United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Kansas Agricultural
Experiment Station

Soil Survey of Washington County, Kansas

How To Use This Soil Survey

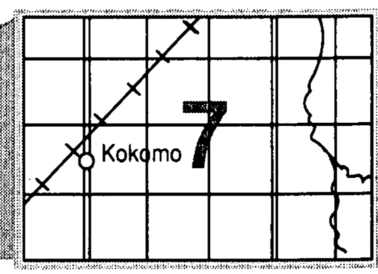
General Soil Map

The general soil map, which is the color map preceding the detailed soil maps, shows the survey area divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** for a general description of the soils in your area.

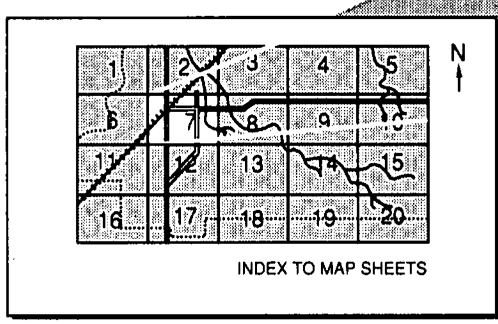
Detailed Soil Maps

The detailed soil maps follow the general soil map. These maps can be useful in planning the use and management of small areas.

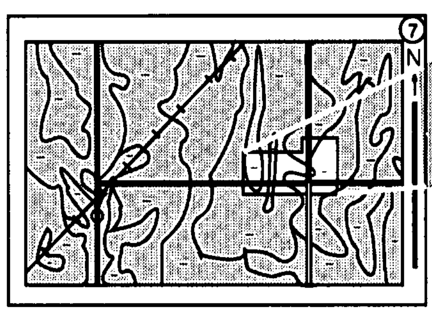


MAP SHEET

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** (see Contents), which lists the map units by symbol and name and shows the page where each map unit is described.



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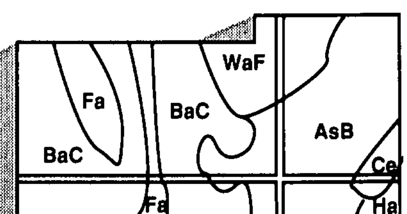

AREA OF INTEREST

NOTE: Map unit symbols in a soil survey may consist only of numbers or letters, or they may be a combination of numbers and letters.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in 1987. Soil names and descriptions were approved in 1988. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1988. 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 Washington County Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

All programs and services of the Soil Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of Kipson-Sogn complex, 5 to 30 percent slopes. A spring has been developed as a stock-water pond. The cultivated field is in an area of Tully silty clay loam, 3 to 7 percent slopes.

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Issued August 1993

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Foreword

This soil survey contains information that can be used in land-planning programs in Washington County, Kansas. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow over bedrock. Some are too unstable to be used as a foundation for buildings or roads. 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 soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

James N. Habiger
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Soil Survey of Washington County, Kansas

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Soil Conservation Service

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

General Nature of the County

WASHINGTON COUNTY is in north-central Kansas (fig. 1). It has a total area of 575,130 acres, or about 899 square miles. In 1986, it had a population of 7,859. In Washington, the county seat and the largest town, the population was 1,458.

Most of the county is in the Central Kansas Sandstone Hills major land resource area. The northern and eastern parts, however, are in the Central Loess Plains major land resource area, and the extreme southeast corner is in the Bluestem Hills major land resource area. The Central Kansas Sandstone Hills major land resource area is dissected by entrenched drainageways. It has soils that are shallow to deep and gently sloping to steep. These soils have a clayey or loamy subsoil. The soils in the Central Loess Plains major land resource area are generally deep and nearly level to moderately sloping and have a clayey or silty subsoil. The Bluestem Hills major land resource area is dissected by limestone and shale uplands with narrow divides and narrow, steep-sided valleys. It has soils that are shallow to deep and gently sloping to steep. These soils have a clayey or loamy subsoil. Elevation within the county ranges from about 1,140 to 1,640 feet above sea level.

Most of the county is drained by the Little Blue River and Mill Creek. The Little Blue River flows south through the northeastern part of the county. Mill Creek flows east through the central part of the county and joins the Little Blue River north of Hanover. The southwestern part of the county is drained by numerous small tributaries of the Republican River. A small area in the southeast corner of the county is drained by Fancy Creek and its tributaries.

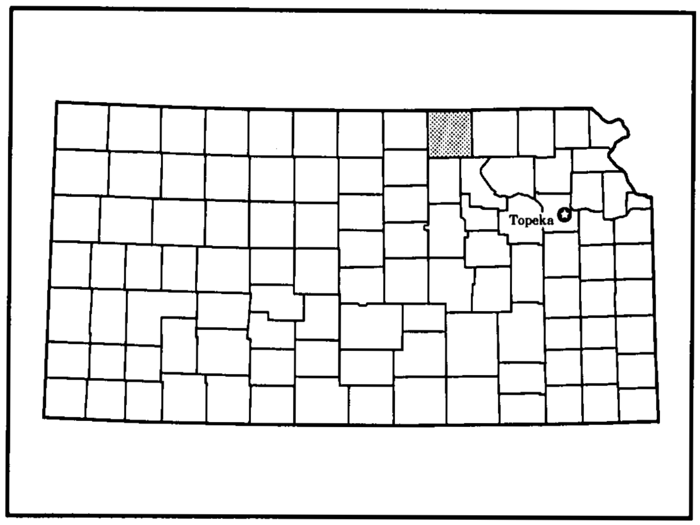

Figure 1.—Location of Washington County in Kansas.

Farming is the most important enterprise in the county. Wheat and grain sorghum are the main crops. Cattle and hogs are the main kinds of livestock.

Climate

Prepared by L. Dean Bark, climatologist, Kansas Agricultural Experiment Station, Manhattan, Kansas, and the Soil Conservation Service Data Access Facility, Portland, Oregon.

The climate of Washington County is typical continental, as can be expected of a location in the interior of a large landmass in the middle latitudes. The climate is characterized by wide daily and annual variations in temperature. Winters are cold because of the frequent outbreaks of polar air. The cold temperatures prevail only from December to February. Warm summer temperatures prevail for about 6 months every year. They provide a long growing season for the crops in the county. Spring and fall are relatively short.

Washington County is generally along the western edge of the flow of moisture-laden air from the Gulf of Mexico. Shifts in these air currents result in a rather wide range in the amount of precipitation received. Precipitation is heaviest from May through September. Much of it falls during late-evening or nighttime thunderstorms. Precipitation in dry years is marginal for agricultural production. Even in wet years there may be prolonged dry periods that result in stress to growing crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Washington in the period 1961 to 1990. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter, the average temperature is about 29 degrees F and the average daily minimum temperature is about 18 degrees. The lowest temperature on record, which occurred at Washington on December 23, 1989, is -29 degrees. In summer, the average temperature is about 77 degrees and the average daily maximum temperature is about 90 degrees. The highest recorded temperature, which occurred at Washington on July 12, 1954, is 112 degrees.

The total annual precipitation is 31.84 inches. Of this, 23.41 inches, or about 74 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 17.11 inches. The heaviest 1-day rainfall during the period of record was 5.28 inches at Washington on August 25, 1972. Thunderstorms occur on about 56 days each year, and most occur in June.

Tornadoes and severe thunderstorms occur occasionally in Washington County. These storms are usually of local extent and short duration, and the risk of severe damage is small. Hail occurs during the warmer part of the year, but it is infrequent and of local extent. Hailstorms cause less damage in this county than in counties farther to the west.

The average seasonal snowfall is 22.4 inches. The greatest snow depth at any one time during the period of record was 20.0 inches. On the average, 7 days of the year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall during the period of record was 13.0 inches.

The sun shines 77 percent of the time possible in summer and 62 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 14 miles per hour, in April.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for cash crops and for the grasses grazed by livestock. Most of the soils are fertile and well suited to agricultural uses. Irrigation water of suitable quality is available in most areas that are adjacent to the Little Blue River. The Dakota Formation, in the western and northern parts of the county, has many springs and yields moderate amounts of good-quality water to wells. The part of the county underlain by rocks of Permian age yields only small quantities of mineralized water to wells. Parts of the county are served by rural water districts.

Sand and gravel are available from pits along the Little Blue River. Limestone is quarried in the northeastern and northwestern parts of the county for use as road surfacing material and agricultural lime.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification used in the United States is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot assure that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by two or three kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soil on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but onsite investigation is needed to plan for intensive uses in small areas.

The descriptions and names of the soils identified on the soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties. Differences result from a better knowledge of soils, modifications in series concepts, a higher or lower intensity of mapping, and variations in the extent of the soils in the survey areas.

General Soil Map Units

The general soil map at the back of this publication shows the soil associations in this survey area. Each association has a distinctive pattern of soils, relief, and drainage. Each is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map 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 soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Crete-Longford Association

Deep, nearly level to moderately sloping, moderately well drained and well drained soils that have a clayey or silty subsoil; on uplands

This association is on broad ridgetops and side slopes that are drained by intermittent streams. Slopes range from 0 to 7 percent.

This association makes up about 23 percent of the county. It is about 75 percent Crete soils, 15 percent Longford soils, and 10 percent minor soils (fig. 2).

The moderately well drained Crete soils formed in loess. They are nearly level to moderately sloping. Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

The well drained Longford soils formed in loess over loamy sediments. They are moderately sloping. Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer also is dark grayish brown silt loam. It is about 5 inches thick. The subsoil is silty clay loam about 28 inches thick. The upper part is brown and firm, the next part is brown and firm or very firm, and the lower part is strong brown and firm. The substratum to a depth of about 60 inches is reddish yellow clay loam.

Of minor extent in this association are Hobbs and Lancaster soils. The moderately deep Lancaster soils are on side slopes. The occasionally flooded Hobbs soils are on narrow flood plains.

About 85 percent of this association is used for cultivated crops. The rest is used mainly as range. Wheat, grain sorghum, and alfalfa are the main crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing cropland.

2. Crete-Lancaster-Longford Association

Deep and moderately deep, gently sloping to strongly sloping, moderately well drained and well drained soils that have a clayey, silty, or loamy subsoil; on uplands

This association is on ridgetops and side slopes that are drained by intermittent streams. Slopes range from 1 to 12 percent.

This association makes up about 25 percent of the county. It is about 50 percent Crete soils, 15 percent Lancaster soils, 10 percent Longford soils, and 25 percent minor soils (fig. 3).

The deep, moderately well drained Crete soils formed in loess. They are gently sloping and moderately sloping. Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The

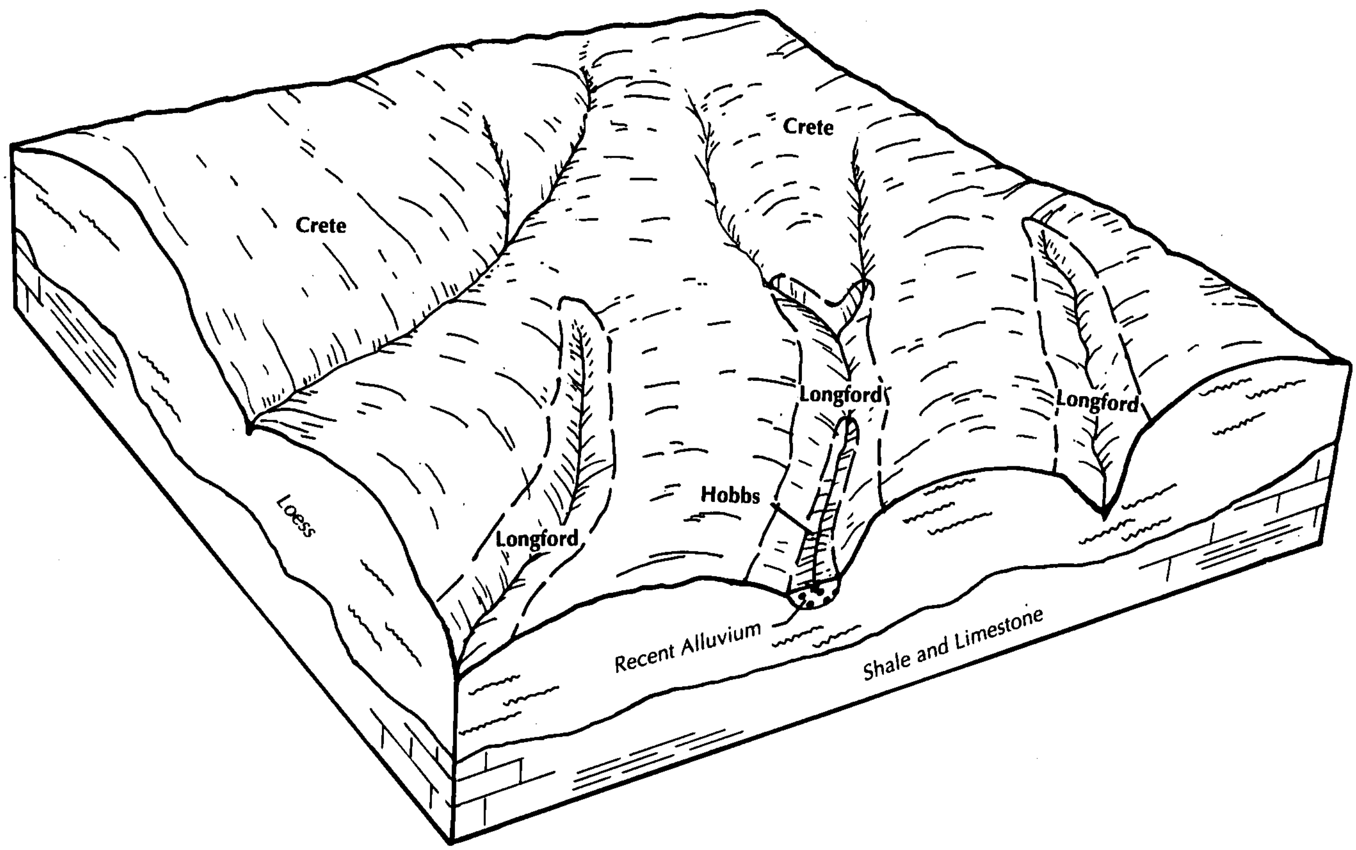

Figure 2.—Typical pattern of soils and parent material in the Crete-Longford association.

substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

The moderately deep, well drained Lancaster soils formed in material weathered from noncalcareous sandstone and sandy shale. They are moderately sloping and strongly sloping. Typically, the surface layer is brown loam about 9 inches thick. The subsoil is about 20 inches thick. The upper part is reddish brown and brown, firm clay loam; the next part is yellowish red, firm clay loam; and the lower part is yellowish red and light gray, firm sandy clay loam. Bedrock of sandy shale and soft sandstone is at a depth of about 29 inches.

The deep, well drained Longford soils formed in loess over loamy sediments. They are moderately sloping. Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer also is dark grayish brown silt loam. It is about 5 inches thick. The subsoil is silty clay loam about 28 inches thick. The upper part is brown and firm, the next part is brown and firm or very firm, and the lower part is strong brown and firm. The substratum to a depth of about 60 inches is reddish yellow clay loam.

Of minor extent in this association are Edalgo, Hedville, Hobbs, and Wells soils. The moderately deep Edalgo soils have a clayey subsoil. The shallow Hedville soils are on the more sloping, narrow ridgetops and on sharp breaks along slopes. The occasionally flooded Hobbs soils are on narrow flood plains. The deep, loamy Wells soils are on the lower side slopes.

This association is used mainly for cultivated crops, but about 25 percent is used as range. Wheat, grain sorghum, and alfalfa are the main crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing cropland.

3. Crete-Mayberry-Morrill Association

Deep, gently sloping to strongly sloping, moderately well drained and well drained soils that have a clayey or loamy subsoil; on uplands

This association is on an undulating to rolling glacial plain that has a mantle of loess. The undulating and gently rolling ridgetops are narrow and winding. The valley slopes below the ridgetops are gently rolling and rolling. The bottom land along most of the streams is narrow, but nearly level areas of broad bottom land are along a few of the larger streams. Relief from the valley floors to the ridgetops ranges from about 50 to 180 feet. Slopes range from 1 to 12 percent.

This association makes up about 21 percent of the county. It is about 50 percent Crete soils, 20 percent Mayberry soils, 15 percent Morrill soils, and 15 percent minor soils (fig. 4).

The moderately well drained Crete soils formed in loess. They are gently sloping and moderately sloping. Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

The moderately well drained Mayberry soils formed in clayey glacial till. They are moderately sloping. Typically, the surface layer is dark grayish brown clay loam about 6 inches thick. The subsurface layer is very dark grayish brown clay loam about 3 inches thick. The subsoil is about 36 inches thick. The upper part is dark grayish brown, firm clay loam; the next part is brown and strong brown, mottled, very firm clay; and the lower part is yellowish brown, mottled, firm clay. The substratum to a depth of about 60 inches is brownish yellow, mottled clay loam.

The well drained Morrill soils formed in loamy glacial till. They are moderately sloping and strongly sloping. Typically, the surface layer is dark grayish brown loam about 8 inches thick. The subsoil is clay loam about 35 inches thick. The upper part is brown and firm, the next part is reddish brown and firm, and the lower part is reddish brown and friable. The substratum to a depth of about 60 inches is reddish brown and light yellowish brown sandy clay loam.

Of minor extent in this association are Hobbs, Kipson, and Sogn soils. The well drained Hobbs soils are on narrow flood plains. The shallow Kipson and Sogn soils are on the steeper side slopes.

This association is used mainly for cultivated crops, but some areas are used as range. Wheat and grain

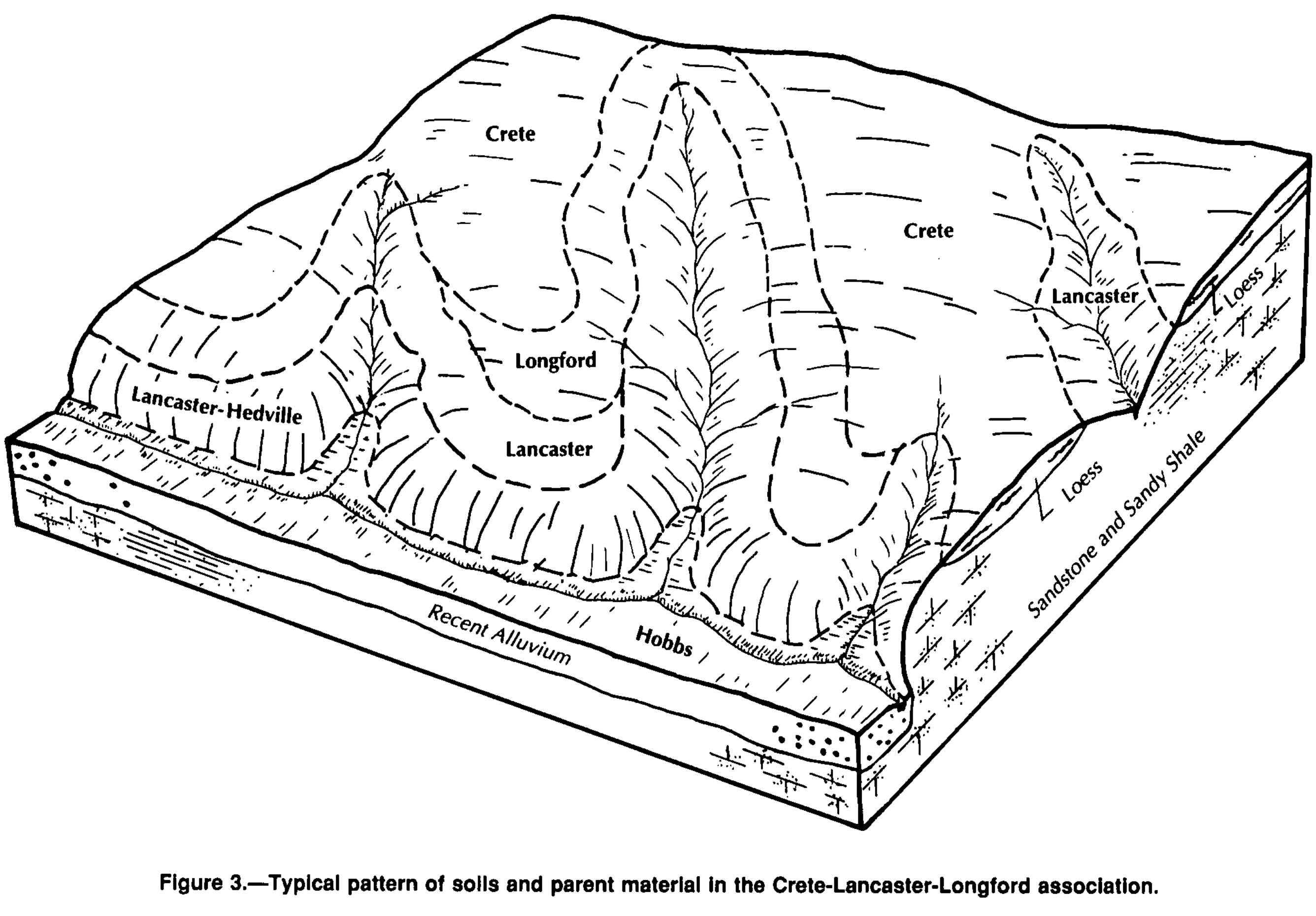

Figure 3.—Typical pattern of soils and parent material in the Crete-Lancaster-Longford association.

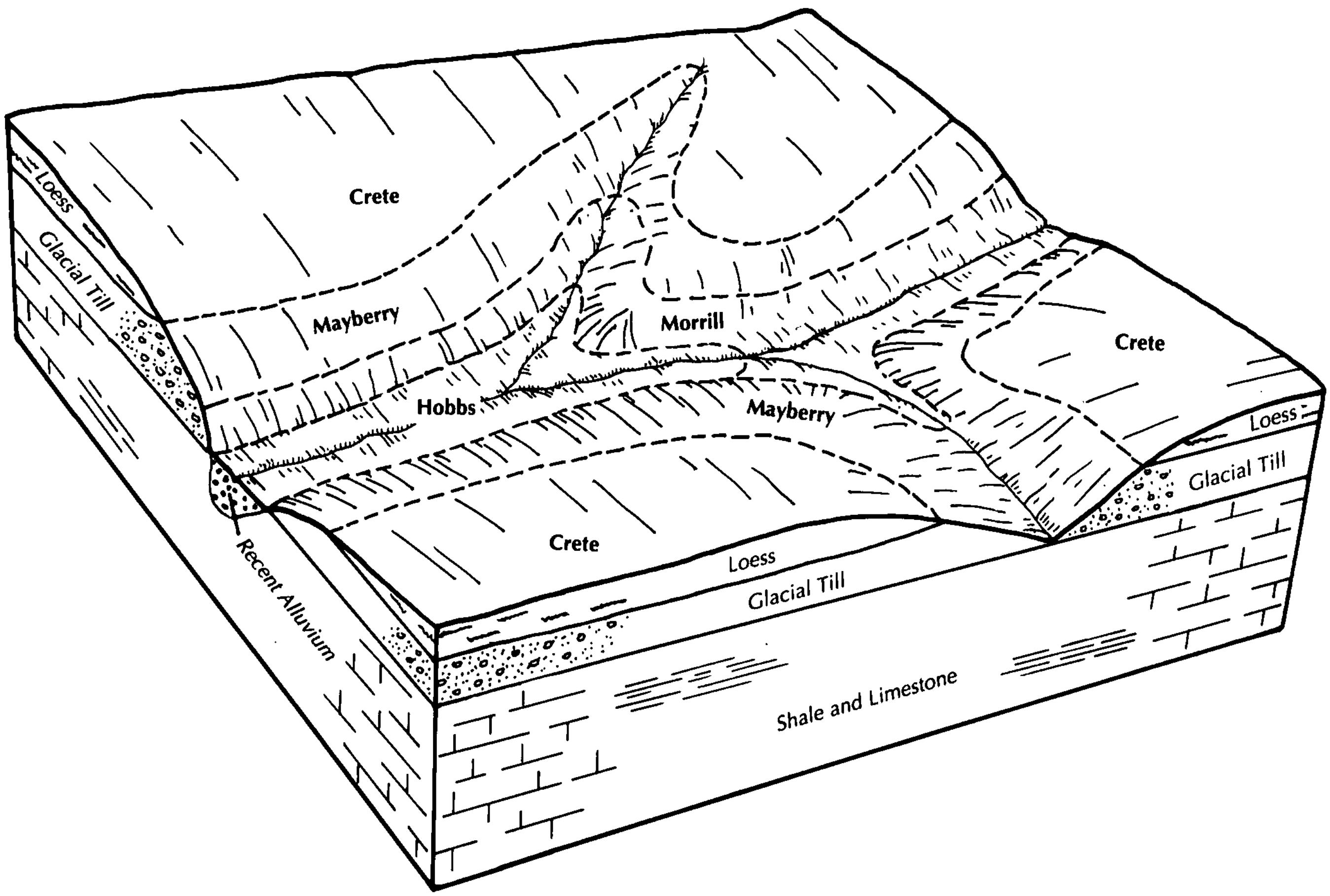

Figure 4.—Typical pattern of soils and parent material in the Crete-Mayberry-Morrill association.

sorghum are the main crops. Controlling erosion, conserving moisture, and maintaining tilth and fertility are the main concerns in managing cropland.

