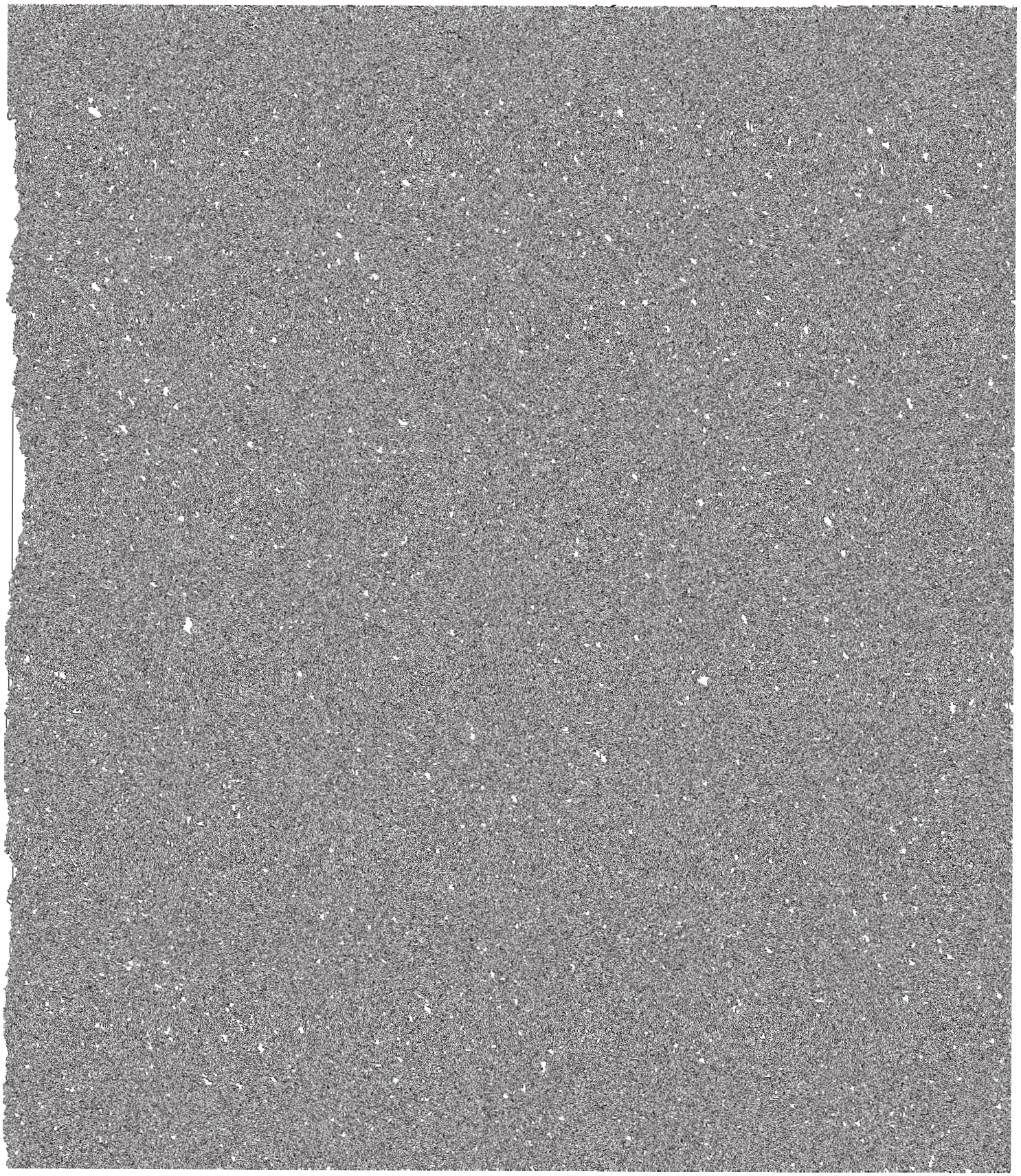


TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

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	
Irwin:											
Ia, Ib, Ic	0-13	Silty clay loam	CL	A-6	0	100	100	95-100	90-100	30-40	11-20
	13-52	Silty clay, clay	CH	A-7-6	0	100	100	95-100	90-100	50-65	25-40
	52-60	Silty clay, clay, silty clay loam.	CH, CL	A-7-6	0	100	100	95-100	90-100	40-60	20-40
Lesho:											
La	0-27	Loam	CL	A-6, A-4, A-7-6	0	100	100	95-100	65-85	30-45	8-20
	27-60	Loamy fine sand, sand, coarse sand.	SM, SP-SM	A-2, A-3, A-4, A-1	0	100	100	30-85	8-35	---	NP
Lincoln:											
Lb	0-8	Loamy fine sand	SM, SM-SP	A-2, A-3	0	90-100	85-100	75-100	8-35	---	NP
	8-60	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	0-11	Loam	CL-ML, CL	A-4, A-6	0	95-100	95-100	95-100	65-85	20-30	5-15
	11-60	Clay loam, sandy	SC, CL	A-6	0	95-100	95-100	65-100	45-80	25-55	15-30