4. Crete-Kipson-Tully Association

Deep and shallow, gently sloping to steep, moderately well drained to somewhat excessively drained soils that have a clayey subsoil or that are silty throughout; on uplands

This association is on ridgetops and side slopes that are dissected by deeply entrenched drainageways. Limestone outcrops are common in the steeper areas. Slopes range from 1 to 30 percent.

This association makes up about 12 percent of the county. It is about 40 percent Crete soils, 20 percent Kipson soils, 15 percent Tully soils, and 25 percent minor soils (fig. 5).

The deep, moderately well drained Crete soils formed in loess. They are gently sloping and moderately sloping. Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

The shallow, somewhat excessively drained Kipson soils formed in material weathered from calcareous shale. They are moderately sloping to steep and are calcareous throughout. Typically, the surface soil is dark gray silty clay loam about 12 inches thick. The next layer is pale yellow, firm silty clay loam about 6 inches thick. Light yellowish brown shale bedrock is at a depth of about 18 inches.

The deep, well drained Tully soils formed in colluvial material generally weathered from shale. They are moderately sloping and strongly sloping. Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil is about 49 inches thick. The upper part is very dark grayish brown, firm silty clay loam; the next part is dark grayish brown, very firm silty clay; and the lower part is brown, very firm silty clay. The substratum to a depth of about 60 inches is brown silty clay loam.

Of minor extent in this association are Benfield, Hobbs, and Sogn soils. The moderately deep Benfield soils are on side slopes. The well drained Hobbs soils are on narrow flood plains. The shallow, somewhat excessively drained Sogn soils are on narrow ridgetops and on sharp breaks along slopes.

About half of this association is used for cultivated crops, and the rest is used as range. Wheat and grain sorghum are the main crops. Controlling erosion and maintaining tilth and fertility are the main concerns in managing cropland. Maintaining a good stand of desirable grasses is the main concern in managing range.

5. Lancaster-Crete-Hedville Association

Deep to shallow, moderately sloping to steep, moderately well drained to somewhat excessively drained soils that have a clayey or loamy subsoil or that are loamy throughout; on uplands

This association is in the Dakota Sandstone Hills. It is on ridgetops and side slopes that are dissected by deeply entrenched, intermittent drainageways and small creeks. Sandstone outcrops are common in the steeper areas. Slopes range from 3 to 30 percent.

This association makes up about 14 percent of the county. It is about 30 percent Lancaster soils, 25 percent Crete soils, 15 percent Hedville soils, and 30 percent minor soils.

The moderately deep, well drained Lancaster soils formed in material weathered from noncalcareous sandstone and sandy shale. They are moderately sloping and strongly sloping. Typically, the surface layer

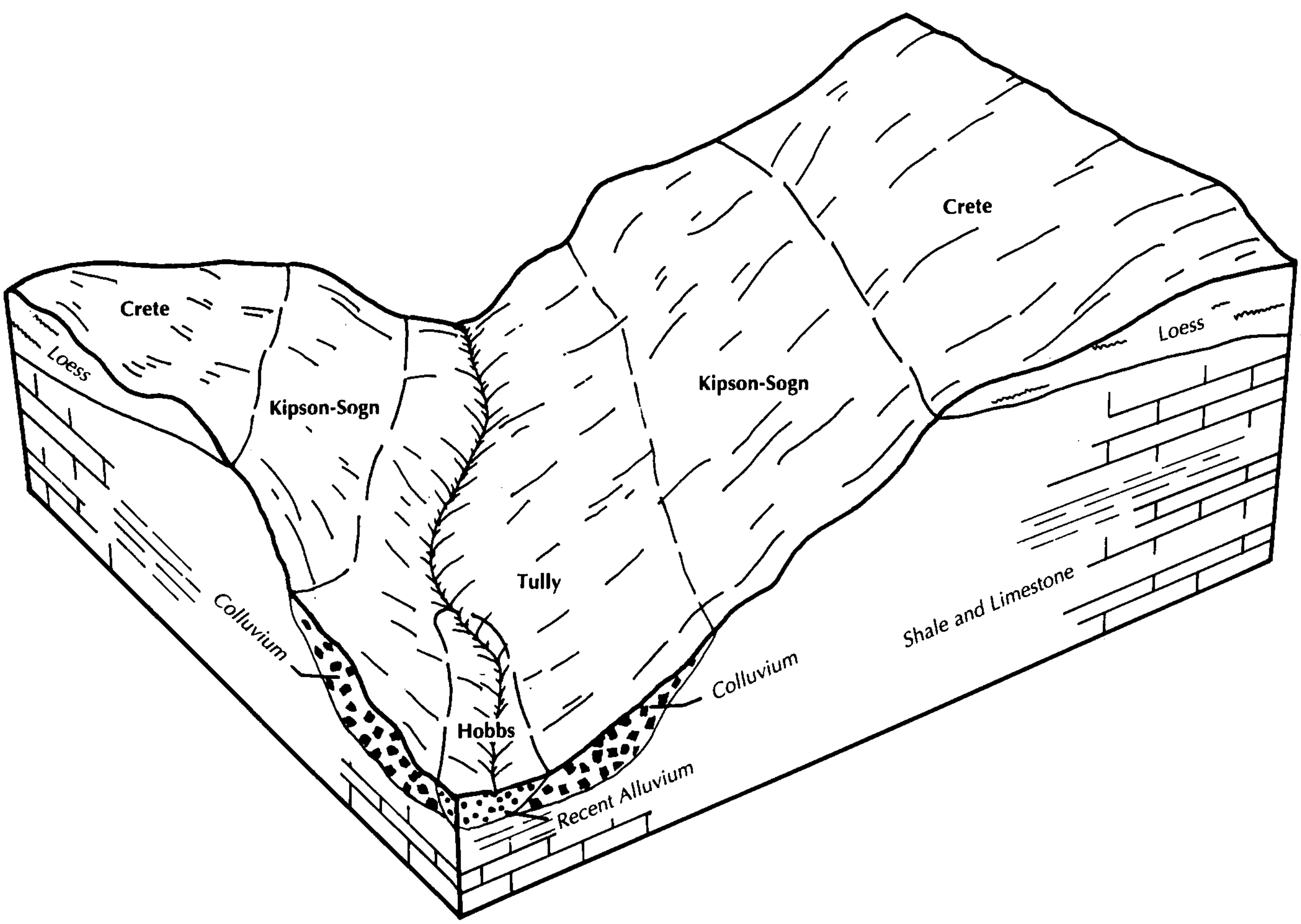

Figure 5.—Typical pattern of soils and parent material in the Crete-Kipson-Tully association.

is brown loam about 9 inches thick. The subsoil is about 20 inches thick. The upper part is reddish brown and brown, firm clay loam; the next part is yellowish red, firm clay loam; and the lower part is yellowish red and light gray, firm sandy clay loam. Bedrock of sandy shale and soft sandstone is at a depth of about 29 inches.

The deep, moderately well drained Crete soils formed in loess. They are moderately sloping. Typically, the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

The shallow, somewhat excessively drained Hedville soils formed in material weathered from noncalcareous sandstone. They are moderately sloping to steep. Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsurface layer is brown loam about 5 inches thick. Sandstone bedrock is at a depth of about 15 inches.

Of minor extent in this association are Edalgo, Hobbs, and Wells soils. The moderately deep Edalgo soils have a clayey subsoil. The occasionally flooded Hobbs soils are on narrow flood plains. The deep, loamy Wells soils are on the lower side slopes.

This association is used mainly as range, but some small areas on foot slopes are used for hay or cultivated crops. Maintaining a vigorous stand of desirable grasses is the main concern in managing range.

6. Muir-Hobbs-Eudora Association

Deep, nearly level, well drained soils that have a silty subsoil or substratum or that are loamy throughout; on terraces and flood plains

This association is on bottom land along the Little Blue River and other major streams. The Muir soils are subject to rare flooding. The Eudora and Hobbs soils are occasionally flooded. Slopes range from 0 to 2 percent.

This association makes up about 5 percent of the county. It is about 50 percent Muir soils, 25 percent Hobbs soils, 15 percent Eudora soils, and 10 percent minor soils.

The Muir soils formed in silty alluvium. Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 11 inches thick. The subsoil extends to a depth of about 60 inches. It is friable silt loam. The upper part is dark grayish brown, and the lower part is grayish brown.

The Hobbs soils formed in silty alluvium. Typically, the surface layer is grayish brown silt loam about 6 inches thick. The substratum to a depth of about 60 inches is friable silt loam. The upper part is stratified light gray and grayish brown, the next part is grayish brown, and the lower part is stratified light gray and grayish brown.

The Eudora soils formed in silty and loamy alluvium. Typically, the surface layer is dark grayish brown loam about 4 inches thick. The subsurface layer also is dark grayish brown loam. It is about 10 inches thick. The upper part of the substratum is brown, very friable very fine sandy loam; the next part is brown, friable silt loam; and the lower part to a depth of about 60 inches is brown, very friable very fine sandy loam.

Of minor extent in this association are Cass, Colo, and Sarpy soils. Cass soils are in the slightly lower positions on the landscape or in positions similar to those of the Eudora soils. The poorly drained Colo soils are in slightly concave areas on stream terraces that are subject to rare flooding. The sandy Sarpy soils are on mounds or near stream channels.

Most of this association is used for cultivated crops. Wheat, grain sorghum, and alfalfa are the main crops. Conserving moisture and maintaining fertility and tilth are management concerns.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

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

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Crete silty clay loam, 1 to 3 percent slopes, is a phase of the Crete series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils, or one or more soils and a miscellaneous area, in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Kipson-Sogn complex, 5 to 30 percent slopes, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The "Glossary" defines many of the terms used in describing the soils.

Soil Descriptions

Be—Benfield silty clay loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes in the uplands. In many places individual areas are narrow bands that follow the contour of the slope. In other places they are irregular in shape. They range from 10 to 200 acres in size.

Typically, the surface layer is grayish brown silty clay loam about 5 inches thick. The subsoil is about 16 inches thick. The upper part is dark grayish brown, friable silty clay loam, and the lower part is brown, firm and very firm silty clay loam. The substratum to a depth of about 24 inches is pale yellow silty clay loam. Shale bedrock is at a depth of about 24 inches. In some places the depth to shale bedrock is more than 40 inches. In other places the surface is partially covered with chert and limestone fragments.

Included with this soil in mapping are small areas of Kipson soils, limestone rock outcrop, and slick spots. The shallow Kipson soils are on the lower side slopes. The rock outcrop is on the steeper breaks on the side slopes. The slick spots are in landscape positions similar to those of the Benfield soil. Included areas make up about 5 percent of the map unit.

Permeability is slow in the Benfield soil, and runoff is medium. Available water capacity and the content of organic matter are moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, and tilth is fair. Root penetration is restricted below a depth of about 24 inches.

Most areas are used for cultivated crops. A few are used as range. This soil is poorly suited to wheat and grain sorghum. Erosion is a hazard in cultivated areas. It can be controlled by contour farming, terraces, grassed waterways, and minimum tillage. The moderate depth to bedrock should be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed. Returning crop residue to the soil improves tilth and fertility and increases the rate of water infiltration.

This soil is suited to range. Some areas that formerly were cultivated have been reseeded to grass. Range seeding is needed to restore the productivity of abandoned cropland. The native vegetation is mainly big bluestem, little bluestem, and indiangrass, but blue grama and buffalograss are dominant in overgrazed areas. Proper stocking rates and timely deferment of grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil generally is unsuitable as a site for septic tank absorption fields because of the slow permeability, seepage, and the thin layer of soil over bedrock. It is poorly suited to sewage lagoons because of seepage. Sealing the bottom of the lagoon helps to prevent excess seepage into fractures in the bedrock.

The land capability classification is IVe, and the range site is Loamy Upland.

Cg—Cass fine sandy loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are irregular in shape and range from about 30 to 200 acres in size. Slopes range from 0 to 2 percent.

Typically, the surface layer is dark grayish brown fine sandy loam about 6 inches thick. The subsurface layer also is dark grayish brown fine sandy loam. It is about 11 inches thick. The next layer is grayish brown, friable fine sandy loam about 15 inches thick. The substratum extends to a depth of more than 60 inches. The upper part is brown very fine sandy loam, the next part is grayish brown fine sandy loam, and the lower part is pale brown fine sand. In some areas the soil is calcareous and has a light brownish gray surface layer.

Included with this soil in mapping are small areas of Sarpy soils. These excessively drained soils are on small mounds. They make up about 10 percent of the map unit.

Permeability is moderately rapid in the Cass soil, and runoff is slow. Available water capacity is moderate. The content of organic matter is moderately low. The surface layer is friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, and alfalfa. The main management concerns are controlling soil blowing and conserving moisture. Also, the occasional flooding can damage the crops. Minimizing tillage and leaving crop residue on the surface help to control soil blowing, conserve moisture, and help to maintain fertility.

This soil generally is not suited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Sandy Lowland.

Ch—Cass fine sandy loam, frequently flooded. This deep, nearly level, well drained soil is on flood plains. It is commonly adjacent to river channels and in abandoned channels of the Little Blue River. Individual areas are long and narrow and range from 20 to 80 acres in size. Slopes range from 0 to 2 percent.

Typically, the surface soil is dark grayish brown fine sandy loam about 15 inches thick. The next layer is grayish brown, friable fine sandy loam about 15 inches thick. The substratum extends to a depth of more than 60 inches. The upper part is brown very fine sandy loam, the next part is grayish brown fine sandy loam, and the lower part is pale brown fine sand. In some areas the surface soil is silt loam.

Included with this soil in mapping are small areas of Eudora and Sarpy soils. Eudora soils are on the higher parts of the flood plain. The sandy Sarpy soils are on small mounds. Included soils make up about 10 percent of the map unit.

Permeability is moderately rapid in the Cass soil, and runoff is slow. Available water capacity is moderate. The content of organic matter is moderately low. The surface layer is friable, and tilth is good.

Nearly all of the acreage is used as wildlife habitat. This soil is generally unsuited to cultivated crops because of the frequent flooding. Also, operating machinery along the stream channels is difficult. The vegetation consists of oak, ash, cottonwood, and hackberry and an understory of mid and tall grasses. This vegetation and the cultivated crops in nearby areas of arable soils provide habitat for many wildlife species, including quail, pheasant, deer, rabbits, squirrels, and numerous songbirds. The abandoned river channels also provide habitat for many wildlife species, including ducks and geese. Establishing feeding areas helps to increase the wildlife populations.

This soil is unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is Vw, and the range site is Sandy Lowland.

Co—Colo silt loam. This deep, nearly level, poorly drained soil is in slightly concave areas on stream terraces. It is subject to rare flooding. Individual areas are irregular in shape and range from 20 to 100 acres in size. Slopes are 0 to 1 percent.

Typically, the surface soil is about 30 inches thick. The upper part is dark gray silt loam, and the lower part is dark gray silty clay loam. The subsoil is dark gray, friable silty clay loam about 6 inches thick. The substratum to a depth of about 60 inches is gray, mottled silty clay loam. In some areas the soil is calcareous below a depth of 12 inches.

Included with this soil in mapping are small areas of Muir soils in the slightly higher areas on the landscape. These soils are well drained. They make up about 5 percent of the map unit.

Permeability is moderate in the Colo soil, and runoff is slow. Available water capacity is high. The shrink-swell potential is moderate. An apparent high water table is at a depth of 1 to 3 feet from winter to early summer. Tilth is fair. If the soil is tilled when it is too wet or too dry, clods form and the natural structure of the soil is destroyed.

Most areas are used for cultivated crops. The remaining areas are used as meadow or wetland. This soil is moderately well suited to grain sorghum. It tends to dry slowly in spring and can be tilled within only a limited range of moisture conditions. Small grain is likely to drown or to grow rank and then lodge before harvest.

This soil is suited to use as meadow or wetland. The native vegetation consists mainly of water-tolerant grasses, cattails, rushes, and some woody species, such as willow and cottonwood. It provides habitat for many wildlife species and numerous songbirds.

This soil is generally unsuited to building site development because of the flooding and the wetness.

The land capability classification is IIw, and the range site is Subirrigated.

Cr—Crete silt loam, 0 to 1 percent slopes. This deep, nearly level, moderately well drained soil is on the tops of ridges in the uplands. Individual areas are irregular in shape and range from about 15 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 5 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 38 inches thick. The upper part is very dark grayish brown, firm silty clay loam; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam. In some areas the upper part of the subsoil is mottled.

Permeability is slow in the upper part of the subsoil and moderate or moderately slow in the lower part. Runoff is slow. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, sorghum, soybeans, and alfalfa. Tillage is sometimes delayed in spring because of the wetness. Returning crop residue to the soil increases the rate of water infiltration, conserves moisture, improves fertility, and helps to maintain good tilth.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the clayey subsoil. Enlarging the absorption field also helps to overcome this limitation. The soil is moderately well suited to sewage lagoons. Seepage is a limitation, but it can be controlled by sealing the lagoon. In places the clayey subsoil can be used to seal the lagoon.

The land capability classification is IIs, and the range site is Clay Upland.

Cs—Crete silty clay loam, 1 to 3 percent slopes. This deep, gently sloping, moderately well drained soil is on the upper side slopes and the tops of ridges in the uplands. Individual areas are irregular in shape and range from 15 to more than 1,000 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is about 31 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam.

Figure 6.—Cracks caused by shrinking in an area of Crete silty clay loam, 1 to 3 percent slopes.

In eroded areas the surface layer is grayish brown silty clay loam. In some places the substratum is brown clay loam. In other places the darker upper layers are less than 20 inches thick.

Included with this soil in mapping are small areas of Hobbs soils along narrow drainageways. These soils are occasionally flooded. They make up about 5 percent of the map unit.

Permeability is slow in the upper part of the subsoil in the Crete soil and moderate or moderately slow in the lower part. Runoff is medium. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is high in the subsoil (fig. 6). The surface layer is friable, and tilth is good.

Most areas are used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil increases the rate of water infiltration, improves fertility, and helps to prevent surface crusting.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the clayey subsoil. Enlarging the absorption field also helps to overcome this limitation.

This soil is moderately well suited to sewage lagoons. Seepage and the slope are limitations. Sealing the lagoon helps to control seepage. In places the clayey subsoil can be used to seal the lagoon. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIe, and the range site is Clay Upland.

Ct—Crete silty clay loam, 3 to 7 percent slopes. This deep, moderately sloping, moderately well drained soil is on convex side slopes in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is very dark grayish brown, firm silty clay; the next part is dark grayish brown and grayish brown, firm silty clay; and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam. In some places the substratum is brown clay loam. In other places the dark upper layers are less than 20 inches thick.

Included with this soil in mapping are small areas of Hobbs, Lancaster, and Longford soils. The moderately deep Lancaster soils are on the upper part of side slopes. Hobbs soils are along narrow drainageways. They are occasionally flooded. Longford soils are on the lower side slopes. Included soils make up about 10 percent of the map unit.

Permeability is slow in the upper part of the subsoil in the Crete soil and moderate or moderately slow in the lower part. Runoff is medium. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, and tilth is fair.

Most of the acreage is used for cultivated crops. This soil is moderately well suited to wheat, grain sorghum, and alfalfa. Erosion is a hazard in cultivated areas. Terraces, grassed waterways, contour farming, minimum tillage, and crop residue management help to control erosion and maintain tilth and the content of organic matter.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the clayey subsoil. Enlarging the absorption field also helps to overcome the restricted permeability.

This soil is moderately well suited to sewage lagoons. Seepage and the slope are limitations. Sealing the lagoon helps to control seepage. In places the clayey subsoil can be used to seal the lagoon. Some land shaping commonly is needed to overcome the slope.

The land capability classification is IIIe, and the range site is Clay Upland.

Cx—Crete silty clay loam, 3 to 7 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on side slopes in the uplands. Rills are common, and some areas are gullied. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. It is a mixture of the original surface layer and the subsoil. The subsoil is about 25 inches thick. The upper part is dark grayish brown and grayish brown, firm silty clay, and the lower part is light brownish gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is light brownish gray, mottled silt loam. In some areas the surface layer is silty clay. In other areas the dark upper layers are less than 20 inches thick. In places the substratum is brown clay loam.

Included with this soil in mapping are small areas of Hobbs and Longford soils. Hobbs soils are along narrow drainageways. They are occasionally flooded. Longford soils are on the lower side slopes. Included soils make up about 10 percent of the map unit.

Permeability is slow in the upper part of the subsoil in the Crete soil and moderate or moderately slow in the lower part. Runoff is medium. Available water capacity is high. The content of organic matter is low. The shrink-swell potential is high in the subsoil. The surface layer is firm, and tilth is poor. The surface crusts when dry and puddles when wet.

Most areas are used for cultivated crops. Some areas are used as range. This soil is poorly suited to wheat and grain sorghum. Further erosion is a hazard in cultivated areas. Poor tilth inhibits seedling emergence, increases soil compaction, and decreases the rate of water infiltration. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. A cover of grasses helps to control erosion. Range seeding is needed to restore the productivity of abandoned cropland. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the clayey subsoil. Enlarging the absorption field also helps to overcome the restricted permeability.

This soil is moderately well suited to sewage lagoons. Seepage and the slope are limitations. Sealing the lagoon helps to control seepage. In places the clayey subsoil can be used to seal the lagoon. Some land shaping is commonly needed.

The land capability classification is IVe, and the range site is Clay Upland.

Ed—Edalgo silty clay loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 14 inches thick. The upper part is brown, firm silty clay loam, and the lower part is yellowish brown, very firm silty clay. The substratum is brownish yellow and pale brown silty clay. Brownish yellow and grayish brown shale bedrock is at a depth of about 30 inches. In some places the depth to shale bedrock is more than 40 inches.

Included with this soil in mapping are small areas of Crete, Hedville, Lancaster, and Wells soils. The deep Crete soils are on the upper side slopes. The shallow Hedville soils are on the steeper slopes and breaks. Lancaster soils have a loamy subsoil. They are on the upper side slopes. The deep Wells soils are on the lower side slopes. Included soils make up about 15 percent of the map unit.