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

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Pratt:											
Pc	0-18	Loamy fine sand	SM	A-2	0	100	95-100	70-100	15-35	---	NP
	18-36	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	36-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
[1]Pd:											
Pratt part	0-18	Loamy fine sand	SM	A-2	0	100	95-100	70-100	15-35	---	NP
	18-36	Loamy fine sand, loamy sand, fine sandy loam.	SM, SM-SC	A-2, A-4	0	100	95-100	90-100	15-40	<20	NP-6
	36-60	Loamy fine sand, fine sand.	SM, SP-SM	A-2, A-3	0	100	95-100	80-100	5-35	---	NP
Tivoli part	0-10	Loamy fine sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-100	5-35	---	NP
	10-60	Fine sand, sand	SM, SP-SM	A-2, A-3	0	100	98-100	80-98	5-20	---	NP
Renfrow:											
Ra, Rb	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	96-100	80-98	33-49	12-26
	9-13	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	37-49	15-26
	13-60	Clay, silty clay, silty clay loam.	ML, CL, CH, MH	A-6, A-7	0	100	100	96-100	80-99	37-70	15-38
[1]Rc:											
Renfrow part	0-9	Clay loam	CL	A-6, A-7	0	100	100	96-100	80-98	33-49	12-26
	9-13	Clay loam, silty clay loam.	CL	A-6, A-7	0	100	100	96-100	80-98	37-49	15-26
	13-60	Clay, silty clay, silty clay loam.	ML, CL, CH, MH	A-6, A-7	0	100	100	96-100	80-99	37-70	15-38
Owens part	0-7	Clay loam	CL, CH	A-7-6	0-5	95-100	95-100	85-100	75-95	45-60	22-32
	7-15	Clay, clay loam	CL, CH	A-7-6	0-5	95-100	90-100	85-100	75-95	45-60	22-32
	15-20	Shaly clay	CL, CH	A-6, A-7-6	0-5	90-100	85-100	80-100	55-95	40-55	25-35
Rosehill:											
Rd	0-8	Silty clay	CH, CL	A-7	0	100	100	95-100	90-100	45-70	30-50
	8-30	Silty clay, clay	CH, CL	A-7	0	100	100	95-100	90-100	45-70	30-50
	30	Unweathered bedrock.									
Shellabarger:											
Sa, Sb, Sc	0-15	Sandy loam	SM, ML	A-4, A-2	0	95-100	95-100	75-100	30-55	<30	NP-5
	15-40	Sandy clay loam, sandy loam, fine sandy loam.	SC, CL	A-4, A-6	0	95-100	95-100	70-90	35-55	25-40	8-20
	40-60	Coarse sandy loam, fine sandy loam, sand.	SC, SM	A-2, A-4	0	70-100	70-100	50-80	10-40	<30	NP-10
Tabler:											
Ta	0-9	Silty clay loam	CL, ML, CL-ML	A-4, A-6	0	100	100	96-100	80-98	20-40	3-18
	9-32	Silty clay, clay	CL, CH	A-7	0	100	100	96-100	90-99	41-65	18-35
	32-60	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

See footnotes at end of table.

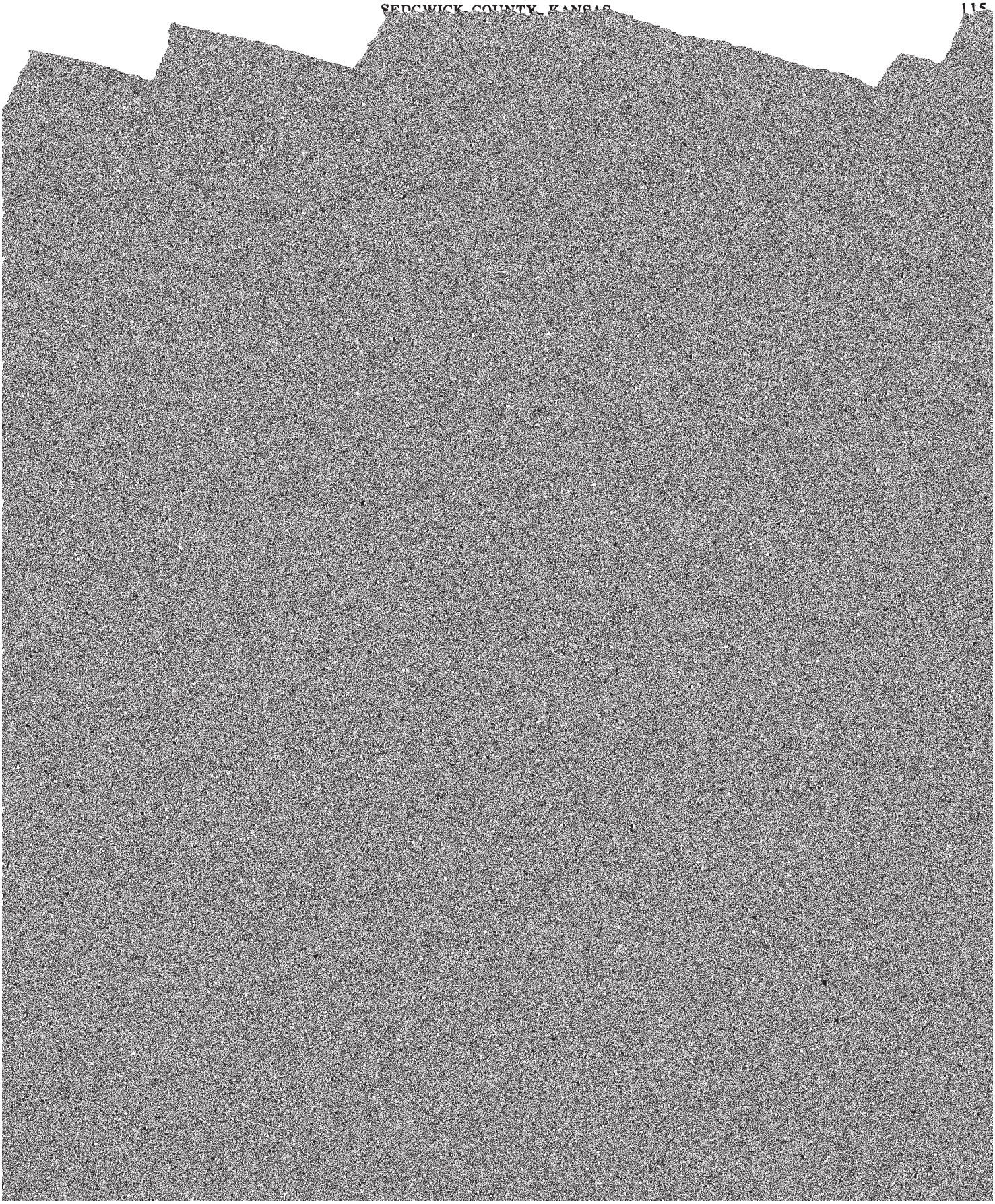


TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Vanoss: Va, Vb, Vc, Vd----	0-13	Silt loam--------	ML, CL	A-4, A-6	0	100	100	96-100	65-95	22-37	2-14
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater then. The erosion tolerance factor (T) is for the entire profile. Absence of an entry means data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	In/hr	In/in	pH						
Albion:										
[1]Aa:										
Albion part	0-9	2.0-6.0	0.13-0.20	5.6-6.5	Low	Low	Low	0.20	3	3
	9-19	2.0-6.0	0.12-0.18	6.1-8.4	Low	Low	Moderate	0.20		
	19-26	2.0-6.0	0.09-0.12	6.1-8.4	Low	Low	Low	0.20		
	26-60	6.0-20	0.03-0.10	6.1-8.4	Low	Low	Low	0.15		
Shellabarger part	0-15	0.6-2.0	0.13-0.21	5.6-6.5	Low	Low	Moderate	0.20	5	3
	15-40	0.6-2.0	0.16-0.18	6.1-7.3	Low	Low	Moderate	0.28		
	40-60	0.6-20	0.05-0.16	6.1-8.4	Low	Low	Low	0.28		
[1]Ab:										
Albion part	0-9	2.0-6.0	0.13-0.20	5.6-6.5	Low	Low	Low	0.20	3	3
	9-19	2.0-6.0	0.12-0.18	6.1-8.4	Low	Low	Moderate	0.20		
	19-26	2.0-6.0	0.09-0.12	6.1-8.4	Low	Low	Low	0.20		
	26-60	6.0-20	0.03-0.10	6.1-8.4	Low	Low	Low	0.15		
Shellabarger part	0-15	0.6-2.0	0.13-0.21	5.6-6.5	Low	Low	Moderate	0.20	5	3
	15-40	0.6-2.0	0.16-0.18	6.1-7.3	Low	Low	Moderate	0.28		
	40-60	0.6-20	0.05-0.16	6.1-8.4	Low	Low	Low	0.28		
Blanket:										
Ba, Bb	0-14	0.6-2.0	0.15-0.20	6.1-7.8	Moderate	High	Low	0.32	5	5
	14-34	0.2-0.6	0.12-0.18	6.1-8.4	Moderate	High	Low	0.37		
	34-60	0.6-2.0	0.12-0.18	7.9-8.4	Moderate	High	Low	0.43		