Permeability is very slow in the Edalgo soil, and runoff is medium. Available water capacity is low. The content of organic matter is moderate. The shrink-swell potential is high in the subsoil. The surface layer is firm, and tilth is poor. Root penetration is restricted below a depth of about 30 inches.

Most areas are used as range, but a few are used for cultivated crops. This soil is poorly suited to cultivated crops. Wheat and grain sorghum are the main crops. Erosion is a hazard in cultivated areas. The poor tilth inhibits seedling emergence, increases soil compaction, and decreases the rate of water infiltration. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, maintain the content of organic matter, and improve tilth.

This soil is best suited to range. The native vegetation is mainly big bluestem, little bluestem, and indiangrass. Overgrazing reduces the extent of the plant cover and causes the deterioration of the plant community. Under these conditions, the taller grasses are replaced by less productive grasses and weeds, such as tall dropseed and western ragweed. Proper stocking rates, a uniform distribution of grazing, and timely deferment of grazing help to keep the range in good condition. In some places the invasion of brushy plants, such as sumac and eastern redcedar, is a management concern. Timely burning helps to control the trees and brush. Range seeding is needed to restore the productivity of abandoned cropland.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is generally unsuitable as a site for septic tank absorption fields because of the very slow permeability, seepage, and the thin layer of soil over bedrock. It is poorly suited to sewage lagoons because of seepage. Sealing the bottom of the lagoon helps to prevent excess seepage into fractures in the bedrock.

The land capability classification is IVe, and the range site is Clay Upland.

Eu—Eudora loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains. Individual areas are irregular in shape and range from 10 to several hundred acres in size. Slopes range from 0 to 2 percent.

Typically, the surface layer is dark grayish brown loam about 4 inches thick. The subsurface layer also is dark grayish brown loam. It is about 10 inches thick. The upper part of the substratum is brown, very friable very fine sandy loam. The next part is brown, friable silt loam. The lower part to a depth of about 60 inches is brown, very friable very fine sandy loam.

Included with this soil in mapping are a few small areas of Cass soils on the slightly lower flood plains. These soils are loamy. They make up about 5 percent of the map unit.

Permeability is moderate in the Eudora soil, and runoff is slow. Available water capacity is very high. The content of organic matter is moderate. The surface layer is friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. The main management concerns are controlling soil blowing and conserving moisture. Also, the occasional flooding can damage the crops. Minimizing tillage and leaving crop residue on the surface help to control soil blowing, conserve moisture, and help to maintain fertility.

A few areas support native hardwoods. This soil is well suited to woodland. The flooding and plant competition limit the establishment and growth of trees. Tree cuttings and seedlings survive and grow well if competing vegetation is controlled by site preparation, including spraying or selective cutting. The dominant species include eastern cottonwood, green ash, and black walnut.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Ho—Hobbs silt loam, occasionally flooded. This deep, nearly level, well drained soil is on flood plains along upland drainageways. Individual areas range from 200 to 1,000 feet in width and from 500 feet to more than a mile in length. They range from 5 to more than 200 acres in size. Slopes range from 0 to 2 percent.

Typically, the surface layer is grayish brown silt loam about 6 inches thick. The substratum to a depth of about 60 inches is friable silt loam. The upper part is stratified light gray and grayish brown, the next part is grayish brown, and the lower part is stratified light gray and grayish brown.

Included with this soil in mapping are small areas of soils that are similar to the Hobbs soil but are more clayey throughout. These soils are in depressions. They make up about 10 percent of the map unit. Also included are frequently flooded, narrow, meandering stream channels that make up 5 to 10 percent of the unit.

Permeability is moderate in the Hobbs soil, and runoff is slow. Available water capacity is very high. The content of organic matter is moderate. The surface layer is friable, and tilth is good.

About half of the acreage is used for cultivated crops, and the rest is used as range or wildlife habitat. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. In some years the flooding damages crops, but in other years the extra moisture increases productivity. Dikes and diversions help to prevent crop damage. Minimizing tillage and leaving crop residue on the surface help to maintain fertility and the content of organic matter and conserve moisture.

This soil is suited to range. In areas where the range is in good condition, the vegetation is mainly big bluestem, little bluestem, and switchgrass. Many areas of range are overgrazed and are in poor condition. Livestock tend to congregate in areas where shade trees and watering facilities are located. In these areas the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition. Placing salt blocks on the steeper adjacent soils also helps to achieve a uniform distribution of grazing.

In wooded areas the dominant species are hackberry, ash, black walnut, and oak. This vegetation provides habitat for many types of wildlife species, including quail, deer, rabbits, squirrels, and numerous songbirds. Effective woodland management practices help to increase the wildlife populations.

This soil is generally unsuited to building site development because of the flooding. Overcoming this hazard is difficult without major flood-control measures.

The land capability classification is IIw, and the range site is Loamy Lowland.

Kp—Kipson silty clay loam, 5 to 30 percent slopes. This shallow, moderately sloping to steep, somewhat excessively drained soil is on side slopes along deeply entrenched drainageways. Individual areas occur as long, narrow bands that follow the contour of the slope. They range from 80 to several hundred acres in size.

Typically, this soil is calcareous throughout. The surface soil is dark gray silty clay loam about 12 inches thick. The next layer is pale yellow, firm silty clay loam about 6 inches thick. Light yellowish brown shale bedrock is at a depth of about 18 inches. In some places the depth to shale bedrock is more than 20 inches. In other places limestone fragments 0.5 foot to 3.0 feet in diameter are on the surface.

Included with this soil in mapping are small areas of Crete, Sogn, and Tully soils; shale and limestone rock outcrop; and very steep areas. The deep Crete soils are on ridgetops and the upper side slopes. The deep Tully soils are on foot slopes below the Kipson soil. Sogn soils have limestone at a depth of less than 20 inches. Sogn soils and limestone rock outcrop are at irregular intervals in areas associated with limestone ledges. Shale rock outcrop makes up some of the steeper areas and breaks. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Kipson soil, and runoff is rapid. Available water capacity is low. The content of organic matter is moderate. The shrink-swell potential is moderate in the subsoil. Root penetration is restricted by shale bedrock below a depth of about 18 inches.

Nearly all areas are used as range. A small acreage is used as native hayland. This soil is generally unsuited to cultivated crops because of the severe hazard of erosion and because rocks at or near the surface interfere with tillage in many areas. It is best suited to range. The native vegetation is mainly little bluestem and big bluestem. Buffalograss, annual broomweed, and other less desirable species invade in severely overgrazed areas. Maintaining an adequate vegetative cover conserves moisture by reducing the runoff rate. In many areas brush control is needed. Proper stocking rates, a uniform distribution of grazing, timely deferment of grazing, timely burning, and a rotation grazing system help to keep the range in good condition and prevent the encroachment of brush.

This soil is poorly suited to dwellings because of the slope. Less land shaping is required if the dwellings are constructed in the smoother, less sloping areas.

This soil generally is unsuitable as a site for septic tank absorption fields because of seepage, the slope, and the thin layer of soil over bedrock. It is poorly suited to sewage lagoons because of seepage and the slope. The construction of sewage lagoons requires borrowing soil or ripping because of the shallowness to bedrock. Sealing the bottom of the lagoon helps to prevent excess seepage into fractures in the bedrock. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction. The deep included soils on the lower side slopes and foot slopes are more favorable sites for sewage lagoons.

The land capability classification is VIe, and the range site is Limy Upland.

Ks—Kipson-Sogn complex, 5 to 30 percent slopes. These moderately sloping to steep, somewhat excessively drained, shallow soils are on side slopes in the uplands. Individual areas are irregular in shape and range from 50 to several hundred acres in size. They are about 70 percent Kipson soil and 15 percent Sogn soil. The two soils are in alternating narrow bands that follow the contour of the slope.

Typically, the Kipson soil is calcareous throughout. The surface soil is dark gray silty clay loam about 12 inches thick. The next layer is pale yellow, firm silty clay loam about 6 inches thick. Light yellowish brown shale bedrock is at a depth of about 18 inches. In some places the depth to shale bedrock is more than 20 inches.

Typically, the surface layer of the Sogn soil is very dark gray silt loam about 8 inches thick. The next layer is very dark grayish brown channery silt loam about 8 inches thick. Hard limestone bedrock is at a depth of about 16 inches. In some areas limestone fragments 0.5 foot to 3.0 feet in diameter are 5 to 50 feet apart on the surface.

Included with these soils in mapping are small areas of Crete and Tully soils and limestone rock outcrop. The deep Crete soils are on the upper side slopes and the tops of ridges. Tully soils are on foot slopes below the Kipson soil. The rock outcrop is on steep breaks below the Sogn soil. Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Kipson and Sogn soils, and runoff is rapid. Available water capacity is low in the Kipson soil and very low in the Sogn soil. The content of organic matter is moderate in both soils. The shrink-swell potential also is moderate. Root penetration is restricted by shale bedrock below a depth of about 18 inches in the Kipson soil and by limestone below a depth of about 16 inches in the Sogn soil.

Nearly all areas are used as range. These soils are generally unsuited to cultivated crops because of the severe hazard of erosion and because rocks at or near the surface interfere with tillage in many areas. The soils are best suited to range. The native vegetation is mainly little bluestem and big bluestem. Sideoats grama is more common on the Sogn soil than on the Kipson soil. Buffalograss, annual broomweed, and other less desirable species invade in severely overgrazed areas. Maintaining an adequate vegetative cover conserves moisture by reducing the runoff rate. In many areas brush control is needed. Proper stocking rates, a uniform distribution of grazing, timely deferment of grazing, timely burning, and a rotation grazing system help to keep the range in good condition and prevent the encroachment of brush.

The Kipson soil is poorly suited to dwellings because of the slope. Less land shaping is required if the dwellings are constructed in the smoother, less sloping areas. The Sogn soil is generally unsuited to building site development because of the depth to hard limestone bedrock.

The Kipson soil is generally unsuited to septic tank absorption fields because of the thin layer of soil over bedrock. It is poorly suited to sewage lagoons because of seepage and the slope. Fill material should be borrowed or the bedrock ripped if sewage lagoons are constructed. Sealing the bottom of the lagoon helps to prevent excessive seepage into fractures in the bedrock. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction. The deep included soils on the lower side slopes and on foot slopes are more favorable sites for lagoons.

The land capability classification is VIe. The Kipson soil is in the Limy Upland range site, and the Sogn soil is in the Shallow Limy range site.

Lc—Lancaster loam, 3 to 7 percent slopes. This moderately deep, moderately sloping, well drained soil is on ridgetops and side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is brown loam about 9 inches thick. The subsoil is about 20 inches thick. The upper part is reddish brown and brown, firm clay loam; the next part is yellowish red, firm clay loam; and the lower part is yellowish red and light gray, firm sandy clay loam. Soft sandstone and sandy shale bedrock is at a depth of about 29 inches. In some places the depth to bedrock is more than 40 inches.

Included with this soil in mapping are small areas of Crete, Edalgo, and Hedville soils. The deep Crete soils are in the less sloping areas. Edalgo soils have a clayey subsoil. They are in landscape positions similar to those of the Lancaster soil. The shallow Hedville soils are on ridgetops. Included soils make up about 15 percent of the map unit.

Permeability is moderate in the Lancaster soil, and runoff is medium. Available water capacity is low. The content of organic matter is moderate. The shrink-swell potential is moderate in the subsoil. The surface layer is friable, and tilth is good. Root penetration is restricted below a depth of about 29 inches.

About half of the acreage is used for cultivated crops, and the rest is used as range. This soil is moderately well suited to cultivated crops. Wheat, grain sorghum, and forage sorghum are the main crops. Erosion and droughtiness are management concerns in cultivated areas. Terracing, establishing grassed waterways, farming on the contour, and returning crop residue to the soil conserve moisture and help to prevent excessive soil loss. The depth to bedrock should be considered when a terrace system is designed. In a few areas where terraces have been built, the root zone is severely restricted because most of the soil overlying the bedrock has been removed.

This soil is suited to range. The native vegetation is mainly big bluestem, little bluestem, and indiangrass. Less productive grasses and weeds, such as blue grama and ragweed, invade in overgrazed areas. Well distributed watering and salting facilities and properly located fences improve the distribution of grazing.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and footings help to prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used. The depth to bedrock is a limitation on sites for dwellings with basements, but in most places the bedrock is soft and can be excavated.

This soil is generally unsuited to septic tank absorption fields because of the thin layer of soil over bedrock and seepage. It is poorly suited to sewage lagoons because of seepage. Sealing the bottom of the lagoon helps to prevent excess seepage into fractures in the bedrock.

The land capability classification is IVe, and the range site is Loamy Upland.

Lh—Lancaster-Hedville loams, 5 to 30 percent slopes. These soils are on side slopes and ridgetops in the uplands. The moderately deep, moderately sloping and strongly sloping, well drained Lancaster soil is on the middle and upper parts of the side slopes. The shallow, moderately sloping to steep, somewhat excessively drained Hedville soil is on narrow, convex ridges and breaks and on the lower side slopes along some drainageways. The soils are dissected by deeply entrenched drainageways. Individual areas are irregular in shape and range from 5 to several hundred acres in size. They are about 50 percent Lancaster soil and 35 percent Hedville soil.

Typically, the surface layer of the Lancaster soil is brown loam about 9 inches thick. The subsoil is about 20 inches thick. The upper part is reddish brown and brown, firm clay loam; the next part is yellowish red, firm clay loam; and the lower part is yellowish red and light gray, firm sandy clay loam. Soft sandstone and sandy shale bedrock is at a depth of about 29 inches. In some places the depth to bedrock is more than 40 inches.

Typically, the surface layer of the Hedville soil is dark grayish brown loam about 10 inches thick. The subsurface layer is brown loam about 5 inches thick. Sandstone bedrock is at a depth of about 15 inches. In some places sandstone fragments 1 to 3 feet in diameter are 5 to 100 feet apart on the surface.

Included with these soils in mapping are small areas of Crete, Edalgo, and Hobbs soils and sandstone rock outcrop. Also included are loamy, poorly drained soils on flood plains along drainageways. The deep Crete soils are on the less sloping ridgetops. Edalgo soils have a clayey subsoil. They are in landscape positions similar to those of the Lancaster soil. The deep, silty Hobbs soils are on flood plains along the drainageways. The rock outcrop is on the steeper points, breaks, and side slopes (fig. 7). Included areas make up about 15 percent of the map unit.

Permeability is moderate in the Lancaster and Hedville soils, and runoff is rapid. Available water capacity is low in the Lancaster soil and very low in the Hedville soil. The shrink-swell potential is moderate in

Figure 7.—Sandstone rock outcrop in an area of Lancaster-Hedville loams, 5 to 30 percent slopes.

the subsoil of the Lancaster soil. Root penetration is restricted by shale bedrock below a depth of about 29 inches in the Lancaster soil and by sandstone bedrock below a depth of about 15 inches in the Hedville soil.

Nearly all of the acreage is used as range. These soils are generally unsuited to cultivated crops because the hazard of erosion is severe. They are suited to range. The native vegetation is mainly big bluestem, little bluestem, and indiangrass, but these grasses are replaced by less desirable plants, such as blue grama and tall dropseed, in overgrazed areas. Proper stocking rates help to keep the range in good condition. Some of the steeper areas are infrequently grazed by livestock. Well distributed watering and salting facilities and properly located fences improve the distribution of grazing. Suitable sites for stock-water ponds generally are available.

The Lancaster soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. The depth to bedrock is an additional limitation on sites for dwellings with basements, but in most areas the bedrock is soft and can be easily excavated. Properly designing and reinforcing foundations and footings help to prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used. The Hedville soil is generally unsuited to building site development because of the shallowness to bedrock and the slope.

The Lancaster soil is generally unsuited to septic tank absorption fields because of the thin layer of soil over bedrock and because of seepage. It is poorly suited to sewage lagoons because of seepage and the slope. Sealing the bottom of the lagoon helps to prevent excess seepage into fractures in the bedrock. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is VIe. The Lancaster soil is in the Loamy Upland range site, and the Hedville soil is in the Shallow Sandstone range site.

Lo—Longford silt loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes along creek and river valleys. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsurface layer also is dark grayish brown silt loam. It is about 5 inches thick. The subsoil is silty clay loam about 28 inches thick. The upper part is brown and firm, the next part is brown and firm or very firm, and the lower part is strong brown and firm. The substratum to a depth of about 60 inches is reddish yellow clay loam.

Included with this soil in mapping are small areas of Crete, Hobbs, and Lancaster soils. Crete soils have a subsoil that is more clayey than that of the Longford soil. They are on the ridgetops and the upper side slopes. The silty Hobbs soils are along narrow drainageways. They are occasionally flooded. The moderately deep Lancaster soils have a loamy subsoil. They are in landscape positions similar to those of the Longford soil. Included soils make up about 15 percent of the map unit.

Permeability is moderately slow in the Longford soil, and runoff is medium. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, and tilth is good.

Most of the acreage is used for cultivated crops. The rest is used as range. This soil is moderately well suited to wheat, grain sorghum, and soybeans. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The native vegetation is mainly mid and tall grasses, such as little bluestem and big bluestem. Overgrazing reduces the vigor and growth of the grasses. Under these conditions, the more desirable grasses are replaced by less productive grasses and by weeds. Proper stocking rates, a uniform distribution of grazing, and deferred grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the moderately slow permeability. Enlarging the absorption field helps to overcome this limitation.

This soil is only moderately well suited to sewage lagoons because of the slope. Some land shaping is commonly needed.

The land capability classification is IIIe, and the range site is Loamy Upland.

Lx—Longford silty clay loam, 3 to 7 percent slopes, eroded. This deep, moderately sloping, well drained soil is on side slopes along creek and river valleys. In some areas rills and gullies are common. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is brown silty clay loam about 6 inches thick. It is a mixture of the original surface layer and the subsoil. The subsoil is firm silty clay loam about 25 inches thick. The upper part is brown, and the lower part is strong brown. The substratum to a depth of about 60 inches is reddish yellow clay loam. In some places the surface layer is silt loam and is thicker.

Included with this soil in mapping are small areas of Crete and Lancaster soils. Crete soils contain more clay in the subsoil than the Longford soil. They are on the upper side slopes and the tops of ridges. The moderately deep Lancaster soils have a loamy subsoil. They are in landscape positions similar to those of the Longford soil. Included soils make up about 10 percent of the map unit.

Permeability is moderately slow in the Longford soil, and runoff is medium. Available water capacity is high. The content of organic matter is low. The shrink-swell potential is high in the subsoil. The surface layer is firm, and tilth is poor. The surface crusts when dry and puddles when wet.

Most of the acreage is used for cultivated crops. The rest is used as range. This soil is poorly suited to cultivated crops. Wheat and grain sorghum are the main crops. Further erosion is a hazard in cultivated areas. Terraces, grassed waterways, contour farming, crop residue management, and minimum tillage help to control erosion, maintain the content of organic matter, and improve tilth.

This soil is suited to range. A cover of range plants helps to control erosion. Range seeding is needed to restore the productivity of abandoned cropland. Overgrazing retards the growth and reduces the vigor of grasses. Proper stocking rates, deferred grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the moderately slow permeability. Enlarging the absorption field helps to overcome this limitation.

This soil is only moderately well suited to sewage lagoons because of the slope. Some land shaping is commonly needed.

The land capability classification is IVe, and the range site is Loamy Upland.

Mc—Mayberry clay loam, 3 to 7 percent slopes. This deep, moderately sloping, moderately well drained soil is on convex side slopes in the uplands. Individual areas are irregular in shape and range from 10 to several hundred acres in size.

Typically, the surface layer is dark grayish brown clay loam about 6 inches thick. The subsurface layer is very dark grayish brown clay loam about 3 inches thick. The subsoil is about 36 inches thick. The upper part is dark grayish brown, firm clay loam; the next part is brown and strong brown, mottled, very firm clay; and the lower part is yellowish brown, mottled, firm clay. The substratum to a depth of about 60 inches is brownish yellow, mottled clay loam. In areas where the upper part of the subsoil has been mixed with the surface layer by tillage, the surface layer is clay. In some places the soil is less red. In other places the subsoil and substratum contain as much as 15 percent rounded pebbles.

Included with this soil in mapping are small areas of Crete and Morrill soils. Crete soils are on the less sloping ridgetops and the upper side slopes. The well drained Morrill soils are on the lower side slopes. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Mayberry soil, and runoff is medium. Available water capacity and the content of organic matter are moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, but tilth is only fair. A seasonal high water table is at a depth of about 1 to 3 feet in spring. The surface tends to crust.

Most areas are used for cultivated crops. Some areas are used as range. This soil is moderately well suited to wheat, soybeans, and grain sorghum. Erosion is a hazard in cultivated areas. Terraces, grassed waterways, contour farming, and minimum tillage help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, reduces surface crusting, and increases the rate of water infiltration.

This soil is suited to range. A cover of grasses helps to control erosion. Range seeding is needed to restore the productivity of abandoned cropland. The vegetation is mainly big bluestem, little bluestem, and indiangrass. Blue grama and buffalograss are dominant in overgrazed areas. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential and the wetness are limitations. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce the damage caused by wetness and by the shrinking and swelling of the soil. Slab-on-grade foundations should not be used.

This soil is generally unsuited to septic tank absorption fields because of the slow permeability and the wetness. It is only moderately well suited to sewage lagoons because of the slope. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Clay Upland.

Mh—Morrill loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 200 acres in size.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. The subsoil is clay loam about 35 inches thick. The upper part is brown and firm, the next part is reddish brown and firm, and the lower part is reddish brown and friable. The substratum to a depth of about 60 inches is reddish brown and light yellowish brown sandy clay loam. In some places the substratum is sand and gravel.

Included with this soil in mapping are small areas of Mayberry soils on the upper side slopes. These soils are moderately well drained. They make up about 10 percent of the map unit.

Permeability is moderately slow in the Morrill soil, and runoff is medium. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is moderate in the subsoil. The surface layer is friable, and tilth is good.

Most areas are used for cultivated crops. This soil is moderately well suited to wheat, soybeans, and grain sorghum. Erosion is a hazard in cultivated areas. Terracing, establishing grassed waterways, farming on the contour, returning crop residue to the soil, and minimizing tillage help to control erosion and maintain tilth and the content of organic matter.

A few areas support native hardwoods. This soil is moderately well suited to woodland. Plant competition limits the establishment and growth of trees. Tree cuttings and seedlings survive and grow well if competing vegetation is controlled by site preparation, including spraying or selective cutting. The dominant species include black walnut, bur oak, hackberry, and green ash.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water help to prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the moderately slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the subsoil. Enlarging the absorption field also helps to overcome the restricted permeability.

This soil is moderately well suited to sewage lagoons. Seepage and the slope are limitations. Sealing the lagoon helps to control seepage. Some land shaping is commonly needed to overcome the slope.

The land capability classification is IIIe, and the range site is Loamy Upland.

Mm—Morrill loam, 7 to 12 percent slopes. This deep, strongly sloping, well drained soil is on side slopes in the uplands. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is firm clay loam about 38 inches thick. The upper part is brown, the next part is dark reddish brown and reddish brown, and the lower part is strong brown. The substratum to a depth of about 60 inches is strong brown sandy loam. In some places the substratum is sand and gravel.

Included with this soil in mapping are small areas of Jansen and Mayberry soils. The well drained Jansen soils are on the lower side slopes. The moderately well drained Mayberry soils are on the upper side slopes. Also included are some steep slopes, sharp breaks, and areas of shale rock outcrop along deeply entrenched drainageways. Included areas make up about 15 percent of the map unit.

Permeability is moderately slow in the Morrill soil, and runoff is rapid. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is moderate in the subsoil.