Canadian:										
Ca	0-20	2.0-6.0	0.11-0.20	5.6-8.4	Low	Low	Low	0.20	5	3
	20-60	2.0-20	0.07-0.20	6.1-8.4	Low	Low	Low	0.20		
[1]Cb:										
Canadian part	0-20	2.0-6.0	0.11-0.20	5.6-8.4	Low	Low	Low	0.20	5	3
	20-60	2.0-20	0.07-0.20	6.1-8.4	Low	Low	Low	0.20		
Waldeck part	0-14	2.0-6.0	0.14-0.18	7.4-8.4	Low	Moderate	Low	0.20	5	3
	14-27	2.0-6.0	0.12-0.17	7.4-8.4	Low	Moderate	Low	0.20		
	27-60	6.0-20	0.05-0.07	7.4-8.4	Low	Moderate	Low	0.15		
Carwile:										
Cc	0-18	0.6-2.0	0.11-0.20	5.1-7.3	Low	Moderate	Moderate	0.43	5	3
	18-24	0.2-2.0	0.12-0.20	5.1-7.3	Moderate	High	Moderate	0.37		
	24-47	0.06-0.2	0.12-0.20	6.1-8.4	High	High	Low	0.37		
	47-60	0.2-2.0	0.12-0.20	6.6-8.4	High	High	Low	0.32		
Clark:										
[1]Cd:										
Clark part	0-11	0.6-2.0	0.17-0.22	7.4-8.4	Moderate	Moderate	Low	0.28	5	4L
	11-60	0.6-2.0	0.15-0.19	7.4-8.4	Moderate	Moderate	Low	0.28		
Ost part	0-7	0.2-0.6	0.17-0.19	6.1-7.3	Moderate	Low	Low	0.28	5	6
	7-60	0.2-0.6	0.15-0.19	6.6-8.4	Moderate	Moderate	Low	0.37		
Clime:										
Ce	0-8	0.06-0.6	0.12-0.20	7.4-8.4	Moderate	High	Low	0.28	3	4
	8-26	0.06-0.6	0.12-0.18	7.9-8.4	Moderate	High	Low	0.28		
	26	---	---	---	---	---	---	---		
Elandco:										
Ea, Eb, Ec	0-40	0.6-2.0	0.15-0.22	6.6-8.4	Moderate	Moderate	Low	0.37	5	5
	40-60	0.6-2.0	0.15-0.22	7.4-8.4	Moderate	Moderate	Low	0.43		
Farnum:										
Fa, Fb	0-14	0.6-2.0	0.20-0.22	5.6-7.3	Low	Low	Low	0.28	5	6
	14-60	0.2-0.6	0.14-0.21	6.1-8.4	Moderate	Moderate	Low	0.28		