Most areas are used as range. This soil is poorly suited to cultivated crops because of the severe hazard of erosion. It is suited to range. The native vegetation is mainly big bluestem, little bluestem, and indiangrass. Blue grama, buffalograss, and sideoats grama are dominant in overgrazed areas. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is moderately well suited to woodland. Plant competition limits the establishment and growth of trees. Tree cuttings and seedlings survive and grow well if competing vegetation is controlled by site preparation, including spraying or selective cutting. A few areas support oak, ash, and hackberry. This vegetation provides habitat for many types of wildlife species, including quail, deer, rabbits, squirrels, and numerous songbirds. Proper grazing use and the establishment of feeding areas help to increase the wildlife populations.

This soil is moderately well suited to dwellings. The shrink-swell potential and the slope are limitations. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water help to prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used. Less land shaping is required if dwellings are constructed in the less sloping areas.

This soil is poorly suited to septic tank absorption fields because of the moderately slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the subsoil. Also, the lateral lines should be installed on the contour. Enlarging the absorption field also helps to overcome the restricted permeability.

This soil is poorly suited to sewage lagoons because of the slope. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The land capability classification is IVe, and the range site is Loamy Upland.

Mp—Morrill-Jansen loams, 7 to 20 percent slopes. These deep, strongly sloping and moderately steep, well drained soils are on side slopes along creek and river valleys. The Morrill soil is on the upper side slopes. The Jansen soil is on the lower side slopes below the Morrill soil. Individual areas are long and narrow and range from 20 to 100 acres in size. They are about 50 percent Morrill soil and 45 percent Jansen soil.

Typically, the surface soil of the Morrill soil is very dark grayish brown loam about 15 inches thick. The subsoil is about 25 inches thick. The upper part is dark brown and brown, firm clay loam, and the lower part is brown, firm sandy clay loam. The substratum to a depth of about 60 inches is reddish brown and light reddish brown sandy clay loam. In some places sand and gravel are below a depth of 40 inches.

Typically, the surface layer of the Jansen soil is dark grayish brown loam about 8 inches thick. The subsoil is about 22 inches thick. The upper part is dark grayish brown, friable clay loam, and the lower part is brown, firm sandy clay loam. The substratum to a depth of about 60 inches is brown. The upper part is loamy coarse sand, and the lower part is gravelly coarse sand. In some places shale is below a depth of 30 inches. In other places the depth to sand and gravel is less than 20 inches.

Included with these soils in mapping are small areas of Mayberry soils on the upper side slopes. These included soils are moderately well drained. They make up about 5 percent of the map unit.

Permeability is moderately slow in the Morrill soil. It is moderate in the upper part of the Jansen soil and rapid in the lower part. Runoff is rapid on the Morrill soil and medium on the Jansen soil. Available water capacity is high in the Morrill soil and moderate in the Jansen soil. The content of organic matter is moderate in both soils. The shrink-swell potential is moderate in the subsoil of both soils.

A few areas support native hardwoods. The Morrill soil is moderately well suited to woodland, but the Jansen soil is poorly suited. The hazard of erosion, the equipment limitation, seedling mortality, and plant competition are moderate management concerns.

Nearly all of the acreage is used as range. These soils are generally unsuited to cultivated crops because of the severe hazard of erosion. They are suited to range. The native vegetation is mainly big bluestem, little bluestem, and indiangrass. Blue grama, buffalograss, and sideoats grama are dominant in overgrazed areas. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

These soils are moderately well suited to dwellings. The shrink-swell potential and the slope are limitations. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water help to prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used. Less land shaping is required if dwellings are constructed in the less sloping areas.

The Morrill soil is poorly suited to septic tank absorption fields because of the moderately slow permeability. The effluent is more readily absorbed if the lateral lines are installed below the subsoil. Also, the lateral lines in these fields should be installed on the contour. Enlarging the absorption field also helps to overcome the restricted permeability. The soil is poorly suited to sewage lagoons because of the slope. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The Jansen soil is poorly suited to septic tank absorption fields. The soil readily absorbs but does not adequately filter the effluent. The poor filtering capacity may result in the pollution of ground water. The soil is poorly suited to sewage lagoons because of seepage and the slope. Sealing the lagoon helps to control seepage. If the less sloping areas are selected as sites for lagoons, less leveling and banking will be needed during construction.

The Jansen soil is a probable source of sand, and many areas have sand pits. Land smoothing and range seeding are needed to restore the productivity of areas around abandoned sand pits.

The land capability classification is VIe. Both soils are in the Loamy Upland range site.

Mu—Muir silt loam. This deep, nearly level, well drained soil is on stream terraces. It is subject to rare flooding. Individual areas are irregular in shape and range from 10 to several hundred acres in size. Slopes range from 0 to 2 percent.

Typically, the surface layer is grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam about 11 inches thick. The subsoil extends to a depth of about 60 inches. It is friable silt loam. It is dark grayish brown in the upper part and grayish brown in the lower part. In some places the lower part of the subsoil is more clayey.

Included with this soil in mapping are small areas of Colo soils in the slightly lower positions on the landscape. These soils are poorly drained. They make up about 2 percent of the map unit.

Permeability is moderate in the Muir soil, and runoff is slow. Available water capacity is very high. The content of organic matter is moderate. The surface layer is friable, and tilth is good.

Nearly all of the acreage is used for cultivated crops. This soil is well suited to wheat, grain sorghum, soybeans, and alfalfa. The main management concerns are maintaining fertility and tilth. Minimizing tillage and returning crop residue to the soil improve fertility, help to prevent surface crusting, and increase the rate of water infiltration.

This soil is poorly suited to dwellings because of flooding. Dikes, levees, and other structures reduce this hazard. Onsite inspection and knowledge of the history of flooding in a given area are needed when building sites are selected.

This soil is moderately well suited to septic tank absorption fields and sewage lagoons. The flooding is a hazard on sites for septic tank systems. Levees reduce this hazard. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon with less permeable material.

The land capability classification is I, and the range site is Loamy Terrace.

Sa—Sarpy loamy fine sand, undulating. This deep, excessively drained soil is on stream terraces. It is subject to rare flooding. Individual areas are irregular in shape and range from 10 to about 100 acres in size. Slopes range from 0 to 5 percent.

Typically, the surface layer is grayish brown loamy fine sand about 8 inches thick. The upper part of the substratum is brown loamy fine sand. The lower part to a depth of about 60 inches is pale brown fine sand.

Included with this soil in mapping are small areas of the loamy, well drained Cass and Eudora soils. These soils are in the lower, concave areas. Also included are small areas of sandy, strongly sloping soils. They are on uplands in the southern part of the county, near Clifton. Included soils make up about 15 percent of the map unit.

Permeability is rapid in the Sarpy soil, and runoff is slow. Available water capacity and the content of organic matter are low. The surface layer is very friable, and tilth is good.

About half of the acreage is used for cultivated crops, and the rest is used as range. This soil is very poorly suited to dryland crops. Wheat is the main cultivated crop. The low available water capacity and the severe hazard of soil blowing are the main management concerns. Minimizing tillage and leaving crop residue on the surface help to control soil blowing, conserve moisture, and improve fertility.

This soil is suited to range. The native vegetation is mainly little bluestem, big bluestem, and prairie sandreed, but annual weeds are dominant in overgrazed areas. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition. Range seeding is needed to restore the productivity of abandoned cropland.

This soil is moderately well suited to woodland. Seedling mortality is a severe hazard because of droughtiness and the sandy surface layer. Thinning and selective harvesting improve the stand.

This soil is poorly suited to dwellings because of flooding. Dikes, levees, and other structures reduce this hazard. Onsite investigation and knowledge of the history of flooding in a given area are needed when building sites are selected.

This soil is poorly suited to septic tank absorption fields and sewage lagoons. It readily absorbs but does not adequately filter the effluent in septic tank systems. The poor filtering capacity may result in the pollution of ground water. Seepage is a limitation on sites for sewage lagoons. It can be controlled by sealing the lagoon with less permeable material.

The land capability classification is VIs, and the range site is Sands.

Tu—Tully silty clay loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on slightly concave foot slopes. Individual areas are irregular in shape and range from 80 to 200 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil is about 49 inches thick. The upper part is very dark grayish brown, firm silty clay loam; the next part is dark grayish brown, very firm silty clay; and the lower part is brown, very firm silty clay. The substratum to a depth of about 60 inches is brown silty clay loam. In some places shale bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Crete soils on side slopes above the Tully soil. These soils are moderately well drained. They make up about 10 percent of the map unit.

Permeability is slow in the Tully soil, and runoff is medium. Available water capacity and the content of organic matter are moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, but tilth is only fair.

About half of the acreage is used for cultivated crops, and the rest is used as range. This soil is moderately well suited to wheat and grain sorghum. Erosion is a hazard in cultivated areas. Terraces, contour farming, and minimum tillage help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The native vegetation is mainly big bluestem, little bluestem, indiangrass, and switchgrass. Blue grama, buffalograss, and sideoats grama are dominant in overgrazed areas. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. Enlarging the absorption field can help to overcome this limitation. The soil is moderately well suited to sewage lagoons. The slope is a limitation. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Loamy Upland.

Ty—Tully silty clay loam, 5 to 12 percent slopes. This deep, strongly sloping, well drained soil is on slightly concave foot slopes in the western part of the county. Individual areas are irregular in shape and range from 40 to 200 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil is about 49 inches thick. The upper part is very dark grayish brown, firm silty clay loam; the next part is dark grayish brown and brown, very firm silty clay; and the lower part is brown, very firm silty clay. The substratum to a depth of about 60 inches is brown silty clay loam. In some places shale bedrock is at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of Crete soils on side slopes below the Tully soil. Also included are small areas of soils that are calcareous throughout. Included soils make up about 15 percent of the map unit.

Permeability is slow in the Tully soil, and runoff is medium. Available water capacity and the content of organic matter are moderate. The shrink-swell potential is high in the subsoil. The surface layer is friable, but tilth is only fair.

About half of the acreage is used for cultivated crops, and the rest is used as range. This soil is poorly suited to wheat and grain sorghum. Erosion is a hazard in cultivated areas. Terraces, contour farming, and minimum tillage help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The native vegetation is mainly big bluestem, little bluestem, indiangrass, and switchgrass. Blue grama, buffalograss, and sideoats grama are dominant in overgrazed areas. Proper stocking rates, timely deferment of grazing, and a uniform distribution of grazing help to keep the range in good condition.

This soil is poorly suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and installing foundation drains that are sealed from surface water reduce or prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is poorly suited to septic tank absorption fields because of the slow permeability. Enlarging the absorption field helps to overcome this limitation. The soil is poorly suited to sewage lagoons. The slope is a limitation. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is IVe, and the range site is Loamy Upland.

We—Wells loam, 3 to 7 percent slopes. This deep, moderately sloping, well drained soil is on convex or slightly concave side slopes in the uplands. Individual areas are irregular in shape and range from 5 to 300 acres in size.

Typically, the surface layer is dark grayish brown loam about 10 inches thick. The subsoil is about 45 inches thick. The upper part is brown, friable clay loam; the next part is yellowish red, firm or friable clay loam; and the lower part is yellowish red, mottled, firm sandy clay loam. The substratum to a depth of about 60 inches is reddish yellow, mottled sandy clay loam. In some places the soil is underlain with sandstone bedrock at a depth of 40 to 60 inches.

Included with this soil in mapping are small areas of the moderately deep Lancaster soils and the shallow Hedville soils. These soils are on the upper parts of side slopes. They make up about 10 percent of the map unit.

Permeability is moderate in the Wells soil, and runoff is medium. Available water capacity is high. The content of organic matter is moderate. The shrink-swell potential is moderate in the subsoil. The surface layer is friable, and tilth is good.

About half of the acreage is used for cultivated crops, and the rest is used as range. This soil is moderately well suited to wheat and grain sorghum. Erosion is a hazard in cultivated areas. Minimum tillage, grassed waterways, terraces, and contour farming help to prevent excessive soil loss. Returning crop residue to the soil improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

This soil is suited to range. The native vegetation is mainly big bluestem, little bluestem, indiangrass, and switchgrass. Sideoats grama, tall dropseed, and blue grama replace the more productive grasses in overgrazed areas. Proper stocking rates and a uniform distribution of grazing help to keep the range in good condition. Range seeding is needed to restore the productivity of abandoned cropland.

This soil is moderately well suited to dwellings. The shrink-swell potential is a limitation. Properly designing and reinforcing foundations and footings help to prevent the damage caused by shrinking and swelling. Slab-on-grade foundations should not be used.

This soil is well suited to septic tank absorption fields. It is moderately well suited to sewage lagoons. Seepage and the slope are limitations on sites for sewage lagoons. Seepage can be controlled by sealing the lagoon with less permeable material. If the less sloping areas are selected as sites for sewage lagoons, less leveling and banking will be needed during construction.

The land capability classification is IIIe, and the range site is Loamy Upland.

Prime Farmland

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the Nation's short- and long-range needs for food and fiber. Because the supply of high-quality farmland is limited, the U.S. Department of Agriculture recognizes that responsible levels of government, as well as individuals, should encourage and facilitate the wise use of our Nation's prime farmland.

Prime farmland, as defined by the U.S. Department of Agriculture, is the land that is best suited to food, feed, forage, fiber, and oilseed crops. It may be cultivated land, pasture, woodland, or other land, but it is not urban or built-up land or water areas. It either is used for food or fiber crops or is available for those crops. The soil qualities, growing season, and moisture supply are those needed for a well managed soil to produce a sustained high yield of crops in an economic manner. Prime farmland produces the highest yields with minimal expenditure of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland has an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The level of acidity or alkalinity is acceptable. Prime farmland has few or no rocks and is permeable to water and air. It is not excessively erodible or saturated with water for long periods and is not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent. More detailed information about the criteria for prime farmland is available at the local office of the Soil Conservation Service.

About 423,130 acres in the survey area, or nearly 74 percent of the total acreage, meets the soil requirements for prime farmland. Scattered areas of this land are throughout the county, mainly in associations 1, 2, 3, and 6, which are described under the heading "General Soil Map Units." About 200,000 acres of this prime farmland is used for crops. The crops grown on this land, mainly wheat, grain sorghum, and soybeans, account for an estimated two-thirds of the county's total agricultural income each year.

A recent trend in land use in some parts of the county has been the loss of some prime farmland to industrial and urban uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, and less productive and cannot be easily cultivated.

The map units in the survey area that are considered prime farmland are listed in table 5. This list does not constitute a recommendation for a particular land use. The extent of each listed map unit is shown in table 4. The location is shown on the detailed soil maps at the back of this publication. The soil qualities that affect use and management are described under the heading "Detailed Soil Map Units."

Some soils that have a seasonal high water table qualify as prime farmland only in areas where this limitation has been overcome by drainage measures. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not this limitation has been overcome by corrective measures.

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavioral characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help to prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

The soils in the survey area are assigned to various interpretive groups at the end of each map unit description and in some of the tables. The groups for each map unit also are shown in the section "Interpretive Groups," which follows the tables at the back of this survey.

Crops

Jerry B. Lee, conservation agronomist, Soil Conservation Service, helped prepare this section.

General management needed for crops is suggested in this section. The crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

About 300,000 acres in Washington County, or 55 percent of the total acreage, is used for cultivated crops. During the period 1973 to 1983, wheat was grown on about 40 percent of the cropland; grain sorghum on 30 percent; and corn, alfalfa, soybeans, and oats on 30 percent *(3)*.

Crop production can be increased on most farms by applying the latest technology. This soil survey can facilitate the application of such technology. A system of soil management consists of a combination of practices used to produce crops and grasses. The main concerns in managing the soils in Washington County are controlling water erosion, making the most efficient use of available water, and maintaining soil fertility and tilth.

Water erosion is the major hazard on about 70 percent of the cropland in Washington County. Most of the erosion occurs on soils that have a slope of more than 1 or 2 percent. Examples are Wells, Longford, Morrill, Crete, Tully, Lancaster, Mayberry, and Benfield soils.

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. Secondly, erosion results in the pollution of streams by sediments, nutrients, and pesticides. Control of erosion minimizes

Figure 8.—Terraces and contour farming help to control erosion in an area of Crete silty clay loam, 1 to 3 percent slopes.

this pollution and improves the quality of water.

Erosion-control measures provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration (fig. 8). A cropping system that keeps a plant cover on the surface for extended periods in combination with a conservation tillage system that keeps crop residue on the surface helps to control erosion and preserves the productive capacity of the soils.

Conservation tillage and conservation cropping systems help to control both water erosion and soil blowing. Conservation tillage leaves the stubble of crops or a protective amount of crop residue on the surface before and during the preparation of a seedbed and during at least part of the growing period of the succeeding crop. The conservation tillage systems that are used in the county are no-till, mulch-till, and reduced till. Where no-till is applied, the seed is planted into undisturbed soil and all residue from the preceding crop is left on the surface. Where mulch-till or reduced till is applied, a seedbed is prepared with stubble mulch plows, chisels, field cultivator disks, or blades that leave crop residue on the surface.

Terraces, diversions, grassed waterways, and contour farming are needed in combination with conservation tillage on soils that have a slope of more than 2 percent. They also are needed on soils that have a slope of more than 1 percent and that are not protected by conservation tillage. Terraces and diversions shorten the length of slopes and thus reduce the runoff rate and the susceptibility to erosion. They are most practical on deep, well drained soils that have uniform slopes. Contour farming generally should be used in combination with terraces. It is best suited to those soils that have smooth, uniform slopes and are suitable for terracing.

Organic matter is a storehouse of available plant nutrients. It increases the rate of water infiltration, helps to prevent surface crusting, helps to control water erosion, and improves tilth. Most of the soils in the county that are used for crops have a loamy surface layer. A surface crust forms during periods of heavy rainfall. When dry, the crusted surface is nearly impervious to water. As a result, the runoff rate is increased. Regularly adding organic material and leaving crop residue on the surface minimize surface crusting, increase the rate of water infiltration, and reduce the runoff rate and the hazard of erosion.

Plants on most of the arable soils in the county respond well to applications of nitrate and phosphate fertilizer. On all soils the amount of fertilizer to be applied should be based on the results of soil tests, on the needs of the crop, on the expected level of yields, and on the experience of farmers. The Cooperative Extension Service can help to determine the kinds and amounts of fertilizer needed.

Information about the design of erosion-control measures is available at the local office of the Soil Conservation Service. The latest information about growing crops can be obtained from the Cooperative Extension Service or the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 6. 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. The land capability classification of each map unit also is shown in the table.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations also are considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 6 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey.

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

The capability classification of each map unit is given in the section "Detailed Soil Map Units" and in the yields table.

Rangeland

Michael S. Meurisse, range conservationist, Soil Conservation Service, helped prepare this section.

About 177,000 acres in Washington County, or 31 percent of the total acreage, is range. Livestock, principally cattle, account for about 46 percent of the value of agricultural products in the county.

Most of the livestock enterprises in the county are cow-calf operations. These operations are primarily small stock farms on which small tracts of rangeland are interspersed among larger areas of cropland. In the north-central part of the county, tracts of rangeland tend to be larger and more continuous.

Some livestock producers extend the grazing season with cool-season bromegrass pastures. Many also supplement the forage produced on the range with forage sorghum and crop residue and occasionally with small grain winter pastures. During the winter, hay and protein concentrates are usually fed to the livestock.

Soils strongly influence the potential natural plant community in any given area of the county. The soils and climate of Washington County support a natural plant community that is in a transitional zone between the Mixed Prairie to the west and the Tall Grass Prairie to the east. The dominant grass species in the county, however, are most like those on the Tall Grass Prairie. The plant communities are dominated by bluestems, indiangrass, and switchgrass.

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

Table 7 shows, for each soil, the range site; the total annual production of vegetation in favorable, normal, and unfavorable years; the characteristic vegetation; and the average percentage of each species. Only those soils that are used as rangeland or are suited to rangeland are listed. An explanation of the column headings in table 7 follows.

A *range site* is a distinctive kind of rangeland that produces a characteristic natural plant community that differs from natural plant communities on other range sites in kind, amount, and proportion of range plants. The relationship between soils and vegetation was ascertained during this survey; thus, range sites generally can be determined directly from the soil map. Soil properties that affect moisture supply and plant nutrients have the greatest influence on the productivity of range plants. Soil reaction, salt content, and a seasonal high water table also are important.

Total production is the amount of vegetation that can be expected to grow annually on well managed rangeland that is supporting the potential natural plant community. It includes all vegetation, whether or not it is palatable to grazing animals. It includes the current year's growth of leaves, twigs, and fruits of woody plants. It does not include the increase in stem diameter of trees and shrubs. It is expressed in pounds per acre of air-dry vegetation for favorable, normal, and unfavorable years. In a favorable year, the amount and distribution of precipitation and the temperatures make growing conditions substantially better than average. In a normal year, growing conditions are about average. In an unfavorable year, growing conditions are well below average, generally because of low available soil moisture.

Dry weight is the total annual yield per acre of air-dry vegetation. Yields are adjusted to a common percent of air-dry moisture content. The relationship of green weight to air-dry weight varies according to such factors as exposure, amount of shade, recent rains, and unseasonable dry periods.

Characteristic vegetation—the grasses, forbs, and shrubs that make up most of the potential natural plant community on each soil—is listed by common name. Under *composition,* the expected percentage of the total annual production is given for each species making up the characteristic vegetation. The amount that can be used as forage depends on the kinds of grazing animals and on the grazing season.

Range management requires a knowledge of the kinds of soil and of the potential natural plant community. It also requires an evaluation of the present range condition. Range condition is determined by comparing the present plant community with the potential natural plant community on a particular range site. The more closely the existing community resembles the potential community, the better the range condition. Range condition is an ecological rating only.

The objective in range management is to control grazing so that the plants growing on a site are about the same in kind and amount as the potential natural plant community for that site. Such management generally results in the optimum production of vegetation, control of undesirable brush species, conservation of water, and control of erosion. Sometimes, however, a range condition somewhat below the potential meets grazing needs, provides wildlife habitat, and protects soil and water resources.

Forage production has been reduced in some areas in Washington County because the natural plant community has been depleted by overgrazing and brush invasion. Proper grazing use and an even distribution of grazing help to keep the range in good condition. These measures also improve the range when combined with timely deferment of grazing, planned grazing systems, measures that control brush, and reseeding of marginal cropland and depleted rangeland.

Sound range management, based on soil survey information and other inventory data, is the basis for maintaining or improving forage production on the county's rangeland.

Woodland Management and Productivity

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

Native woodland in Washington County occurs mostly along the major streams and rivers and in the upland drainageways. Eastern redcedar is common on the steep breaks in the Lancaster-Crete-Hedville association and invades some pastured areas.

Approximately 14,800 acres in Washington County, or 2.6 percent of the total acreage, is forested. Almost all of the woodland is suitable for commercial forest land. Most of the forested areas are on bottom land and have good potential for the production of commercial wood products. Only a small part of the forested acreage is managed for commercial wood production, however, because the wooded areas occur as small and scattered tracts that make up only a very small acreage on most farms. Despite the small amount of commercial production, the forest land is an important resource for local use. Expanded markets and improved timber sales would promote the application of forest management practices and preserve the existing woodland.

The areas of bottom land in the Muir-Hobbs-Eudora association and the upland drainageways generally support the hackberry-American elm-green ash forest cover type. Some nearly pure stands of bur oak and concentrations of eastern cottonwood are also in these areas. The composition of species varies from one drainageway to another. Green ash, American elm, boxelder, eastern cottonwood, and bur oak are the prevalent species. Associated species include hackberry, red elm, mulberry, black willow, peachleaf willow, sandbar willow, black walnut, silver maple, eastern redcedar, honeylocust, Osage-orange, Kentucky coffeetree, bitternut hickory, common chokecherry, burningbush, roughleaf dogwood, American plum, smooth sumac, indigobush, American elder, gooseberry, indiancurrant coralberry (buckbrush), and numerous vines, such as bristly greenbrier, American bittersweet, Virginia creeper, and riverbank grape.

Bur oak is limited mostly to the northern half of the county. It is sometimes dominant in areas that have moderately deep to shallow soils or on dry, high banks along the rivers and streams.

Table 8 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for an indicator tree species. The number indicates the volume, in cubic meters per hectare per year, which the indicator species can produce. The number 1 indicates low potential productivity; 2 and 3, moderate; 4 and 5, moderately high; 6 to 8, high; 9 to 11, very high; and 12 to 39, extremely high. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *R* indicates steep slopes; *X*, stoniness or rockiness; *W*, excess water in or on the soil; *T*, toxic substances in the soil; *D*, restricted rooting depth; *C*, clay in the upper part of the soil; *S*, sandy texture; and *F*, a high content of rock fragments in the soil. The letter *A* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: R, X, W, T, D, C, S, and F.

In table 8, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Erosion hazard is the probability that damage will occur as a result of site preparation and cutting where the soil is exposed along roads, skid trails, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed also are subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment or season of use is not significantly restricted by soil factors. Soil wetness can restrict equipment use, but the wet period does not exceed 1 month. A rating of *moderate* indicates that equipment use is moderately restricted because of one or more soil factors. If the soil is wet, the wetness restricts equipment use for a period of 1 to 3 months. A rating of *severe* indicates that equipment use is severely restricted either as to the kind of equipment that can be used or the season of use. If the soil is wet, the wetness restricts equipment use for more than 3 months.

Seedling mortality refers to the death of naturally occurring or planted tree seedlings, as influenced by the kinds of soil, soil wetness, or topographic conditions. The factors used in rating the soils for seedling mortality are texture of the surface layer, depth to a seasonal high water table and the length of the period when the water table is high, rock fragments in the surface layer, effective rooting depth, and slope aspect. A rating of *slight* indicates that seedling mortality is not likely to be a problem under normal conditions. Expected mortality is less than 25 percent. A rating of *moderate* indicates that some problems from seedling mortality can be expected. Extra precautions are advisable. Expected mortality is 25 to 50 percent. A rating of *severe* indicates that seedling mortality is a serious problem. Extra precautions are important. Replanting may be necessary. Expected mortality is more than 50 percent.

Plant competition ratings indicate the degree to which undesirable species are expected to invade and grow when openings are made in the tree canopy. The main factors that affect plant competition are the depth to the water table and the available water capacity. A rating of *slight* indicates that competition from undesirable plants is not likely to prevent natural regeneration or suppress the more desirable species. Planted seedlings can become established without undue competition. A rating of *moderate* indicates that competition may delay the establishment of desirable species. Competition may hamper stand development, but it will not prevent the eventual development of fully stocked stands. A rating of *severe* indicates that competition can be expected to prevent regeneration unless precautionary measures are applied.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *productivity class*. The site index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

The *productivity class*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic meters per hectare per year, indicates the amount of fiber produced in a fully stocked, even-aged, unmanaged stand.

The first species listed under *common trees* for a soil is the indicator species for that soil. It is the dominant species on the soil and the one that determines the ordination class.

Trees to plant are those that are suitable for commercial wood production.

Windbreaks and Environmental Plantings

Keith A. Ticknor, forester, Soil Conservation Service, helped prepare this section.

Windbreaks or environmental plantings are around most farmsteads in Washington County. The dominant species grown as windbreaks and environmental plantings are Siberian elm and eastern redcedar. Other common species on the farmsteads include honeylocust, American elm, Scotch pine, Austrian pine, ponderosa pine, green ash, Kentucky coffeetree, mulberry, eastern redbud, lilac, and honeysuckle.

Tree and shrub planting is a continual need because old trees pass maturity and deteriorate, because some trees are destroyed by insects, disease, or storms, and because new plantings are needed on sites for new homes and on expanding farmsteads.

Field windbreaks in the form of hedgerows of Osage-orange are numerous throughout the county. They were planted to mark property lines and field boundaries and to serve as living fences and as a source of posts. Many hedgerows have been removed to enlarge fields.

In order for windbreaks and environmental plantings to fulfill their intended purpose, the soils on the site should be suited to the trees and shrubs selected for planting. Permeability, available water capacity, fertility, soil depth, and soil texture greatly affect the growth rate of woody plants.

Trees and shrubs generally can be easily established in Washington County. Dry conditions and competition from weeds and grasses are the major management concerns. Proper site preparation before planting and control of competing vegetation after planting are important concerns. Cover crops between tree rows may be needed to protect new plants from hot winds. Supplemental watering provides moisture during dry periods.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help to keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To ensure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 9 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 9 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

Washington County has several areas of scenic, geologic, and historic interest. The Hollenberg Station of the Pony Express is located near Hanover in the northeastern part of the county. Riders changed horses at this station for the next leg of their journey. The Washington State Fishing Lake is located in the north-central part of the county. This 103-acre lake is part of a 320-acre area that is owned and operated by the state as a public recreation area. Facilities are available for fishing, camping, picnicking, and sightseeing.

Mill Creek, farm ponds, and the Little Blue River provide opportunities for fishing. Hunting is good for several species of wild game during the fall and winter seasons.

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

In table 10, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 10 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 13 and interpretations for dwellings without basements and for local roads and streets in table 12.

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

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

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

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

Wildlife Habitat

Robert J. Higgins, biologist, Soil Conservation Service, helped prepare this section.

The primary game species in Washington County are pheasant, prairie chicken, bobwhite quail, mourning dove, cottontail rabbit, and waterfowl. Wild turkey and deer also are hunted.

Nongame species are numerous because of the diversity of habitat types in the county. Cropland, woodland, and grassland are intermixed throughout the county. This intermixture creates the desirable edge effect conducive to many wildlife species. Establishing additional fringe areas generally increases the wildlife populations. The naturally wooded watercourses within the county provide permanent habitat and travel lanes for many species.

Furbearers are common along many of the streams. They are trapped on a limited basis.

Farm ponds, streams, and the Washington State Fishing Lake provide good to excellent fishing. Species commonly caught are largemouth bass, bluegill, crappie, carp, channel catfish, and flathead catfish.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

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

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

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

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, grain sorghum, soybeans, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flooding. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, indiangrass, sunflowers, ragweed, native legumes, goldenrod, wheatgrass, and grama grasses.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, cottonwood, sycamore, elm, hackberry, black walnut, willow, ash, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian olive, autumn olive, crabapple, plum, and fragrant sumac.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, and redcedar.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are gooseberry, dogwood, blackberry, buckbrush, prairie rose, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, cattails, prairie cordgrass, buttonbush, indigobush, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include bobwhite quail, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include owls, hawks, wild turkey, thrushes, woodpeckers, squirrels, opossum, raccoon, and white-tailed deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, redwing blackbirds, and beaver (fig. 9).

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyote, badgers, jackrabbits, hawks, meadowlark, and killdeer.

Technical assistance in planning wildlife developments and in determining suitable vegetation for plantings can be obtained from the Soil Conservation Service. Additional information and assistance can be obtained from the Kansas Fish and Game Commission and from the Cooperative Extension Service.

Engineering

John Eberwein, civil engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations should be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution,

Figure 9.—A beaver dam in a stream flowing through an area of Hobbs silt loam, occasionally flooded.

liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kinds of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, the shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreational uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations.

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

Building Site Development

Table 12 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

Dwellings and *small commercial buildings* are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 or 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), the shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Sanitary Facilities

Table 13 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 13 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 13 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground-water pollution. Ease of excavation and revegetation should be considered.

The ratings in table 13 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 14 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and depth to the water table is less than 1 foot. These soils may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are natural aggregates suitable for commercial use with a minimum of processing. They are used in many kinds of construction. Specifications for each use vary widely. In table 14, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable, loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal high water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 15 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability in the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and the potential for frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to control erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 19.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help to characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classification, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

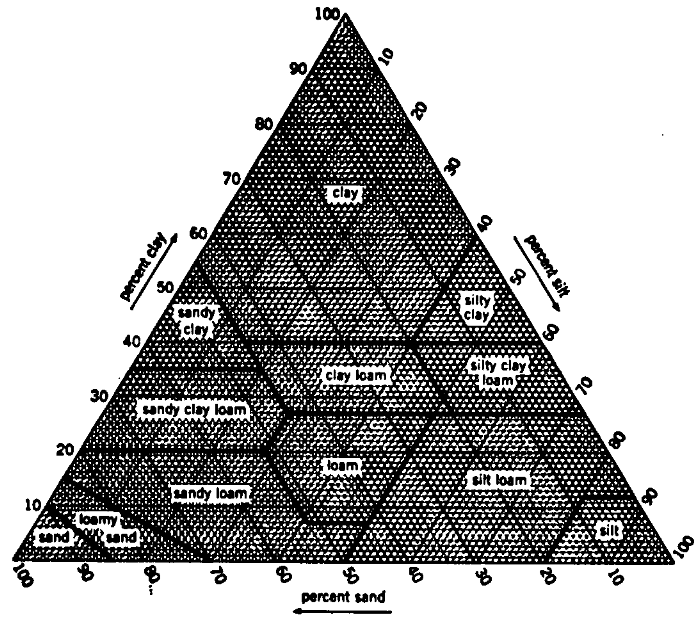

Figure 10.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 16 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given 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 the fraction of the soil that is less than 2 millimeters in diameter (fig. 10). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(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 and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups 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 (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

The estimates of grain-size distribution, liquid limit, and plasticity index are generally rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterberg limits extend a marginal amount (1 or 2 percentage points) across classification boundaries, the classification in the marginal zone is omitted in the table.

Physical and Chemical Properties

Table 17 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated content of clay in each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at ⅓ bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

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

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to soil blowing in cultivated areas. The groups indicate the susceptibility to soil blowing. Soils are grouped according to the following distinctions:

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

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

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

4L. Calcareous loams, silt loams, clay loams, and silty clay loams. These soils are erodible. Crops can be grown if intensive measures to control soil blowing are used.

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

5. Noncalcareous loams and silt loams that are less than 20 percent clay and sandy clay loams, sandy clays, and hemic soil material. These soils are slightly erodible. Crops can be grown if measures to control soil blowing are used.

6. Noncalcareous loams and silt loams that are more than 20 percent clay and noncalcareous clay loams that are less than 35 percent clay. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

7. Silts, noncalcareous silty clay loams that are less than 35 percent clay, and fibric soil material. These soils are very slightly erodible. Crops can be grown if ordinary measures to control soil blowing are used.

8. Soils that are not subject to wind erosion because of coarse fragments on the surface or because of surface wetness.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 17, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 18 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

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

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

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

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

If a soil is assigned to two hydrologic groups in table 18, the first letter is for drained areas and the second is for undrained areas.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 18 gives the frequency and duration of flooding and the time of year when flooding is most likely.

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 the average, once or less in 2 years; and *frequent* that it occurs, on the average, 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.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 18 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 18. Only saturated zones within a depth of about 6 feet are indicated.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured, clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion also is expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering Index Test Data

Table 19 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are representative of the series described in the section "Soil Series and Their Morphology." The soil samples were tested by the Kansas Department of Transportation.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(5)*. Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 20 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Ustolls (*Ust*, meaning intermittent dryness, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiustolls (*Argi*, meaning argillic horizon, plus *ustolls*, the suborder of the Mollisols that has an ustic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Pachic* identifies the subgroup that has a thicker surface layer than is typical for the great group. An example is Pachic Argiustolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Pachic Argiustolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(4)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(5)*. Unless otherwise stated, matrix colors in the descriptions are for dry soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed Soil Map Units."

Benfield Series

The Benfield series consists of moderately deep, well drained, slowly permeable soils on uplands. These soils

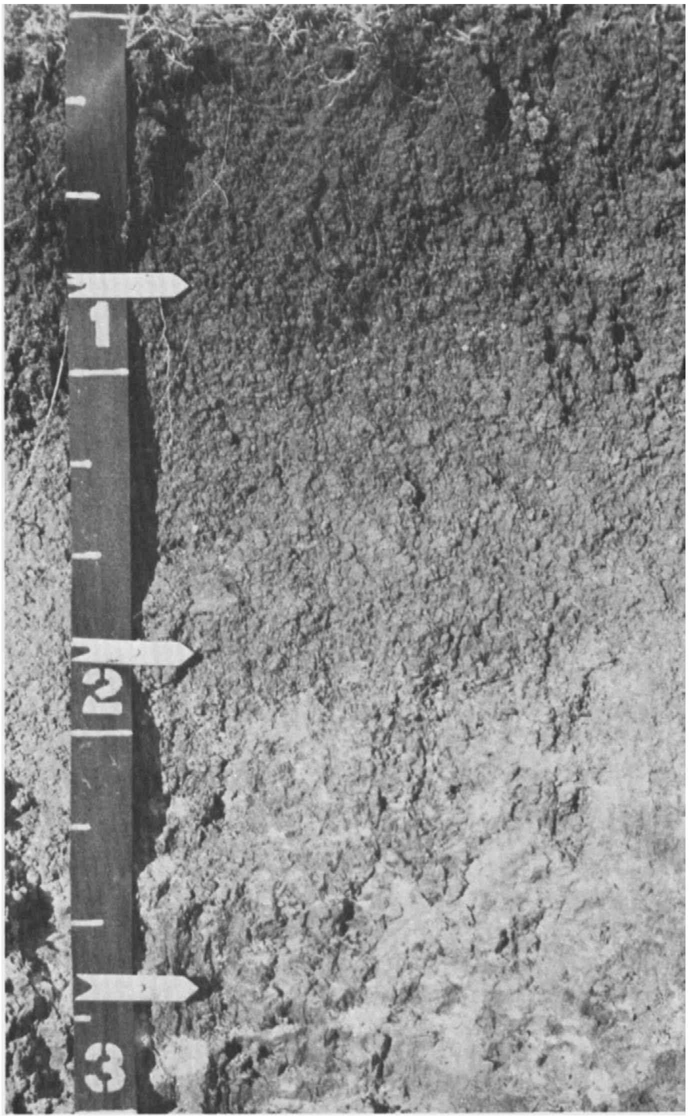

Figure 11.—Profile of Benfield silty clay loam, 3 to 7 percent slopes. Calcareous shale is at a depth of about 32 inches. Depth is marked in feet.

formed in shale residuum (fig. 11). Slope ranges from 3 to 7 percent.

Typical pedon of Benfield silty clay loam, 3 to 7 percent slopes, 2,500 feet north and 2,000 feet east of the southwest corner of sec. 11, T. 2 S., R. 4 E.

Ap—0 to 5 inches; grayish brown (10YR 5/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; mildly alkaline; clear smooth boundary.

BA—5 to 8 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; common fine roots; mildly alkaline; clear smooth boundary.

Bt1—8 to 16 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; moderate fine subangular blocky structure; hard, firm; common fine roots; few faint clay films on faces of peds; mildly alkaline; clear smooth boundary.

Bt2—16 to 21 inches; brown (10YR 5/3) silty clay loam, brown (10YR 4/3) moist; moderate fine subangular blocky structure; very hard, very firm; few fine roots between peds; few faint clay films on faces of peds; mildly alkaline; clear smooth boundary.

C—21 to 24 inches; pale yellow (2.5Y 7/4) silty clay loam, light yellowish brown (2.5Y 6/4) moist; massive; hard, firm; about 3 percent shale fragments; strong effervescence; moderately alkaline; clear wavy boundary.

Cr—24 inches; light gray (5Y 7/2), calcareous shale.

The depth to calcareous shale bedrock ranges from 20 to 40 inches. The mollic epipedon is 7 to 20 inches thick.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It ranges from slightly acid to mildly alkaline. The Bt horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is silty clay or silty clay loam. It ranges from neutral to moderately alkaline. The C horizon has hue of 5YR to 5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is silty clay loam, silty clay, or the cherty analogs of those textures. It is mildly alkaline or moderately alkaline.

Cass Series

The Cass series consists of deep, well drained, moderately rapidly permeable soils on flood plains. These soils formed in loamy alluvium over sandy alluvium. Slope ranges from 0 to 2 percent.

Typical pedon of Cass fine sandy loam, occasionally flooded, 500 feet east and 2,000 feet north of the southwest corner of sec. 31, T. 5 S., R. 1 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, friable; common fine roots; neutral; clear smooth boundary.

A—6 to 17 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) moist; weak fine granular structure; soft, friable; common fine roots; neutral; clear smooth boundary.

AC—17 to 32 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; weak fine granular structure; soft, friable; few very fine roots; neutral; clear smooth boundary.

C1—32 to 42 inches; brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable; mildly alkaline; clear smooth boundary.

C2—42 to 48 inches; grayish brown (10YR 5/2) fine sandy loam, dark grayish brown (10YR 4/2) moist; massive; soft, very friable; mildly alkaline; clear smooth boundary.

C3—48 to 60 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; single grained; loose; mildly alkaline.

The mollic epipedon is 10 to 20 inches thick. The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is typically fine sandy loam or loam, but in some pedons it is silt loam. It ranges from medium acid to neutral. The C horizon has value of 5 to 7 (4 or 5 moist) and chroma of 2 or 3. It ranges from slightly acid to mildly alkaline.

Colo Series

The Colo series consists of deep, poorly drained, moderately permeable soils on stream terraces. These soils formed in silty alluvium. Slope is 0 to 1 percent.

Typical pedon of Colo silt loam, 2,500 feet west and 1,000 feet south of the northeast corner of sec. 7, T. 3 S., R. 4 E.

Ap—0 to 6 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak fine granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

A1—6 to 19 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) moist; weak medium granular structure; slightly hard, friable; many fine roots; slightly acid; gradual smooth boundary.

A2—19 to 30 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) moist; weak fine subangular blocky structure; slightly hard, friable; slightly acid; gradual smooth boundary.

Bg—30 to 36 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; weak medium subangular blocky structure; slightly hard, friable; neutral; gradual smooth boundary.

Cg1—36 to 55 inches; gray (10YR 5/1) silty clay loam, dark gray (10YR 4/1) moist; few fine prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable; neutral; gradual smooth boundary.

Cg2—55 to 60 inches; gray (10YR 5/1) silty clay loam, dark gray (10YR 4/1) moist; few fine prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable; slight effervescence; moderately alkaline.

The mollic epipedon is 36 or more inches thick. The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1. It is typically silt loam, but the range includes silty clay loam. It is slightly acid or neutral. The Bg horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1. The Cg horizon has hue of 10YR or 2.5Y, value of 4 to 6 (3 to 5 moist), and chroma of 1 or 2. It is silty clay loam or silt loam. It ranges from neutral to moderately alkaline.

Crete Series

The Crete series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in loess. Slope ranges from 0 to 7 percent.

Typical pedon of Crete silty clay loam, 1 to 3 percent slopes, 1,100 feet east and 2,400 feet north of the southwest corner of sec. 19, T. 3 S., R. 1 E.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

A—5 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

BA—9 to 12 inches; very dark grayish brown (10YR 3/2) silty clay, very dark brown (10YR 2/2) moist; moderate fine blocky structure; hard, firm; common fine roots; slightly acid; clear smooth boundary.

Bt1—12 to 21 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure; hard, firm; common fine roots; few faint clay films on faces of peds; few distinct organic coatings on vertical faces of peds; neutral; gradual smooth boundary.

Bt2—21 to 26 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) moist; strong medium subangular blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few distinct organic coatings on vertical faces of peds; neutral; gradual smooth boundary.

Bt3—26 to 32 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) moist; moderate fine subangular blocky structure; hard, firm; few faint clay films on faces of peds; few fine rounded carbonate concretions; mildly alkaline; gradual smooth boundary.

BC—32 to 40 inches; light brownish gray (2.5Y 6/2) silty clay loam, grayish brown (2.5Y 5/2) moist; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; slightly hard, friable; few fine rounded carbonate concretions; slight effervescence; moderately alkaline; gradual smooth boundary.

C—40 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, grayish brown (2.5Y 5/2) moist; common medium prominent strong brown (7.5YR 5/6) mottles; massive; slightly hard, friable; few fine rounded carbonate concretions; slight effervescence; moderately alkaline.

The mollic epipedon is 20 to 30 inches thick. In most pedons the depth to lime is 25 to 40 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is typically silty clay loam, but in some pedons it is silt loam. The upper part of the Bt horizon has value of 4 or 5 (3 moist) and chroma of 2 or 3. It is neutral or slightly acid. The lower part has hue of 10YR or 2.5Y, value of 4 to 7 (4 or 5 moist), and chroma of 2 to 4. It is silty clay or silty clay loam. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Edalgo Series

The Edalgo series consists of moderately deep, well drained, very slowly permeable soils on uplands. These soils formed in shale residuum. Slope ranges from 3 to 7 percent.

Typical pedon of Edalgo silty clay loam, 3 to 7 percent slopes, 850 feet south and 100 feet west of the northeast corner of sec. 13, T. 1 S., R. 2 E.

A—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

BA—6 to 10 inches; brown (10YR 4/3) silty clay loam, dark brown (10YR 3/3) moist; weak medium subangular blocky structure; hard, firm; few fine roots; slightly acid; gradual smooth boundary.

Bt—10 to 20 inches; yellowish brown (10YR 5/4) silty clay, dark yellowish brown (10YR 4/4) moist; moderate medium subangular blocky structure; very hard, very firm; few very fine roots; few faint clay films on faces of peds; slightly acid; clear wavy boundary.

C—20 to 30 inches; brownish yellow (10YR 6/6) and pale brown (10YR 6/3) silty clay, yellowish brown (10YR 5/6) and brown (10YR 5/3) moist; massive; very hard, very firm; neutral; clear smooth boundary.

Cr—30 inches; brownish yellow (10YR 6/6) and grayish brown (10YR 5/2) shale.

The depth to shale bedrock ranges from 20 to 40 inches. The mollic epipedon is 8 to 18 inches thick. The solum ranges from medium acid to neutral.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 or 2. It is typically silty clay loam, but the range includes loam and clay loam. The Bt 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 silty clay or silty clay loam. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 4 to 7 (3 to 6 moist), and chroma of 1 to 8. It is silty clay, clay, or silty clay loam. Some pedons do not have a C horizon. Other pedons have carbonate concretions in this horizon.

Eudora Series

The Eudora series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in silty and loamy alluvium. Slope ranges from 0 to 2 percent.

Typical pedon of Eudora loam, occasionally flooded, 2,000 feet east and 500 feet south of the northwest corner of sec. 8, T. 3 S., R. 5 E.

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

A—4 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; soft, very friable; few fine roots; neutral; clear smooth boundary.

C1—14 to 36 inches; brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable; few fine roots; neutral; clear smooth boundary.

C2—36 to 54 inches; brown (10YR 5/3) silt loam, brown (10YR 4/3) moist; massive; slightly hard, friable; neutral; clear smooth boundary.

C3—54 to 60 inches; brown (10YR 5/3) very fine sandy loam, brown (10YR 4/3) moist; massive; soft, very friable; neutral.