See footnote at end of table.

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

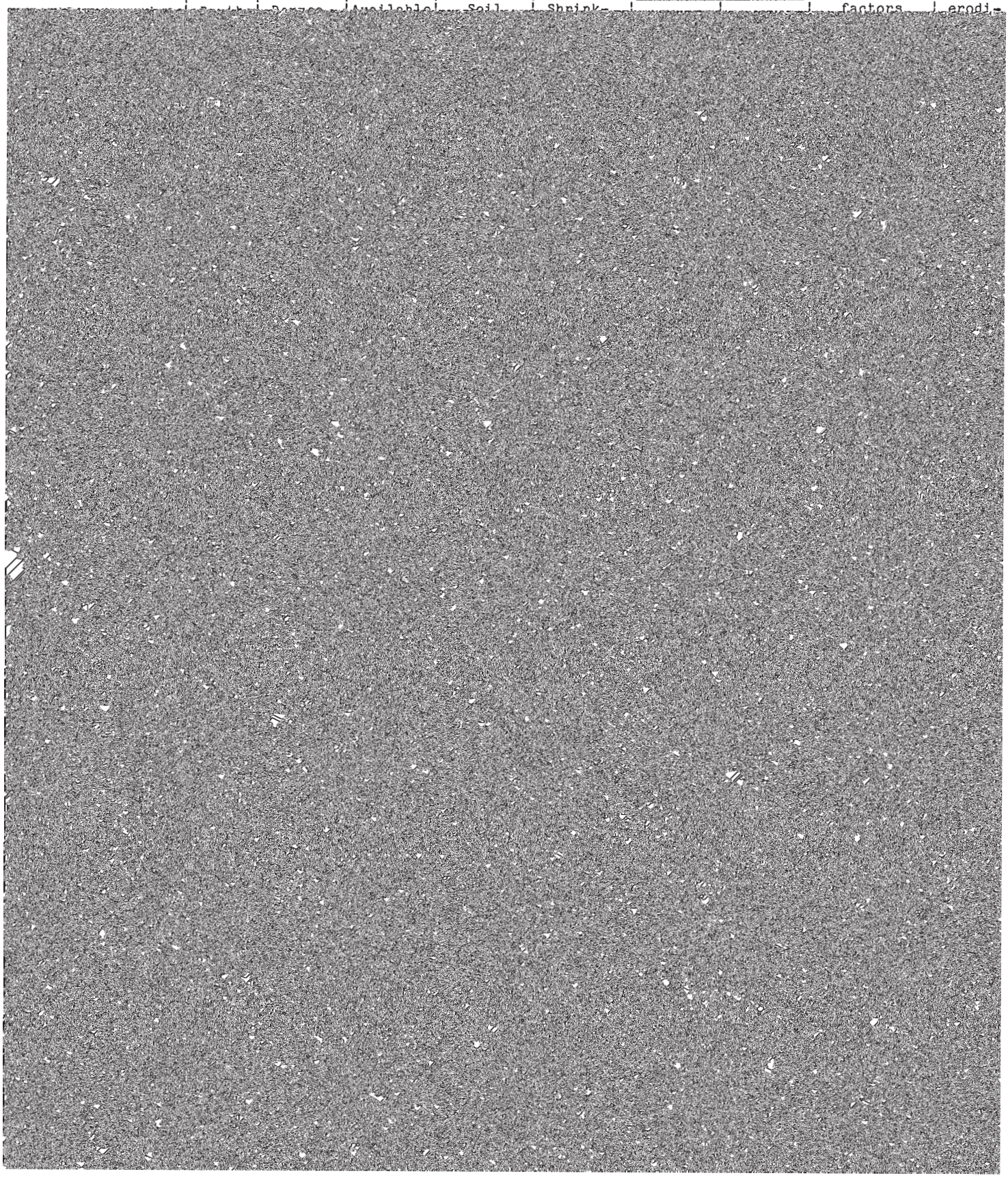


TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	In/hr	In/in	pH						
Renfrow:										
[1]Rc:										
Renfrow part----	0-9	0.2-0.6	0.15-0.22	6.1-7.8	Moderate	Moderate	Low-------	0.43	4	7
	9-13	0.2-0.6	0.15-0.22	6.1-7.8	Moderate	Moderate	Low-------	0.43		
	13-60	<0.06	0.12-0.22	6.1-8.4	High-------	High------	Low-------	0.43		
Owens part------	0-7	<0.06	0.13-0.17	7.9-8.4	High-------	High------	Low-------	0.32	1	6
	7-15	<0.06	0.13-0.17	7.9-8.4	High-------	High------	Low-------	0.32		
	15-20	<0.06	0.03-0.08	7.9-8.4	High-------	High------	Low-------	0.37		
Rosehill:										
Rd----------	0-8	<0.06	0.11-0.14	6.1-7.3	High-------	High------	Low-------	0.28	3	4
	8-30	<0.06	0.10-0.14	6.6-8.4	High-------	High------	Low-------	0.28		
	30	---	---	---	----------	---------	---------	---		
Shellabarger:										
Sa, Sb, Sc------	0-15	0.6-2.0	0.13-0.21	5.6-6.5	Low--------	Low-------	Moderate	0.20	5	3
	15-40	0.6-2.0	0.16-0.18	6.1-7.3	Low--------	Low-------	Moderate	0.28		
	40-60	0.6-20	0.05-0.16	6.1-8.4	Low--------	Low-------	Low-------	0.28		
Tabler:										
Ta----------	0-9	0.2-0.6	0.15-0.24	5.6-8.4	Low--------	Moderate	Low-------	0.49	5	7
	9-32	<0.06	0.12-0.18	6.1-8.4	High-------	High------	Low-------	0.37		
	32-60	<0.06	0.12-0.22	7.4-8.4	High-------	High------	Low-------	0.43		
[1]Tb:										
Tabler part------	0-9	0.2-0.6	0.15-0.24	5.6-8.4	Low--------	Moderate	Low-------	0.49	5	7
	9-32	<0.06	0.12-0.18	6.1-8.4	High-------	High------	Low-------	0.37		
	32-60	<0.06	0.12-0.22	7.4-8.4	High-------	High------	Low-------	0.43		
Drummond part---	0-8	0.6-2.0	0.11-0.18	6.1-8.4	Low--------	High------	Low-------	0.49	3	5
	8-48	<0.06	0.09-0.17	7.4-9.0	High-------	High------	High------	0.55		
	48-60	---	---	---	----------	---------	---------	---		
Urban land:										
[1]Ua:										
Urban land part.										
Canadian part---	0-20	2.0-6.0	0.11-0.20	5.6-8.4	Low--------	Low-------	Low-------	0.20	5	3
	20-60	2.0-20	0.07-0.20	6.1-8.4	Low--------	Low-------	Low-------	0.20		
[1]Ub:										
Urban land part.										
Elandco part----	0-40	0.6-2.0	0.15-0.22	6.6-8.4	Moderate	Moderate	Low-------	0.37	5	5
	40-60	0.6-2.0	0.15-0.22	7.4-8.4	Moderate	Moderate	Low-------	0.43		
[1]Uc:										
Urban land part.										
Farnum part-----	0-14	0.6-2.0	0.20-0.22	5.6-7.3	Low--------	Low-------	Low-------	0.28	5	6
	14-28	0.2-0.6	0.14-0.21	6.1-7.8	Moderate	Moderate	Low-------	0.28		
	28-40	0.6-2.0	0.13-0.19	6.1-7.8	Low--------	Low-------	Low-------	0.28		
	40-60	6.0-20	0.02-0.10	6.1-8.4	Low--------	Low-------	Low-------	0.15		
[1]Ud:										
Urban land part.										
Irwin part------	0-13	0.2-2.0	0.18-0.23	5.6-7.3	Moderate	Moderate	Low-------	0.37	4	7
	3-52	<0.06	0.10-0.15	5.6-8.4	High-------	High------	Low-------	0.37		
	52-60	<0.2	0.09-0.15	6.6-8.4	High-------	High------	Low-------	0.37		
[1]Ue:										
Urban land part.										
Tabler part------	0-9	0.2-0.6	0.15-0.24	5.6-8.4	Low--------	Moderate	Low-------	0.49	5	7
	9-32	<0.06	0.12-0.18	6.1-8.4	High-------	High------	Low-------	0.37		
	32-60	<0.06	0.12-0.22	7.4-8.4	High-------	High------	Low-------	0.43		

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	Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
						Uncoated steel	Concrete	K	T	
	In	In/hr	In/in	pH						
Vanoss:										
Va, Vb, Vc, Vd----	0-13	0.6-2.0	0.15-0.20	5.1-6.5	Low--------	Low-------	Low-------	0.37	5	5
	13-16	0.6-2.0	0.16-0.21	5.1-6.5	Low--------	Low-------	Low-------	0.37		
	16-60	0.6-2.0	0.17-0.22	5.1-6.5	Moderate	Moderate	Moderate	0.37		
Vernon:										
Ve----------	0-13	2.0-6.0	0.10-0.17	7.9-8.4	Low--------	Moderate	Low-------	0.20	5	3
	13-28	<0.06	0.10-0.15	7.9-8.4	High-------	High------	Low-------	0.32		
	28-60	<0.06	0.00-0.10	7.9-8.4	High-------	High------	Low-------	---		
Vf----------	0-13	2.0-6.0	0.10-0.17	7.9-8.4	Low--------	Moderate	Low-------	0.20	5	6
	13-28	<0.06	0.10-0.15	7.9-8.4	High-------	High------	Low-------	0.32		
	28-60	<0.06	0.00-0.10	7.9-8.4	High-------	High------	Low-------	---		
Waldeck:										
Wa----------	0-14	2.0-6.0	0.14-0.18	7.4-8.4	Low--------	Moderate	Low-------	0.20	5	3
	14-27	2.0-6.0	0.12-0.17	7.4-8.4	Low--------	Moderate	Low-------			
	27-60	6.0-20	0.05-0.07	7.4-8.4	Low--------	Moderate	Low-------	0.15		
Waurika:										
Wb----------	0-15	0.6-2.0	0.16-0.20	5.6-7.3	Low--------	High------	Low-------	0.49	5	5
	15-40	<0.06	0.13-0.17	6.6-8.4	High-------	High------	Moderate			
	40-53	0.06-0.2	0.15-0.19	7.4-8.4	Moderate	High------	Moderate	0.37		
	53-60	0.06-0.2	0.15-0.19	7.4-8.4	Moderate	High------	Moderate	0.37		

[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 definitions of "flooding" and "water table" in the Glossary explain such terms as "rare," "brief," and "perched." The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Albion:									
[1]Aa:									
Albion part	B	None	---	---	>6.0	---	---	>60	---
Shellabarger part	B	None	---	---	>6.0	---	---	>60	---
[1]Ab:									
Albion part	B	None	---	---	>6.0	---	---	>60	---
Shellabarger part	B	None	---	---	>6.0	---	---	>60	---
Blanket:									
Ba, Bb	C	None	---	---	>6.0	---	---	>60	---
Canadian:									
Ca	B	Rare	---	---	>6.0	---	---	>60	---
[1]Cb:									
Canadian part	B	Rare	---	---	>6.0	---	---	>60	---
Waldeck part	C	Occasional	Brief	Mar-Oct	2.0-6.0	Apparent	Oct-Apr	>60	---
Carwile:									
Cc	D	Occasional	Brief to very long.	Apr-Oct	2.0-6.0	Apparent	Oct-Apr	>60	---
Clark:									
[1]Cd:									
Clark part	B	None	---	---	>6.0	---	---	>60	---
Ost part	B	None	---	---	>6.0	---	---	>60	---
Clime:									
Ce	C	None	---	---	>6.0	---	---	20-40	Rippable
Elandco:									
Ea, Eb, Ec	B	Rare to common.	Brief	Oct-May	>6.0	---	---	>60	---
Farnum:									
Fa, Fb, Fc	B	None	---	---	>6.0	---	---	>60	---
Goessel:									
Ga, Gb	D	None	---	---	>6.0	---	---	>60	---
Irwin:									
Ia, Ib, Ic	D	None	---	---	>6.0	---	---	>40	Hard
Lesho:									
La	C	Occasional	Very brief	Mar-Jul	2.0-6.0	Apparent	Jan-Dec	>60	---
Lincoln:									
Lb	A	Common	Very brief to brief.	Apr-Oct	5.0-8.0	Apparent	Nov-May	>60	---
Milan:									
Ma, Mb, Mc	B	None	---	---	>6.0	---	---	>60	---

See footnote at end of table.