The mollic epipedon is 10 to 24 inches thick. The depth to lime ranges from 20 to more than 60 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is typically loam, but the range includes very fine sandy loam and silt loam. It ranges from slightly acid to mildly alkaline. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 1 to 3. It ranges from neutral to moderately alkaline. It is very

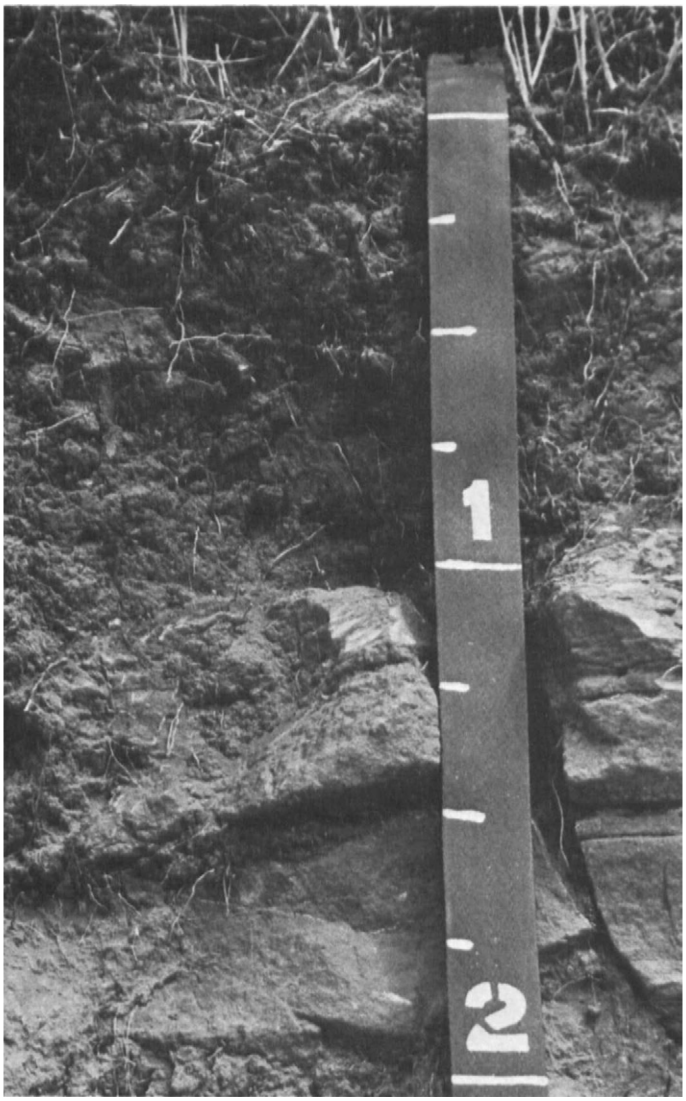

Figure 12.—Profile of Hedville loam, in an area of Lancaster-Hedville loams, 5 to 30 percent slopes. Sandstone bedrock is at a depth of about 12 inches. Depth is marked in feet.

fine sandy loam or silt loam, but in some pedons it has thin strata of loamy fine sand or silty clay loam.

Hedville Series

The Hedville series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone (fig. 12). Slope ranges from 5 to 30 percent.

Typical pedon of Hedville loam, in an area of Lancaster-Hedville loams, 5 to 30 percent slopes; 2,250 feet north and 75 feet west of the southeast corner of sec. 30, T. 2 S., R. 2 E.

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

A2—10 to 15 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; about 15 percent sandstone pebbles; slightly acid; abrupt smooth boundary.

R—15 inches; brown sandstone.

The depth to bedrock ranges from 4 to 20 inches. Reaction ranges from medium acid to neutral throughout the profile. The content of coarse fragments less than 10 inches in diameter ranges from 0 to 35 percent.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but the range includes cobbly loam and sandy loam. In some pedons a thin B or C horizon is between the mollic epipedon and the bedrock. This horizon has hue of 10YR, 7.5YR, or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 4. It has textures similar to those of the A horizon.

Hobbs Series

The Hobbs series consists of deep, well drained, moderately permeable soils on flood plains. These soils formed in stratified, silty alluvium. Slope ranges from 0 to 2 percent.

Typical pedon of Hobbs silt loam, occasionally flooded, 1,600 feet west and 800 feet south of the northeast corner of sec. 26, T. 2 S., R. 1 E.

Ap—0 to 6 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; mildly alkaline; clear smooth boundary.

C1—6 to 35 inches; stratified light gray (10YR 7/2) and grayish brown (10YR 5/2) silt loam, grayish brown (10YR 5/2) and very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; common very fine tubular pores; mildly alkaline; gradual smooth boundary.

C2—35 to 44 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; weak medium subangular blocky structure; slightly hard, friable; few fine roots; common very fine tubular pores; mildly alkaline; gradual smooth boundary.

C3—44 to 60 inches; stratified light gray (10YR 7/2) and grayish brown (10YR 5/2) silt loam, grayish brown (10YR 5/2) and very dark grayish brown (10YR 3/2) moist; massive; slightly hard, friable; common very fine continuous tubular pores; mildly alkaline.

The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is typically silt loam, but in some pedons it is silty clay loam. It ranges from slightly acid to mildly alkaline.

The C horizon has value of 4 to 7 (3 to 5 moist) and chroma of 1 or 2. It is commonly stratified. It is dominantly silt loam or silty clay loam, but some pedons have thin strata of more clayey material in the lower part. This horizon ranges from slightly acid to moderately alkaline. Some pedons have a buried A horizon (fig. 13).

Jansen Series

The Jansen series consists of deep, well drained soils on uplands. These soils formed in loamy alluvial sediments over sand and gravel. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slope ranges from 7 to 20 percent.

The Jansen soils in Washington County are taxadjuncts because they have a slightly higher mean annual precipitation than is defined as the range for the series. This difference, however, does not significantly affect the use and management of the soils.

Typical pedon of Jansen loam, in an area of Morrill-Jansen loams, 7 to 20 percent slopes; 400 feet west and 200 feet south of the northeast corner of sec. 7, T. 3 S., R. 5 E.

A—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; soft, very friable; many fine roots; slightly acid; clear smooth boundary.

Bt1—8 to 13 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; slightly hard, friable; many fine roots; few faint clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2—13 to 30 inches; brown (7.5YR 4/4) sandy clay loam, dark brown (7.5YR 3/4) moist; moderate fine subangular blocky structure; slightly hard, firm; common fine roots; few faint clay films on faces of peds; slightly acid; about 15 percent rounded pebbles; clear wavy boundary.

2C1—30 to 34 inches; brown (7.5YR 5/4) loamy coarse sand, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; soft, friable; few fine roots; about 15 percent rounded pebbles; medium acid; clear wavy boundary.

2C2—34 to 60 inches; brown (7.5YR 5/4) gravelly coarse sand, brown (7.5YR 5/4) moist; single grained; loose; about 30 percent rounded pebbles; slightly acid.

The depth to sand and gravel ranges from 20 to 36

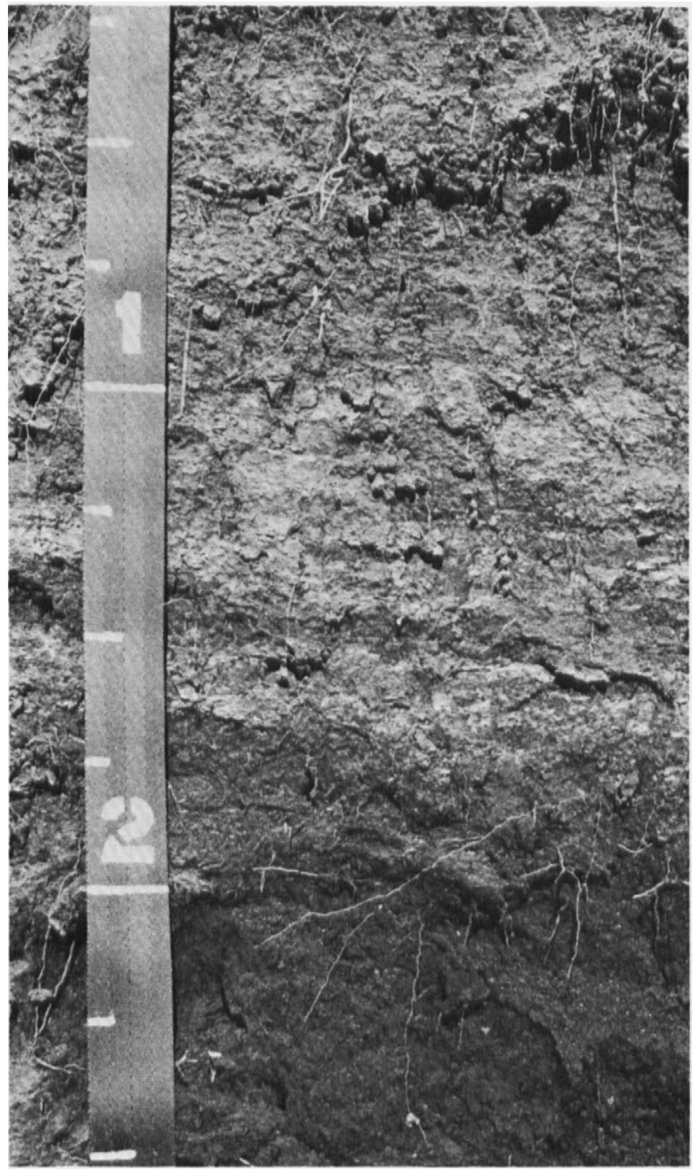

Figure 13.—Profile of Hobbs silt loam, occasionally flooded. Note the stratification in the upper 20 inches and the buried soil at a depth of about 2 feet. Depth is marked in feet.

inches. The mollic epipedon is 7 to 20 inches thick. In some pedons gravel is on the surface and is mixed throughout the profile.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 or 2. It is typically loam, but in some pedons it is sandy loam. It is slightly acid or neutral. The Bt horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 or 4 moist), and chroma of 2 to 4. It is loam, clay loam, or sandy clay loam. The 2C horizon is loamy coarse sand or gravelly coarse sand. It contains 2 to 35 percent coarse fragments. It typically ranges from medium acid to neutral.

Kipson Series

The Kipson series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in calcareous shale residuum. Slope ranges from 5 to 30 percent.

Typical pedon of Kipson silty clay loam, in an area of Kipson-Sogn complex, 5 to 30 percent slopes; 1,400 feet south and 25 feet east of the northwest corner of sec. 33, T. 5 S., R. 5 E.

A—0 to 12 inches; dark gray (10YR 4/1) silty clay loam, very dark gray (10YR 3/1) moist; moderate medium granular structure; slightly hard, friable; common fine roots; about 5 percent limestone fragments less than 3 inches in size; slight effervescence; moderately alkaline; clear smooth boundary.

AC—12 to 18 inches; pale yellow (2.5Y 7/4) silty clay loam, light olive brown (2.5Y 5/4) moist; moderate fine subangular blocky structure; slightly hard, firm; few fine roots between peds; about 10 percent limestone fragments less than 3 inches in size; strong effervescence; moderately alkaline; clear wavy boundary.

Cr—18 inches; light yellowish brown, calcareous shale.

The mollic epipedon is 6 to 12 inches thick. The depth to shale ranges from 7 to 20 inches.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is typically silty clay loam, but the range includes silt loam, flaggy silty clay loam, and flaggy silt loam. This horizon is mildly alkaline or moderately alkaline. Some pedons have a C horizon, which has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 6. This horizon is silty clay loam or silt loam. It is moderately alkaline or strongly alkaline.

Lancaster Series

The Lancaster series consists of moderately deep, well drained, moderately permeable soils on uplands. These soils formed in material weathered from noncalcareous sandstone and sandy shale. Slope ranges from 3 to 12 percent.

Typical pedon of Lancaster loam, 3 to 7 percent slopes, 500 feet north and 200 feet east of the southwest corner of sec. 36, T. 2 S., R. 1 E.

A—0 to 9 inches; brown (7.5YR 4/2) loam, dark brown (7.5YR 3/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

BA—9 to 12 inches; reddish brown (5YR 5/4) and brown (7.5YR 4/2) clay loam, reddish brown (5YR 4/4) and dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; common fine roots; medium acid; gradual smooth boundary.

Bt—12 to 24 inches; yellowish red (5YR 5/6) clay loam, reddish brown (5YR 4/4) moist; moderate medium subangular blocky structure; hard, firm; few very fine roots; few faint clay films on faces of peds; about 5 percent sandstone pebbles; slightly acid; gradual smooth boundary.

BC—24 to 29 inches; yellowish red (5YR 5/6) and light gray (10YR 7/2) sandy clay loam, yellowish red (5YR 4/6) and light brownish gray (10YR 6/2) moist; weak coarse subangular blocky structure; hard, firm; few very fine roots; slightly acid; clear smooth boundary.

Cr—29 inches; soft sandstone and sandy shale.

The depth to shale or sandstone ranges from 20 to 40 inches. The mollic epipedon is 8 to 20 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but in some pedons it is sandy loam. It is medium acid or slightly acid. The Bt horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam. It ranges from medium acid to neutral. Some pedons have a C horizon, which has hue of 7.5YR or 5YR, value of 5 or 6 (4 or 5 moist), and chroma of 4 to 6. This horizon is sandy clay loam, clay loam, fine sandy loam, or loam.

Longford Series

The Longford series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loess over loamy sediments. Slope ranges from 3 to 7 percent.

Typical pedon of Longford silt loam, 3 to 7 percent slopes, 100 feet east and 200 feet south of the northwest corner of sec. 4, T. 5 S., R. 1 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, very friable; common fine roots; medium acid; clear smooth boundary.

A—6 to 11 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.

BA—11 to 18 inches; brown (7.5YR 4/2) silty clay loam, dark brown (7.5YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; slightly acid; clear smooth boundary.

Bt1—18 to 27 inches; brown (7.5YR 4/4) silty clay loam, dark brown (7.5YR 3/4) moist; moderate fine blocky structure; hard, firm; few very fine roots; few faint clay films on faces of peds; neutral; gradual smooth boundary.

Bt2—27 to 34 inches; brown (7.5YR 5/4) silty clay loam, dark brown (7.5YR 3/4) moist; moderate fine blocky structure; very hard, very firm; few very fine roots; few faint clay films on faces of peds; neutral; gradual smooth boundary.

BC—34 to 39 inches; strong brown (7.5YR 5/6) silty clay loam, strong brown (7.5YR 4/6) moist; weak medium subangular blocky structure; hard, firm; neutral; clear smooth boundary.

2C—39 to 60 inches; reddish yellow (7.5YR 6/6) clay loam, strong brown (7.5YR 5/6) moist; massive; hard, friable; common medium rounded carbonate concretions; mildly alkaline.

The mollic epipedon is 10 to 20 inches thick. The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is typically silt loam, but in some pedons it is silty clay loam. The Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 6. It is silty clay loam, silty clay, or clay loam. It is slightly acid or neutral. The 2C or C horizon, if it occurs, has hue of 7.5YR or 5YR, value of 5 to 7 (4 to 6 moist), and chroma of 3 to 6. It is loam, silt loam, silty clay loam, or clay loam. It is neutral or mildly alkaline.

Mayberry Series

The Mayberry series consists of deep, moderately well drained, slowly permeable soils on uplands. These soils formed in clayey glacial till. Slope ranges from 3 to 7 percent.

Typical pedon of Mayberry clay loam, 3 to 7 percent slopes, 400 feet east and 150 feet south of the northwest corner of sec. 25, T. 2 S., R. 5 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) moist; weak fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

A—6 to 9 inches; very dark grayish brown (10YR 3/2) clay loam, very dark brown (10YR 2/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

BA—9 to 14 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; hard, firm; common fine roots; medium acid; clear smooth boundary.

Bt1—14 to 25 inches; brown (7.5YR 4/4) clay, dark brown (7.5YR 3/4) moist; common fine prominent dark red (2.5YR 3/6) mottles; moderate fine blocky structure; very hard, very firm; few fine roots; few faint clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2—25 to 38 inches; strong brown (7.5YR 5/6) clay, strong brown (7.5YR 4/6) moist; common medium distinct yellowish red (5YR 4/6) mottles; weak fine subangular blocky structure; very hard, very firm; few very fine roots; few faint clay films on faces of peds; slight effervescence; mildly alkaline; clear smooth boundary.

BC—38 to 45 inches; yellowish brown (10YR 5/6) clay, dark yellowish brown (10YR 4/6) moist; many coarse prominent reddish brown (5YR 4/4) mottles; weak fine subangular blocky structure; hard, firm; slight effervescence; moderately alkaline; gradual smooth boundary.

C—45 to 60 inches; brownish yellow (10YR 6/6) clay loam, yellowish brown (10YR 5/6) moist; many medium prominent reddish brown (5YR 4/4) and many coarse prominent dark grayish brown (10YR 4/2) mottles; massive; hard, firm; slight effervescence; moderately alkaline.

The mollic epipedon is 10 to 22 inches thick. Reaction ranges from medium acid to neutral in the A horizon and the upper part of the B horizon. It ranges from slightly acid to moderately alkaline in the lower part of the B horizon and in the C horizon.

The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 or 2. It is typically clay loam, but the range includes silty clay loam, loam, and silt loam. The upper part of the Bt horizon has hue of 7.5YR or 5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. The lower part has hue of 5YR, 7.5YR, or 10YR, value of 5 or 6 (4 or 5 moist), and chroma of 2 to 6. The Bt horizon is typically clay, but the range includes sandy clay. The C horizon has hue of 10YR or 2.5Y, value of 5 to 7 (4 to 6 moist), and chroma of 2 to 6. It is typically clay loam,

Figure 14.—Profile of Morrill loam, 3 to 7 percent slopes. Depth is marked in feet.

but in some pedons it is clay, silty clay loam, loam, or sandy loam.

Morrill Series

The Morrill series consists of deep, well drained, moderately slowly permeable soils on uplands. These soils formed in loamy glacial till or outwash deposits (fig. 14). Slope ranges from 3 to 20 percent.

Typical pedon of Morrill loam, 3 to 7 percent slopes, 2,200 feet south and 50 feet west of the northeast corner of sec. 7, T. 1 S., R. 4 E.

A—0 to 8 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; common fine roots; medium acid; clear smooth boundary.

BA—8 to 15 inches; brown (7.5YR 4/2) clay loam, dark brown (7.5YR 3/2) moist; strong fine blocky structure; hard, firm; common fine roots; medium acid; clear smooth boundary.

Bt1—15 to 20 inches; reddish brown (5YR 4/3) clay loam, dark reddish brown (5YR 3/3) moist; moderate fine and medium blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few very fine continuous tubular pores; slightly acid; gradual smooth boundary.

Bt2—20 to 35 inches; reddish brown (5YR 4/4) clay loam, dark reddish brown (5YR 3/4) moist; moderate fine subangular blocky structure; hard, firm; few fine roots; few faint clay films on faces of peds; few very fine continuous tubular pores; slightly acid; gradual smooth boundary.

BC—35 to 43 inches; reddish brown (5YR 5/3) clay loam, reddish brown (5YR 4/3) moist; moderate fine subangular blocky structure; hard, friable; few very fine continuous tubular pores; slightly acid; gradual smooth boundary.

C—43 to 60 inches; reddish brown (5YR 5/4) and light yellowish brown (10YR 6/4) sandy clay loam, reddish brown (5YR 4/4) and yellowish brown (10YR 5/4) moist; weak fine subangular blocky structure; hard, firm; about 1 percent rounded pebbles; slightly acid.

Reaction typically ranges from neutral to medium acid throughout the profile. The mollic epipedon is 10 to 24 inches thick.

The A horizon has hue of 10YR or 7.5YR, value of 3 to 5 (2 or 3 moist), and chroma of 1 to 3. It is typically loam, but in some pedons it is clay loam, sandy loam, or gravelly sandy loam. The content of pebbles ranges from 0 to 35 percent, by volume.

The Bt horizon has hue of 7.5YR or 5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 to 6. It is clay loam, sandy clay loam, gravelly clay loam, or gravelly sandy clay loam. The content of pebbles ranges from 0 to 20 percent, by volume.

The C horizon has hue of 10YR, 7.5YR, or 5YR, value of 4 to 6 (4 or 5 moist), and chroma of 3 to 6. It is clay loam, loam, sandy loam, sandy clay loam, or the gravelly analogs of those textures. The content of pebbles ranges from 0 to 20 percent, by volume.

Muir Series

The Muir series consists of deep, well drained, moderately permeable soils on stream terraces. These soils formed in noncalcareous, silty alluvium. Slope ranges from 0 to 2 percent.

Typical pedon of Muir silt loam, 2,000 feet east and 300 feet north of the southwest corner of sec. 33, T. 5 S., R. 2 E.

Ap—0 to 7 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate fine granular structure; slightly hard, friable; common fine roots; slightly acid; clear smooth boundary.

A—7 to 18 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; few fine roots; slightly acid; gradual smooth boundary.

Bw—18 to 33 inches; dark grayish brown (10YR 4/2) silt loam, very dark grayish brown (10YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable; few fine roots; few very fine continuous tubular pores; slightly acid; gradual smooth boundary.

BC—33 to 60 inches; grayish brown (10YR 5/2) silt loam, dark grayish brown (10YR 4/2) moist; weak fine subangular blocky structure; slightly hard, friable; few very fine roots; few very fine continuous tubular pores; slightly acid.

The thickness of the mollic epipedon ranges from 20 to more than 40 inches. The A horizon has value of 4 or 5 (2 or 3 moist) and chroma of 1 or 2. It is typically silt loam, but the range includes loam. It typically ranges from medium acid to neutral. The Bw horizon has value of 4 or 5 (3 or 4 moist) and chroma of 2 or 3. It is silty clay loam, silt loam, or loam. It typically ranges from slightly acid to mildly alkaline. The BC horizon has value of 5 to 7 (3 to 5 moist) and chroma of 2 or 3. It is silt loam, silty clay loam, or loam. It typically ranges from slightly acid to mildly alkaline.

Sarpy Series

The Sarpy series consists of deep, excessively drained, rapidly permeable soils on stream terraces. These soils formed in sandy alluvium. Slope ranges from 0 to 5 percent.

Typical pedon of Sarpy loamy fine sand, undulating, 1,940 feet west and 50 feet north of the southeast corner of sec. 31, T. 5 S., R. 1 E.

A—0 to 8 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) moist; weak fine granular structure; soft, very friable; common very fine roots; neutral; clear smooth boundary.

C1—8 to 30 inches; brown (10YR 5/3) loamy fine sand, brown (10YR 4/3) moist; single grained; loose; few very fine roots; neutral; gradual smooth boundary.

C2—30 to 60 inches; pale brown (10YR 6/3) fine sand, brown (10YR 5/3) moist; single grained; loose; neutral.

Reaction is neutral or mildly alkaline throughout the profile. The A horizon has value of 4 to 6 (3 to 5 moist) and chroma of 2 or 3. It is typically loamy fine sand, but the range includes fine sand and fine sandy loam. The C horizon has value of 5 to 7 (4 to 6 moist) and chroma of 2 to 4. It is fine sand, loamy fine sand, or loamy sand. Some pedons have thin strata of finer textured material below a depth of 40 inches.

Sogn Series

The Sogn series consists of shallow, somewhat excessively drained, moderately permeable soils on uplands. These soils formed in material weathered from limestone. Slope ranges from 5 to 20 percent.

Typical pedon of Sogn silt loam, in an area of Kipson-Sogn complex, 5 to 30 percent slopes; 900 feet south and 50 feet west of the northeast corner of sec. 9, T. 3 S., R. 5 E.

A—0 to 8 inches; very dark gray (10YR 3/1) silt loam, black (10YR 2/1) moist; moderate fine granular structure; slightly hard, friable; many fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

AC—8 to 16 inches; very dark grayish brown (10YR 3/2) channery silt loam, very dark brown (10YR 2/2) moist; moderate fine granular structure; slightly hard, friable; many fine roots; about 25 percent limestone fragments less than 3 inches in diameter; strong effervescence; moderately alkaline; abrupt wavy boundary.

R—16 inches; fractured limestone that has cracks more than 18 inches apart.