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

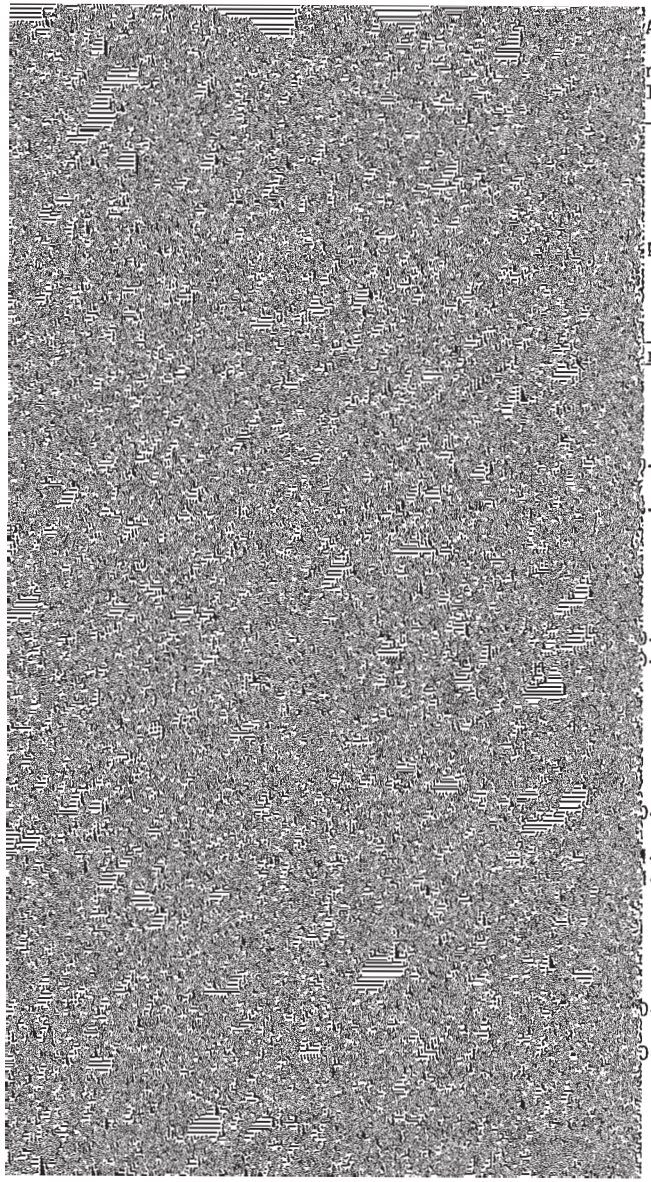
Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness
					Ft			In	
Naron:									
Na	B	None	---	---	>6.0	---	---	>60	---
Owens:									
Oc	D	None	---	---	>6.0	---	---	10-20	Rippable
[1]Od:									
Owens part	D	None	---	---	>6.0	---	---	10-20	Rippable
Rock outcrop part.									
Pits:									
Pa.									
Plevna:									
Pb	D	Frequent	Brief to long.	Mar-Oct	0-4.0	Apparent	Jan-Dec	>60	---
Pratt:									
Pc	A	None	---	---	>6.0	---	---	>60	---
[1]Pd:									
Pratt part	A	None	---	---	>6.0	---	---	>60	---
Tivoli part	A	None	---	---	>6.0	---	---	>60	---
Renfrow:									
Ra, Rb	D	None	---	---	>6.0	---	---	>60	---
[1]Rc:									
Renfrow part	D	None	---	---	>6.0	---	---	>60	---
Owens part	D	None	---	---	>6.0	---	---	10-20	Rippable
Rosehill:									
Rd	D	None	---	---	>6.0	---	---	20-40	Rippable
Shellabarger:									
Sa, Sb, Sc	B	None	---	---	>6.0	---	---	>60	---
Tabler:									
Ta	D	None	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
[1]Tb:									
Tabler part	D	None	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
Drummond part	D	Rare	---	---	2.0-6.0	Apparent	Nov-Apr	>60	---
Urban land:									
[1]Ua:									
Urban land part.									
Canadian part	B	Rare	---	---	>6.0	---	---	>60	---
[1]Ub:									
Urban land part.									
Elandco part	B	Rare to common.	Brief	Oct-May	>6.0	---	---	>60	---
[1]Uc:									
Urban land part.									
Farnum part	B	None	---	---	>6.0	---	---	>60	---

See footnote at end of table.

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	
Urban land:									
[1]Ud:									
Urban land part.									
Irwin part-----	D	None--------	---	---	>6.0	---	---	>40	Hard
[1]Ue:									
Urban land part.									
Tabler part-----	D	None--------	---	---	2.5-3.5	Perched	Oct-Apr	>60	---
Vanoss:									
Va, Vb, Vc, Vd---	B	None--------	---	---	>6.0	---	---	>60	---
Vernon:									
Ve, Vf----------	D	None--------	---	---	>6.0	---	---	>60	---
Waldeck:									
Wa----------	C	Occasional	Brief-----	Mar-Oct	2.0-6.0	Apparent	Oct-Apr	>60	---
Waurika:									
Wb----------	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.



ABLE 17.--ENGINEERING TEST DATA

nsportation, in accordance with standard procedures of the American Association
ls (AASHTO) except as stated in footnotes 1 and 2]

pth	Moisture density[1]		Percentage less than 3 inches passing sieve--[2]			Percentage smaller than--[2]				Liquid limit	Plasticity index	Classification[3]	
	Maximum	Optimum	No. 10	No. 40	No. 200	0.05 mm	0.02 mm	0.005 mm	0.002 mm			AASHTO	Unified
n	lb/cu ft	Pct								Pct			
0-28	118	10	99	91	28	21	12	7	7	18	3	A-2-4 (0)	SM
-48	113	11	99	86	12	9	5	3	3	18	[4]/ NP	A-2-4 (0)	SP-SM
0-10	110	13	100	98	59	50	30	18	13	27	8	A-4(2)	CL
0-27	118	12	100	97	40	34	25	15	13	22	5	A-4(0)	SM-SC
0-11	124	9	100	71	41	35	24	15	13	19	5	A-4(0)	SM-SC
-31	110	15	99	79	45	40	35	31	29	38	18	A-6(4)	SC
-44	110	16	100	96	51	47	37	28	25	32	15	A-6(4)	CL
0-20	115	12	100	91	62	53	32	18	14	23	5	A-4(1)	CL-ML
0-45	114	13	98	86	64	56	38	23	19	31	12	A-6(5)	CL

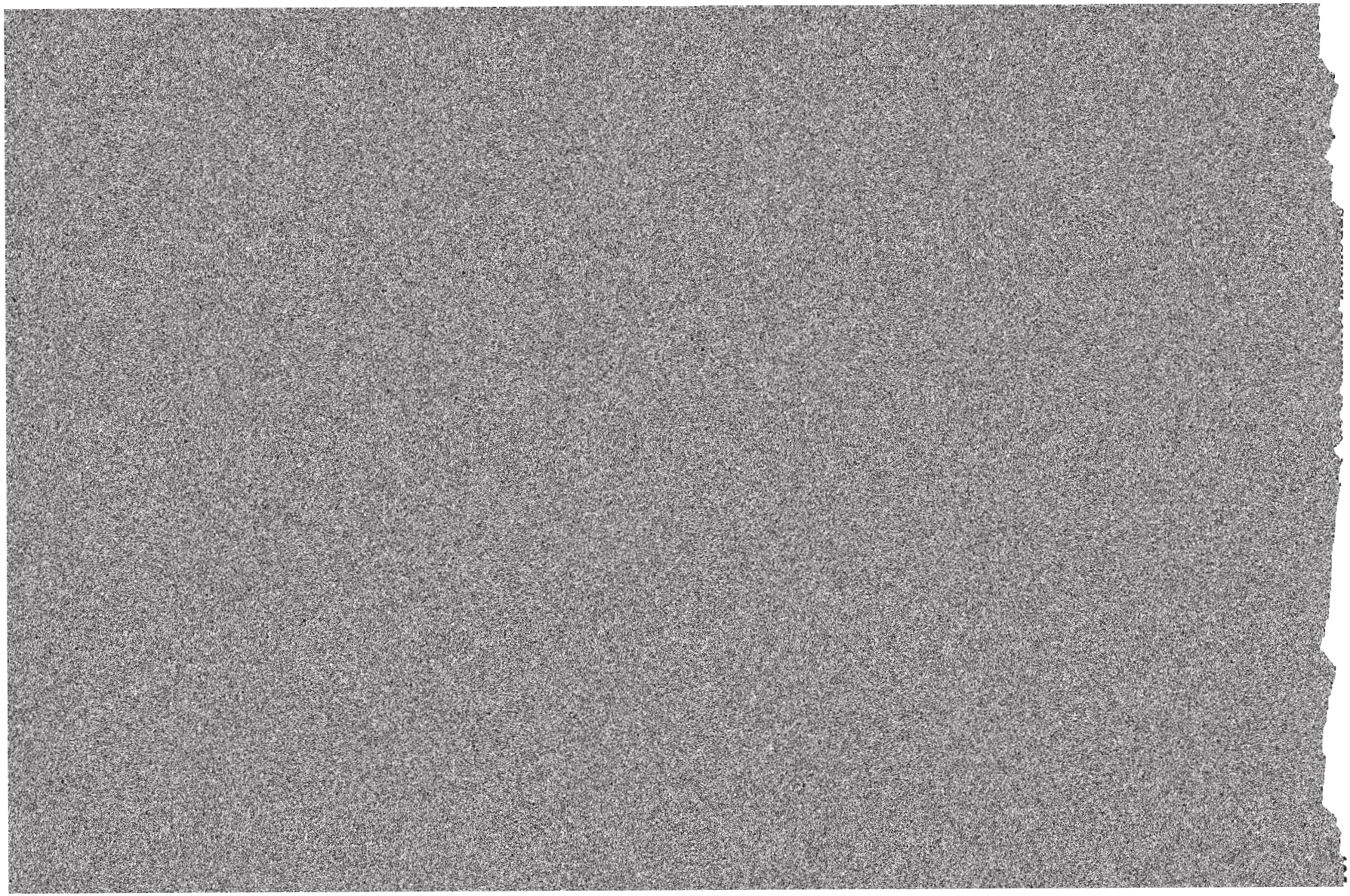


TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Albion	Coarse-loamy, mixed, thermic Udic Argiustolls
Blanket	Fine, mixed, thermic Pachic Argiustolls
Canadian	Coarse-loamy, mixed, thermic Udic Haplustolls
Carwile	Fine, mixed, thermic Typic Argiaquolls
Clark	Fine-loamy, mixed, thermic Typic Calciustolls
Clime	Fine, mixed, mesic Udic Haplustolls
Drummond	Fine, mixed, thermic Mollic Natrustalfs
Elandco	Fine-silty, mixed, thermic Cumulic Haplustolls
Farnum	Fine-loamy, mixed, thermic Pachic Argiustolls
Goessel	Fine, montmorillonitic, mesic Udic Pellusterts
Irwin	Fine, mixed, mesic Pachic Argiustolls
*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
Naron	Fine-loamy, mixed, thermic Udic Argiustolls
Ost	Fine-loamy, mixed, thermic Typic Argiustolls
Owens	Clayey, mixed, thermic, shallow Typic Ustochrepts
Plevna	Coarse-loamy, mixed, thermic Fluvaquentic Haplaquolls
Pratt	Sandy, mixed, thermic Psammentic Haplustalfs
*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
Vanoss	Fine-silty, mixed, thermic Udic Argiustolls
*Vernon	Fine, mixed, thermic Typic Ustochrepts
Waldeck	Coarse-loamy, mixed, thermic Fluvaquentic Haplustolls
Waurika	Fine, montmorillonitic, thermic Typic Argialbolls

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