The depth to limestone ranges from 4 to 20 inches. Reaction ranges from neutral to moderately alkaline throughout the profile.

The A horizon has value of 3 or 4 (2 or 3 moist) and chroma of 1 or 2. It is typically silt loam, but in some pedons it is silty clay loam. The AC horizon, if it occurs, has colors similar to those of the A horizon. It is channery silt loam or channery silty clay loam.

Tully Series

The Tully series consists of deep, well drained, slowly permeable soils on upland foot slopes. These soils formed in a thick deposit of colluvial material generally weathered from shale. Slope ranges from 3 to 12 percent.

Typical pedon of Tully silty clay loam, 3 to 7 percent slopes, 500 feet north and 150 feet west of the southeast corner of sec. 29, T. 5 S., R. 5 E.

A—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, black (10YR 2/1) moist; moderate medium granular structure; slightly hard, friable; many fine roots; slightly acid; clear smooth boundary.

BA—8 to 15 inches; very dark grayish brown (10YR 3/2) silty clay loam, very dark brown (10YR 2/2) moist; moderate fine subangular blocky structure; slightly hard, firm; many fine roots; neutral; clear smooth boundary.

Bt1—15 to 24 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine blocky structure; hard, very firm; common fine roots; few faint clay films on faces of peds; neutral; gradual smooth boundary.

Bt2—24 to 47 inches; brown (10YR 4/3) silty clay, very dark grayish brown (10YR 3/2) moist; moderate medium blocky structure; very hard, very firm; few very fine roots; few faint clay films on faces of peds; neutral; gradual smooth boundary.

BC—47 to 57 inches; brown (10YR 4/3) silty clay, very dark grayish brown (10YR 3/2) moist; moderate fine subangular blocky structure; very hard, very firm; common very fine discontinuous tubular pores; mildly alkaline; gradual smooth boundary.

C—57 to 60 inches; brown (7.5YR 5/4) silty clay loam, brown (7.5YR 4/4) moist; weak fine subangular blocky structure; hard, firm; common very fine discontinuous tubular pores; mildly alkaline.

The thickness of the mollic epipedon ranges from 20 to more than 40 inches. The A horizon has value of 3 to 5 (2 or 3 moist) and chroma of 1 to 3. It is typically silty clay loam, but in some pedons it is silt loam. It ranges from medium acid to neutral. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5 (3 or 4 moist), and chroma of 2 or 3. It is silty clay or clay. It typically ranges from slightly acid to mildly alkaline. The C horizon has hue of 10YR or 7.5YR, value of 4 to 6 (3 to 5 moist), and chroma of 2 to 4. It ranges from neutral to moderately alkaline.

Wells Series

The Wells series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in old alluvium and in material weathered from noncalcareous sandstone and sandy shale. Slope ranges from 3 to 7 percent.

Typical pedon of Wells loam, 3 to 7 percent slopes, 1,300 feet west and 400 feet south of the northeast corner of sec. 6, T. 5 S., R. 4 E.

A—0 to 10 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) moist; moderate medium granular structure; slightly hard, friable; common fine roots; common very fine tubular pores; slightly acid; clear smooth boundary.

BA—10 to 18 inches; brown (7.5YR 5/2) clay loam, dark brown (7.5YR 3/2) moist; moderate medium subangular blocky structure; slightly hard, friable; common fine roots; common very fine tubular pores; slightly acid; gradual smooth boundary.

Bt1—18 to 25 inches; yellowish red (5YR 5/6) clay loam, reddish brown (5YR 4/4) moist; moderate medium blocky structure; slightly hard, friable; few fine roots; few faint clay films on faces of peds; common very fine tubular pores; slightly acid; gradual smooth boundary.

Bt2—25 to 46 inches; yellowish red (5YR 5/6) clay loam, yellowish red (5YR 4/6) moist; moderate medium subangular blocky structure; slightly hard, firm; few fine roots; few clay films on faces of peds; common very fine tubular pores; about 2 percent sandstone pebbles; slightly acid; gradual smooth boundary.

BC—46 to 55 inches; yellowish red (5YR 5/6) sandy clay loam, yellowish red (5YR 4/6) moist; few medium prominent pinkish gray (7.5YR 6/2) mottles; weak medium subangular blocky structure; slightly hard, firm; about 2 percent sandstone pebbles; neutral; gradual smooth boundary.

C—55 to 60 inches; reddish yellow (7.5YR 6/6) sandy clay loam, strong brown (7.5YR 5/6) moist; few medium prominent light brownish gray (10YR 6/2) mottles; massive; slightly hard, firm; few fine rounded soft dark masses; about 2 percent sandstone pebbles; neutral.

The mollic epipedon is 10 to 20 inches thick. The A horizon has hue of 10YR or 7.5YR, value of 4 or 5 (2 or 3 moist), and chroma of 1 to 3. It is medium acid or slightly acid. The Bt horizon has hue of 7.5YR or 5YR, value of 4 or 5 (3 or 4 moist), and chroma of 3 to 6. It is clay loam or sandy clay loam. It is typically slightly acid or neutral. The C horizon has hue of 7.5YR or 5YR, value of 5 to 7 (5 or 6 moist), and chroma of 4 to 6. It is loam, clay loam, sandy clay loam, or sandy loam. It is typically slightly acid or neutral.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the interaction of five major factors of soil formation. These factors are parent material, climate, plants and other living organisms, relief, and time. Each of these factors influences the formation of every soil, and each modifies the effects of the other four. The relative effects of the individual factors vary from place to place. The interactions among the factors are more complex for some soils than for others.

Parent Material

Parent material is the unconsolidated material in which soils form. It either is material weathered from rocks through freezing and thawing, abrasion, erosion, or chemical processes or is weathered material deposited by wind or water. The parent material affects texture, structure, color, natural fertility, and many other soil properties. Soils differ partly because of the various kinds of parent material. The texture of the parent material influences the rate of the downward movement of water and air and thus greatly affects soil formation. The composition of the parent material largely determines the mineralogical composition of the soil and, hence, its natural fertility.

The kinds of parent material in Washington County include shale, sandstone, and limestone residuum; loess; glacial till and outwash; colluvium; and alluvium.

Permian rocks are the oldest rocks that crop out in the county. They occur as thin beds of limestone alternating with thick beds of shale. These rocks crop out to the east and west of the Little Blue River, which cuts across the northeastern part of the county. Benfield, Kipson, and Sogn soils formed in material weathered from these rocks.

Most of the consolidated bedrock that crops out in Washington County is of the Cretaceous System (fig. 15). Cretaceous rocks crop out extensively throughout the central and western parts of the county. They include limestone, sandstone, sandy shale, and shale. Lancaster and Hedville soils formed in material weathered from sandstone, Kipson and Sogn soils in material weathered from limestone, and Benfield and Edalgo soils in material weathered from shale.

Loess is wind-deposited material made up mainly of silt and clay particles. Some of this material was carried hundreds of miles from its source. Loess deposits of varying thickness cover most of the county. Those on unstable landscapes generally have been removed by geologic erosion. Crete soils formed in Peorian loess deposited during the Wisconsin glacial age. Longford soils formed in Loveland loess deposits, which were deposited during Illinoian time.

The northeastern part of the county is covered by glacial till. The thickness of loess over the till varies. The till is an unsorted mixture made up mainly of silt, sand, and clay. It may contain pebbles and a few stones or boulders. It was transported and deposited by glacial ice. Glacial outwash is sand, sand and gravel, or stratified sand and gravel deposited by water flowing from a melting glacier. Mayberry soils formed in glacial till, and Morrill soils formed in glacial till or glacial outwash.

Colluvium is weathered bedrock and soil material that has been moved downhill by gravity. Tully soils formed in silty colluvium.

Alluvium is material deposited by floodwater in stream and river valleys. It is a mixture of silt, clay, and sand washed from upland areas. Soils that formed in alluvium differ from one another depending on the source of the material and on drainage characteristics. Cass, Colo, Eudora, Hobbs, Muir, and Sarpy soils formed in alluvium.

Climate

Climate is an active factor of soil formation. It directly influences soil formation by weathering the parent material. It indirectly affects soil formation through its effect on plants and animals.

The climate of Washington County is typical continental. It is characterized by intermittent dry and

Figure 15.—An outcropping of sandstone from the Dakota Formation of the Cretaceous System.

moist periods, which can last for less than a year or for several years. The soil dries to varying depths during dry periods. It slowly regains moisture during wet periods and can become so saturated that excess moisture penetrates the substratum. Because of the wetting and drying, some of the basic nutrients, and even clay particles, have been leached from the upper horizons in some soils. Freezing and thawing cycles modify soil structure. In clayey soils they can result in soil aggregates, thus forming a granular structure that favors plant growth.

Plant and Animal Life

Plants and animals have important effects on soil formation. Plants generally influence the content of nutrients and organic matter in the soil and the color of the surface layer. Ants, earthworms, cicadas, and burrowing animals help to keep the soil open and porous. Bacteria and fungi help to decompose the plants, thus releasing plant nutrients.

Mid and tall grasses have greatly affected soil formation in Washington County. As a result of the grasses, the upper part of a typical soil in the county is dark and is high in content of organic matter. In many areas the next layer is slightly finer textured and somewhat lighter colored than the layer above. The underlying parent material generally is light in color.

Relief

Relief, or lay of the land, influences the formation of soils through its effect on drainage, runoff, plant cover, and soil temperature. Although climate and plants are the most active factors of soil formation, relief also is important, mainly because it controls the movement of water on the surface and into the soil.

Runoff is more rapid on the steeper soils in the uplands than on the less sloping soils. As a result, less water penetrates the surface and erosion is more extensive. Kipson soils formed in old parent material, but relief has restricted their formation. Runoff is rapid on these moderately sloping to moderately steep soils, and much of the soil material is removed as soon as a soil forms.

Soils having well expressed horizons generally formed in the less sloping areas where runoff is slow, erosion is less extensive, and more water percolates through the profile. In areas where relief is gentle, the soils generally receive runoff from higher areas.

Time

Differences in the length of time that the parent material has been exposed to the processes of soil formation are reflected in the degree of profile development. Soils that do not have well expressed horizons are in the earlier stages of development, whereas those that have well expressed horizons are in the later stages.

Profile development in the soils in Washington County varies. The soils on bottom land, such as Hobbs soils, are subject to stream overflow. They receive new sediments with each period of flooding. They have a thick, dark surface layer but have weakly defined lower horizons. These soils are considered to be in the early stages of development. In contrast, the older Crete soils, which have been exposed to soil-forming processes for thousands of years, have well defined horizons. Much of the clay in these soils has been translocated to the subsoil.

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Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly, such soil formed in recent alluvium or on steep, rocky slopes.

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

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

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

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

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

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

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

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

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

Bedding system. A drainage system made by plowing, grading, or otherwise shaping the surface of a flat field. It consists of a series of low ridges separated by shallow, parallel dead furrows.

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

Bottom land. The normal flood plain of a stream, subject to flooding.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

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

Clayey soils. Soils that have texture of clay, sandy clay, or silty clay.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax vegetation. The stabilized plant community on a particular site. The plant cover reproduces itself and does not change so long as the environment remains the same.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

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

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

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

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

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

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

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Decreasers. The most heavily grazed climax range plants. Because they are the most palatable, they are the first to be destroyed by overgrazing.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum or periodically receive high rainfall, or both.

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

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

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of humans or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

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

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Increasers. Species in the climax vegetation that increase in amount as the more desirable plants are reduced by close grazing. Increasers commonly are the shorter plants and the less palatable to livestock.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Invaders. On range, plants that encroach into an area and grow after the climax vegetation has been reduced by grazing. Generally, invader plants follow disturbance of the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

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

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

Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.

Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.

Sprinkler.—Water is sprayed over the surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loamy soils. Soils that have texture of loam, clay loam, sandy loam, or sandy clay loam. This group can also include soils that have texture of silt, silt loam, or silty clay loam.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

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

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

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

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 three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

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 (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

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

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

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

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

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor on the basis of how much the present plant community has departed from the potential.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure 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 degrees of acidity or alkalinity, expressed as pH values, are:

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

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

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

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.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sandy soils. Soils that have texture of sand or loamy sand.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

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 (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

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 surface runoff.

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.

Silty soils. Soils that have texture of silt, silt loam, or silty clay loam.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

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.

Slick spot. 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. In this survey, the terms used to describe slope are:

Nearly level	0 to 2 percent
Gently sloping	1 to 5 percent
Moderately sloping	2 to 8 percent
Strongly sloping	5 to 15 percent
Moderately steep	15 to 20 percent
Steep	20 to 30 percent

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

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

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediments of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or 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. It protects the soil 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.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

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

Surface soil. The A, E, AB, and EB horizons. It includes all subdivisions of these horizons.

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 and behavior.

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 water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or 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 loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

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.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1961-90 at Washington, Kansas)

Month	Temperature					Precipitation				
	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----	38.0	14.6	26.3	65	-17	0.64	0.24	1.01	2	6.5
February---	44.1	19.2	31.6	73	-14	.80	.34	1.24	2	5.9
March------	55.8	29.9	42.9	84	1	2.32	.88	3.82	4	4.1
April------	68.6	41.1	54.9	90	19	2.74	1.36	3.95	5	.3
May--------	77.8	52.0	64.9	94	31	4.53	2.64	6.21	7	---
June-------	87.1	61.7	74.4	102	44	4.77	2.50	6.77	7	---
July-------	92.5	66.9	79.7	105	50	3.51	1.25	5.39	5	---
August-----	89.9	64.5	77.2	104	49	3.83	1.83	5.79	5	---
September--	81.3	55.5	68.4	99	33	4.03	1.97	5.81	5	---
October----	70.9	43.4	57.2	91	22	2.26	.75	3.51	3	.1
November---	54.2	30.5	42.4	77	8	1.42	.34	2.35	2	1.3
December---	41.1	19.1	30.1	68	-12	.99	.31	1.60	2	4.2
Year-----	66.8	41.5	54.2	105	-17	31.84	---	---	49	22.4

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1961-90 at Washington, Kansas)

Probability	Temperature 24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 13	Apr. 26	May 9
2 years in 10 later than--	Apr. 8	Apr. 21	May 3
5 years in 10 later than--	Mar. 30	Apr. 12	Apr. 24
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 21	Oct. 10	Sept. 27
2 years in 10 earlier than--	Oct. 25	Oct. 14	Oct. 1
5 years in 10 earlier than--	Nov. 3	Oct. 23	Oct. 9

TABLE 3.--GROWING SEASON

(Recorded in the period 1961-90 at Washington, Kansas)

Probability	Daily minimum temperature during growing season: Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	186	170	150
8 years in 10	192	176	156
5 years in 10	205	187	167
2 years in 10	217	198	179
1 year in 10	224	204	185

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

Map symbol	Soil name	Acres	Percent
Be	Benfield silty clay loam, 3 to 7 percent slopes	8,300	1.4
Cg	Cass fine sandy loam, occasionally flooded	780	0.1
Ch	Cass fine sandy loam, frequently flooded	1,850	0.3
Co	Colo silt loam	500	0.1
Cr	Crete silt loam, 0 to 1 percent slopes	11,300	2.0
Cs	Crete silty clay loam, 1 to 3 percent slopes	152,500	26.4
Ct	Crete silty clay loam, 3 to 7 percent slopes	104,500	18.2
Cx	Crete silty clay loam, 3 to 7 percent slopes, eroded	12,400	2.2
Ed	Edalgo silty clay loam, 3 to 7 percent slopes	20,750	3.6
Eu	Eudora loam, occasionally flooded	4,550	0.8
Ho	Hobbs silt loam, occasionally flooded	37,500	6.5
Kp	Kipson silty clay loam, 5 to 30 percent slopes	7,200	1.3
Ks	Kipson-Sogn complex, 5 to 30 percent slopes	16,100	2.8
Lc	Lancaster loam, 3 to 7 percent slopes	19,400	3.4
Lh	Lancaster-Hedville loams, 5 to 30 percent slopes	47,500	8.3
Lo	Longford silt loam, 3 to 7 percent slopes	33,500	5.8
Lx	Longford silty clay loam, 3 to 7 percent slopes, eroded	4,350	0.8
Mc	Mayberry clay loam, 3 to 7 percent slopes	23,400	4.1
Mh	Morrill loam, 3 to 7 percent slopes	14,250	2.5
Mm	Morrill loam, 7 to 12 percent slopes	4,900	0.9
Mp	Morrill-Jansen loams, 7 to 20 percent slopes	1,800	0.3
Mu	Muir silt loam	27,100	4.7
Sa	Sarpy loamy fine sand, undulating	200	*
Tu	Tully silty clay loam, 3 to 7 percent slopes	7,800	1.4
Ty	Tully silty clay loam, 5 to 12 percent slopes	3,150	0.5
We	Wells loam, 3 to 7 percent slopes	9,450	1.6
	Water	100	*
	Total	575,130	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

(Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name)

Map symbol	Soil name
Cg	Cass fine sandy loam, occasionally flooded
Co	Colo silt loam (where drained)
Cr	Crete silt loam, 0 to 1 percent slopes
Cs	Crete silty clay loam, 1 to 3 percent slopes
Ct	Crete silty clay loam, 3 to 7 percent slopes
Eu	Eudora loam, occasionally flooded
Ho	Hobbs silt loam, occasionally flooded
Lc	Lancaster loam, 3 to 7 percent slopes
Lo	Longford silt loam, 3 to 7 percent slopes
Mh	Morrill loam, 3 to 7 percent slopes
Mu	Muir silt loam
Tu	Tully silty clay loam, 3 to 7 percent slopes
We	Wells loam, 3 to 7 percent slopes

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS

(Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil)

Soil name and map symbol	Land capability	Winter wheat	Grain sorghum	Corn	Soybeans	Alfalfa hay
		Bu	Bu	Bu	Bu	Tons
Be----------------------- Benfield	IVe	30	50	---	25	3.0
Cg----------------------- Cass	IIw	42	70	67	---	4.0
Ch----------------------- Cass	Vw	---	---	---	---	---
Co----------------------- Colo	IIw	30	50	47	30	3.7
Cr----------------------- Crete	IIs	39	65	55	33	3.2
Cs----------------------- Crete	IIe	36	59	52	30	2.9
Ct----------------------- Crete	IIIe	32	54	47	28	2.5
Cx----------------------- Crete	IVe	29	49	45	---	2.2
Ed----------------------- Edalgo	IVe	30	50	48	---	---
Eu----------------------- Eudora	IIw	44	73	80	38	5.0
Ho----------------------- Hobbs	IIw	47	78	85	38	4.0
Kp----------------------- Kipson	VIe	---	---	---	---	---
Ks----------------------- Kipson-Sogn	VIe	---	---	---	---	---
Lc----------------------- Lancaster	IVe	32	53	---	---	---
Lh----------------------- Lancaster-Hedville	VIe	---	---	---	---	---
Lo----------------------- Longford	IIIe	35	57	52	24	2.5
Lx----------------------- Longford	IVe	31	50	42	21	2.0
Mc----------------------- Mayberry	IIIe	29	50	45	22	3.0
Mh----------------------- Morrill	IIIe	36	59	55	30	3.6
Mm----------------------- Morrill	IVe	32	53	48	28	3.4

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS--Continued

Soil name and map symbol	Land capability	Winter wheat	Grain sorghum	Corn	Soybeans	Alfalfa hay
		Bu	Bu	Bu	Bu	Tons
Mp------------------------ Morrill-Jansen	VIe	---	---	---	---	---
Mu------------------------ Muir	I	47	78	85	38	5.0
Sa------------------------ Sarpy	VIs	---	---	---	---	---
Tu------------------------ Tully	IIIe	35	59	49	30	3.3
Ty------------------------ Tully	IVe	30	50	40	---	---
We------------------------ Wells	IIIe	37	62	57	32	3.5

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Be: Benfield	Loamy Upland	Favorable	6,000	Big bluestem	25
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	10
				Tall dropseed	5
				Eastern gamagrass	5
				Sideoats grama	5
Cg, Ch: Cass	Sandy Lowland	Favorable	5,500	Little bluestem	20
		Normal	4,000	Sand bluestem	30
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Prairie sandreed	5
				Porcupinegrass	5
				Sedge	5
Co: Colo	Subirrigated	Favorable	9,000	Eastern gamagrass	25
		Normal	8,000	Prairie cordgrass	5
		Unfavorable	7,000	Big bluestem	20
				Switchgrass	10
				Indiangrass	5
				Sedge	5
Cr, Cs, Ct, Cx: Crete	Clay Upland	Favorable	6,000	Big bluestem	30
		Normal	4,000	Little bluestem	15
		Unfavorable	3,000	Switchgrass	10
				Sideoats grama	5
				Indiangrass	5
				Western wheatgrass	5
				Tall dropseed	5
Ed: Edalgo	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,500	Switchgrass	15
				Indiangrass	10
				Tall dropseed	5
				Sideoats grama	5
Eu: Eudora	Loamy Lowland	Favorable	8,000	Big bluestem	35
		Normal	6,000	Indiangrass	15
		Unfavorable	5,000	Prairie cordgrass	5
				Eastern gamagrass	10
				Switchgrass	10
Ho: Hobbs	Loamy Lowland	Favorable	8,000	Big bluestem	35
		Normal	6,000	Switchgrass	10
		Unfavorable	5,000	Little bluestem	5
				Eastern gamagrass	10
				Indiangrass	5
				Prairie cordgrass	5
Kp: Kipson	Limy Upland	Favorable	4,500	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,500	Sideoats grama	15
				Switchgrass	5
				Indiangrass	5

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production		Characteristic vegetation	Composition
		Kind of year	Dry weight		
			Lb/acre		Pct
Ks*:					
Kipson	Limy Upland	Favorable	4,500	Big bluestem	30
		Normal	3,500	Little bluestem	25
		Unfavorable	2,500	Sideoats grama	15
				Switchgrass	5
				Indiangrass	5
Sogn	Shallow Limy	Favorable	3,500	Sideoats grama	20
		Normal	2,500	Big bluestem	25
		Unfavorable	2,000	Little bluestem	15
				Indiangrass	5
				Switchgrass	5
				Tall dropseed	5
				Blue grama	5
Lc Lancaster	Loamy Upland	Favorable	5,500	Big bluestem	35
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Lh*:					
Lancaster	Loamy Upland	Favorable	5,500	Big bluestem	35
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
Hedville	Shallow Sandstone	Favorable	4,000	Little bluestem	35
		Normal	2,500	Big bluestem	30
		Unfavorable	1,500	Switchgrass	5
				Indiangrass	5
				Sideoats grama	5
Lo, Lx Longford	Loamy Upland	Favorable	5,500	Big bluestem	25
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	10
				Blue grama	5
				Western wheatgrass	5
Mc Mayberry	Clay Upland	Favorable	5,000	Big bluestem	30
		Normal	3,500	Little bluestem	15
		Unfavorable	2,500	Switchgrass	10
				Indiangrass	5
				Tall dropseed	5
				Sideoats grama	5
Mh, Mm Morrill	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	5

See footnote at end of table.

TABLE 7.--RANGELAND PRODUCTIVITY AND CHARACTERISTIC PLANT COMMUNITIES--Continued

Soil name and map symbol	Range site	Total production: Kind of year	Total production: Dry weight	Characteristic vegetation	Composition
			Lb/acre		Pct
Mp*:					
Morrill	Loamy Upland	Favorable	6,000	Big bluestem	35
		Normal	4,500	Little bluestem	20
		Unfavorable	3,500	Indiangrass	10
				Switchgrass	5
Jansen	Loamy Upland	Favorable	5,500	Little bluestem	25
		Normal	4,000	Big bluestem	30
		Unfavorable	3,000	Sideoats grama	10
				Indiangrass	10
				Switchgrass	5
Mu: Muir	Loamy Terrace	Favorable	6,500	Big bluestem	30
		Normal	5,000	Indiangrass	15
		Unfavorable	3,500	Switchgrass	10
				Little bluestem	5
				Tall dropseed	5
				Eastern gamagrass	5
Sa: Sarpy	Sands	Favorable	4,500	Sand bluestem	35
		Normal	3,500	Little bluestem	10
		Unfavorable	2,500	Switchgrass	10
				Prairie sandreed	10
				Indiangrass	5
				Sand dropseed	5
Tu, Ty: Tully	Loamy Upland	Favorable	6,000	Big bluestem	30
		Normal	4,500	Little bluestem	15
		Unfavorable	3,500	Switchgrass	10
				Indiangrass	10
				Eastern gamagrass	5
We: Wells	Loamy Upland	Favorable	5,500	Big bluestem	30
		Normal	4,000	Little bluestem	20
		Unfavorable	3,000	Indiangrass	10
				Switchgrass	10
				Sideoats grama	5
				Tall dropseed	5

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--WOODLAND MANAGEMENT AND PRODUCTIVITY

(Only the soils suitable for production of commercial trees are listed. Absence of an entry indicates that information was not available)

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Productivity class*	Trees to plant
Eu-------------- Eudora	10A	Slight	Slight	Slight	Moderate	Eastern cottonwood--	105	10	Eastern cottonwood, green ash, black walnut.
						American sycamore---	---	---	
						Hackberry-----------	---	---	
						Black walnut--------	---	---	
						Green ash-----------	---	---	
Mh, Mm---------- Morrill	3A	Slight	Slight	Slight	Severe	Bur oak-------------	55	3	Black walnut, white oak, black oak, hackberry, green ash.
						Black walnut--------	---	---	
						Green ash-----------	---	---	
Mp**:									
Morrill--------	3A	Slight	Slight	Slight	Severe	Bur oak-------------	55	3	Black walnut, white oak, black oak, hackberry, green ash.
						Black walnut--------	---	---	
						Green ash-----------	---	---	
Jansen.									
Sa-------------- Sarpy	3S	Slight	Slight	Severe	Slight	Silver maple--------	90	3	Eastern cottonwood, American sycamore, black willow.
						Eastern cottonwood--	95	8	

* Productivity class is the yield in cubic meters per hectare per year calculated at the age of culmination of mean annual increment for fully stocked natural stands.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

(The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil)

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Be----------------- Benfield	Siberian peashrub, Peking cotoneaster, lilac.	Amur honeysuckle, Manchurian crabapple.	Eastern redcedar, Austrian pine, Russian olive, hackberry, green ash.	Siberian elm, honeylocust.	---
Cg, Ch------------- Cass	---	Peking cotoneaster, Amur honeysuckle, lilac, American plum.	Eastern redcedar	Austrian pine, hackberry, eastern white pine, honeylocust, bur oak, green ash.	Eastern cottonwood.
Co----------------- Colo	---	Amur privet, Amur honeysuckle, lilac, Peking cotoneaster.	Eastern redcedar, Austrian pine.	Eastern white pine, bur oak, honeylocust, hackberry, green ash.	Eastern cottonwood.
Cr, Cs, Ct, Cx----- Crete	Lilac, Peking cotoneaster.	Manchurian crabapple, Amur honeysuckle, Austrian pine, Siberian peashrub.	Eastern redcedar, hackberry, Russian olive, green ash.	Honeylocust, Siberian elm.	---
Ed----------------- Edalgo	Siberian peashrub, Amur honeysuckle, Peking cotoneaster, lilac.	Eastern redcedar, Manchurian crabapple.	Austrian pine, honeylocust, Russian olive, green ash, hackberry.	Siberian elm------	---
Eu----------------- Eudora	---	Lilac, Peking cotoneaster, Amur honeysuckle, American plum.	Eastern redcedar	Austrian pine, bur oak, honeylocust, hackberry, green ash, eastern white pine.	Eastern cottonwood.
Ho----------------- Hobbs	---	American plum, Peking cotoneaster, lilac, Amur honeysuckle.	Eastern redcedar	Green ash, hackberry, Austrian pine, honeylocust, eastern white pine, bur oak.	Eastern cottonwood.
Kp. Kipson					
Ks*: Kipson.					
Sogn.					

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Lc: Lancaster	Fragrant sumac, lilac, Amur honeysuckle, Peking cotoneaster.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, honeylocust, Russian olive.	Siberian elm	---
Lh*: Lancaster	Fragrant sumac, lilac, Amur honeysuckle, Peking cotoneaster.	---	Eastern redcedar, green ash, Austrian pine, bur oak, hackberry, honeylocust, Russian olive.	Siberian elm	---
Hedville.					
Lo, Lx: Longford	Peking cotoneaster.	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, bur oak, honeylocust, green ash, Austrian pine, hackberry, Russian olive.	Siberian elm, Scotch pine.	---
Mc: Mayberry	Siberian peashrub, Amur honeysuckle, lilac, Peking cotoneaster.	Eastern redcedar, Manchurian crabapple.	Russian olive, Austrian pine, green ash, hackberry, honeylocust.	Siberian elm	---
Mh, Mm: Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, hackberry, Russian olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Mp*: Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, hackberry, Russian olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Jansen	Amur honeysuckle, Peking cotoneaster, lilac, fragrant sumac.	---	Green ash, honeylocust, eastern redcedar, Austrian pine, hackberry, bur oak, Russian olive.	Siberian elm	---

See footnote at end of table.

TABLE 9.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Mu: Muir	---	Peking cotoneaster, Amur honeysuckle, American plum, lilac.	Eastern redcedar	Eastern white pine, honeylocust, bur oak, Austrian pine, green ash, hackberry.	Eastern cottonwood.
Sa: Sarpy	Blackhaw	American plum, lilac, common chokecherry.	Eastern redcedar, Washington hawthorn.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood, Siberian elm.
Tu, Ty: Tully	Peking cotoneaster	Lilac, fragrant sumac, Amur honeysuckle.	Eastern redcedar, Russian olive, hackberry, green ash, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
We: Wells	Peking cotoneaster	Fragrant sumac, Amur honeysuckle, lilac.	Russian olive, eastern redcedar, hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--RECREATIONAL DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated)

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Be: Benfield	Slight	Slight	Moderate: slope, small stones.	Slight.
Cg: Cass	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Ch: Cass	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.
Co: Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.
Cr: Crete	Slight	Slight	Slight	Slight.
Cs, Ct, Cx: Crete	Slight	Slight	Moderate: slope.	Slight.
Ed: Edalgo	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones, thin layer.	Slight.
Eu: Eudora	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Ho: Hobbs	Severe: flooding.	Slight	Moderate: flooding.	Slight.
Kp: Kipson	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: small stones, thin layer, area reclaim.	Moderate: slope.
Ks*:				
Kipson	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: small stones, thin layer, area reclaim.	Moderate: slope.
Sogn	Severe: thin layer, area reclaim.	Severe: thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Slight.
Lc: Lancaster	Slight	Slight	Moderate: slope, thin layer.	Slight.
Lh*:				
Lancaster	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.

See footnote at end of table.

TABLE 10.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lh*:				
Hedville	Severe: slope, thin layer, area reclaim.	Severe: slope, thin layer, area reclaim.	Severe: slope, small stones.	Moderate: slope.
Lo, Lx Longford	Slight	Slight	Moderate: slope.	Slight.
Mc Mayberry	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Slight.
Mh Morrill	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, small stones.	Slight.
Mm Morrill	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
Mp*:				
Morrill	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight.
Jansen	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight.
Mu Muir	Severe: flooding.	Slight	Slight	Slight.
Sa Sarpy	Severe: flooding.	Slight	Moderate: slope.	Slight.
Tu Tully	Slight	Slight	Moderate: slope, small stones.	Slight.
Ty Tully	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.
We Wells	Slight	Slight	Moderate: slope.	Slight.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--WILDLIFE HABITAT

(See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that 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	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Be: Benfield	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Cg, Ch: Cass	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Co: Colo	Good	Fair	Good	Fair	Poor	Poor	Good	Good	Fair	Fair	Good	Fair.
Cr, Cs: Crete	Good	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Ct, Cx: Crete	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Good.
Ed: Edalgo	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Good.
Eu: Eudora	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Ho: Hobbs	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Kp: Kipson	Poor	Fair	Fair	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Poor.
Ks*:												
Kipson	Poor	Fair	Fair	---	---	Poor	Very poor.	Very poor.	Fair	---	Very poor.	Poor.
Sogn	Very poor.	Very poor.	Poor	---	---	Poor	Very poor.	Very poor.	Very poor.	---	Very poor.	Poor.
Lc: Lancaster	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Lh*:												
Lancaster	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Hedville	Very poor.	Poor	Poor	---	---	Poor	Very poor.	Very poor.	Poor	---	Very poor.	Poor.
Lo, Lx: Longford	Fair	Good	Fair	---	---	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Mc: Mayberry	Fair	Good	Fair	---	Fair	Fair	Very poor.	Very poor.	Fair	---	Very poor.	Fair.
Mh, Mm: Morrill	Fair	Good	Good	Fair	Fair	Good	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Mp*:												
Morrill	Fair	Good	Good	Fair	Fair	Good	Very poor.	Very poor.	Good	Fair	Very poor.	Good.

See footnote at end of table.

TABLE 11.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements								Potential as habitat for--			
	Grain and seed crops	Grasses and legumes	Wild herba- ceous plants	Hard- wood trees	Conif- erous plants	Shrubs	Wetland plants	Shallow water areas	Open- land wild- life	Wood- land wild- life	Wetland wild- life	Range- land wild- life
Mp*:												
Jansen	Poor	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Mu Muir	Good	Good	Good	Good	Fair	Good	Poor	Very poor.	Good	Good	Very poor.	Good.
Sa Sarpy	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Tu, Ty Tully	Fair	Good	Good	---	---	Fair	Poor	Poor	Fair	---	Poor	Fair.
We Wells	Good	Good	Good	---	---	Fair	Very poor.	Very poor.	Good	---	Very poor.	Fair.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--BUILDING SITE DEVELOPMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Be---------------- Benfield	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Cg, Ch------------ Cass	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
Co---------------- Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, frost action.
Cr, Cs, Ct, Cx---- Crete	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ed---------------- Edalgo	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Eu---------------- Eudora	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action.
Ho---------------- Hobbs	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.
Kp---------------- Kipson	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ks*:					
Kipson-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Sogn-------------	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.
Lc---------------- Lancaster	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Lh*:					
Lancaster--------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Hedville---------	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope, depth to rock.	Severe: depth to rock, slope.
Lo, Lx------------ Longford	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.

See footnote at end of table.

TABLE 12.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Mc----------------- Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.
Mh----------------- Morrill	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, low strength.
Mm----------------- Morrill	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Mp*:					
Morrill----------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: shrink-swell, low strength, slope.
Jansen-----------	Severe: cutbanks cave.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength.
Mu----------------- Muir	Slight-----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: low strength, flooding, frost action.
Sa----------------- Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
Tu----------------- Tully	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, shrink-swell.
Ty----------------- Tully	Moderate: too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.
We----------------- Wells	Slight-----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--SANITARY FACILITIES

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "slight," "good," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Be: Benfield	Severe: thin layer, seepage, percs slowly.	Severe: seepage.	Severe: seepage, too clayey.	Moderate: seepage.	Poor: area reclaim, too clayey, hard to pack.
Cg, Ch: Cass	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: thin layer.
Co: Colo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Cr: Crete	Severe: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight	Poor: hard to pack.
Cs, Ct, Cx: Crete	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Poor: hard to pack.
Ed: Edalgo	Severe: thin layer, seepage, percs slowly.	Severe: seepage.	Severe: seepage, too clayey.	Moderate: seepage.	Poor: area reclaim, too clayey, hard to pack.
Eu: Eudora	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Ho: Hobbs	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Fair: too clayey.
Kp: Kipson	Severe: thin layer, seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, small stones, slope.
Ks*:					
Kipson	Severe: thin layer, seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, small stones, slope.
Sogn	Severe: thin layer, seepage.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: area reclaim, thin layer.
Lc: Lancaster	Severe: thin layer, seepage.	Severe: seepage.	Severe: seepage.	Moderate: seepage.	Poor: area reclaim, thin layer.
Lh*:					
Lancaster	Severe: thin layer, seepage.	Severe: seepage, slope.	Severe: seepage.	Moderate: seepage, slope.	Poor: area reclaim, thin layer.

See footnote at end of table.

TABLE 13.--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
Lh*:					
Hedville	Severe: thin layer, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: depth to rock, seepage, slope.	Severe: seepage, slope.	Poor: area reclaim, slope, thin layer.
Lo, Lx Longford	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Mc Mayberry	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Mh Morrill	Severe: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey, small stones.
Mm Morrill	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, small stones, slope.
Mp*:					
Morrill	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, small stones, slope.
Jansen	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Mu Muir	Moderate: flooding.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
Sa Sarpy	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
Tu Tully	Severe: percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey, hard to pack.
Ty Tully	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
We Wells	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--CONSTRUCTION MATERIALS

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Be: Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Cg, Ch: Cass	Good	Probable	Improbable: too sandy.	Good.
Co: Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Cr, Cs, Ct, Cx: Crete	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Ed: Edalgo	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Eu: Eudora	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Ho: Hobbs	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Kp: Kipson	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, thin layer.
Ks*:				
Kipson	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, thin layer.
Sogn	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, thin layer.
Lc: Lancaster	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
Lh*:				
Lancaster	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.

See footnote at end of table.

TABLE 14.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Lh*:				
Hedville	Poor: area reclaim, thin layer.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, thin layer.
Lo, Lx Longford	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
Mc Mayberry	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Mh, Mm Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Mp*:				
Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
Jansen	Good	Probable	Improbable: too sandy.	Poor: area reclaim.
Mu Muir	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Sa Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Tu, Ty Tully	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
We Wells	Good	Improbable: excess fines.	Improbable: excess fines.	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--WATER MANAGEMENT

(Some terms that describe restrictive soil features are defined in the "Glossary." See text for definitions of "moderate" and "severe." Absence of an entry indicates that the soil was not evaluated. The information in this table indicates the dominant soil condition but does not eliminate the need for onsite investigation)

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Be----------------- Benfield	Moderate: seepage, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, thin layer, slope.	Area reclaim, erodes easily.	Erodes easily, area reclaim.
Cg, Ch------------ Cass	Severe: seepage.	Severe: piping.	Deep to water	Soil blowing, flooding.	Soil blowing---	Favorable.
Co----------------- Colo	Moderate: seepage.	Severe: wetness.	Frost action---	Wetness--------	Wetness--------	Wetness.
Cr, Cs------------ Crete	Moderate: seepage.	Moderate: hard to pack.	Deep to water	Percs slowly, erodes easily.	Erodes easily	Erodes easily, percs slowly.
Ct, Cx------------ Crete	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope, erodes easily.	Erodes easily	Erodes easily, percs slowly.
Ed----------------- Edalgo	Moderate: seepage, slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, thin layer, slope.	Area reclaim, erodes easily.	Erodes easily, area reclaim.
Eu----------------- Eudora	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-------	Erodes easily	Erodes easily.
Ho----------------- Hobbs	Moderate: seepage.	Severe: piping.	Deep to water	Flooding-------	Favorable------	Favorable.
Kp----------------- Kipson	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, large stones, area reclaim.	Large stones, slope, area reclaim.
Ks*:						
Kipson------------	Severe: seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, large stones, area reclaim.	Large stones, slope, area reclaim.
Sogn--------------	Severe: depth to rock, seepage, slope.	Severe: thin layer.	Deep to water	Slope, thin layer.	Slope, depth to rock, area reclaim.	Slope, depth to rock, area reclaim.
Lc----------------- Lancaster	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Thin layer, slope.	Area reclaim---	Area reclaim.
Lh*:						
Lancaster---------	Severe: slope.	Severe: thin layer.	Deep to water	Thin layer, slope.	Slope, area reclaim.	Slope, area reclaim.
Hedville----------	Severe: depth to rock, seepage, slope.	Severe: piping, thin layer.	Deep to water	Slope, thin layer.	Slope, large stones, depth to rock.	Slope, depth to rock, area reclaim.

See footnote at end of table.

TABLE 15.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Lo, Lx: Longford	Moderate: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope.	Percs slowly	Percs slowly.
Mc: Mayberry	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Mh: Morrill	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Favorable	Favorable.
Mm: Morrill	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope	Slope.
Mp*:						
Morrill	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope	Slope.
Jansen	Severe: seepage, slope.	Severe: seepage, piping.	Deep to water	Slope	Slope, too sandy.	Slope.
Mu: Muir	Moderate: seepage.	Severe: piping.	Deep to water	Favorable	Favorable	Favorable.
Sa: Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake.	Too sandy, soil blowing.	Droughty.
Tu: Tully	Moderate: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Ty: Tully	Severe: slope.	Moderate: hard to pack.	Deep to water	Percs slowly, slope.	Slope, erodes easily, percs slowly.	Slope, erodes easily, percs slowly.
We: Wells	Moderate: seepage, slope.	Moderate: thin layer, piping.	Deep to water	Slope	Favorable	Favorable.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--ENGINEERING INDEX PROPERTIES

(The symbol < means less than; > means more than. Absence of an entry indicates that 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	
Be---------------- Benfield	0-5	Silty clay loam	CL	A-6, A-7	0-10	85-100	85-100	85-95	85-95	30-50	11-25
	5-24	Silty clay, silty clay loam, cherty silty clay.	CH, CL	A-7	0-10	85-100	70-100	70-95	70-95	40-60	20-35
	24	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Cg, Ch----------- Cass	0-17	Fine sandy loam	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-40	<20	NP-5
	17-48	Fine sandy loam, sandy loam, very fine sandy loam.	SM, SM-SC	A-4, A-2	0	100	95-100	85-95	20-50	<20	NP-5
	48-60	Loamy fine sand, fine sand, coarse sand.	SM, SP-SM	A-2, A-3	0	95-100	95-100	50-75	5-30	---	NP
Co---------------- Colo	0-19	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	19-36	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	36-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Cr---------------- Crete	0-5	Silt loam--------	CL, ML	A-4, A-6	0	100	100	100	90-100	30-40	5-15
	5-12	Silty clay loam	CL	A-6, A-7	0	100	100	100	90-100	35-50	15-30
	12-32	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	90-100	50-65	25-40
	32-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Cs, Ct----------- Crete	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	100	90-100	35-50	15-30
	9-32	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	90-100	50-65	25-40
	32-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Cx---------------- Crete	0-5	Silty clay loam	CL	A-6, A-7	0	100	100	100	90-100	35-50	15-30
	5-30	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	90-100	50-65	25-40
	30-60	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	10-35
Ed---------------- Edalgo	0-6	Silty clay loam	CL	A-6, A-7	0	95-100	85-100	75-100	60-95	30-45	10-25
	6-10	Silty clay loam, clay loam, sandy clay loam.	CL	A-6, A-7	0	95-100	85-100	75-100	65-95	25-45	10-25
	10-30	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	95-100	85-100	75-100	70-95	45-70	20-40
	30	Weathered bedrock	---	---	---	---	---	---	---	---	---
Eu---------------- Eudora	0-14	Loam-------------	ML, CL, CL-ML	A-4, A-6	0	100	100	95-100	60-100	20-35	2-11
	14-60	Silt loam, very fine sandy loam, loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	80-100	<25	NP-10

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
Ho---------------- Hobbs	0-6	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
	6-60	Silt loam, silty clay loam, very fine sandy loam.	CL, CL-ML, MH	A-4, A-6, A-7	0	100	100	95-100	80-100	25-55	5-25
Kp---------------- Kipson	0-12	Silty clay loam	CL	A-6, A-7	0-10	90-100	85-100	80-100	70-95	35-45	15-22
	12-18	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0-10	90-100	85-100	70-100	50-95	25-45	10-22
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
Ks*:											
Kipson-----------	0-12	Silty clay loam	CL	A-6, A-7	0-10	90-100	85-100	80-100	70-95	35-45	15-22
	12-18	Loam, silt loam, silty clay loam.	CL	A-6, A-7	0-10	90-100	85-100	70-100	50-95	25-45	10-22
	18	Weathered bedrock	---	---	---	---	---	---	---	---	---
Sogn-------------	0-8	Silt loam--------	CL	A-6, A-4	0-10	90-100	85-100	75-100	60-90	28-36	10-15
	8-16	Channery silt loam.	CL, GC	A-6, A-4, A-7	0-15	60-95	50-85	45-85	36-80	28-43	10-20
	16	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Lc---------------- Lancaster	0-9	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-35	5-15
	9-24	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6, A-7-6	0	100	95-100	80-95	40-65	25-45	8-25
	24-29	Clay loam, loam, sandy clay loam.	CL-ML, SC, SM-SC, CL	A-4, A-6	0-10	95-100	90-100	80-100	36-80	20-35	5-15
	29	Weathered bedrock	---	---	---	---	---	---	---	---	---
Lh*:											
Lancaster--------	0-9	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	90-100	85-100	60-90	20-35	5-15
	9-20	Sandy clay loam, clay loam, loam.	CL, SC	A-4, A-6, A-7-6	0	100	95-100	80-95	40-65	25-45	8-25
	20-29	Clay loam, loam, sandy clay loam.	CL-ML, SC, SM-SC, CL	A-4, A-6	0-10	95-100	90-100	80-100	36-80	20-35	5-15
	29	Weathered bedrock	---	---	---	---	---	---	---	---	---
Hedville---------	0-10	Loam-------------	ML, CL, SM, SC	A-4, A-6	0-15	80-100	75-100	65-95	45-75	<35	NP-13
	10-15	Loam, cobbly loam, fine sandy loam.	SM, ML, SC, CL	A-4, A-6, A-2, A-1-b	0-15	60-90	50-85	30-80	15-60	<35	NP-13
	15	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Lo---------------- Longford	0-11	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	90-100	75-95	25-40	5-20
	11-39	Silty clay loam, silty clay, clay loam.	CH, CL	A-7	0	100	95-100	90-100	85-100	40-60	20-35
	39-60	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	100	95-100	90-100	70-95	30-45	10-25

See footnote at end of table.

TABLE 16.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Lx--------------- Longford	0-6	Silty clay loam	CL	A-6	0	100	95-100	90-100	75-95	30-40	10-20
	6-31	Silty clay loam, silty clay, clay loam.	CH, CL	A-7	0	100	95-100	90-100	85-100	40-60	20-35
	31-60	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0	100	95-100	90-100	70-95	30-45	10-25
Mc--------------- Mayberry	0-14	Clay loam--------	CL	A-6, A-7	0	100	95-100	90-100	75-100	35-50	15-25
	14-45	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-65	25-40
	45-60	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-100	70-95	35-60	15-35
Mh, Mm----------- Morrill	0-8	Loam-------------	CL	A-4, A-6	0	95-100	75-100	65-100	50-80	25-40	7-20
	8-43	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7, A-2	0	85-100	70-100	55-100	25-80	30-45	11-25
	43-60	Clay loam, sandy clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	45-100	20-80	20-35	2-15
Mp*: Morrill---------	0-15	Loam-------------	CL	A-4, A-6	0	95-100	75-100	65-100	50-80	25-40	7-20
	15-40	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7, A-2	0	85-100	70-100	55-100	25-80	30-45	11-25
	40-60	Clay loam, sandy clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	45-100	20-80	20-35	2-15
Jansen----------	0-8	Loam-------------	CL, ML, CL-ML	A-6, A-4	0	100	100	90-100	50-95	25-40	3-15
	8-30	Clay loam, loam, sandy clay loam.	CL, SC	A-6, A-7, A-2	0	95-100	75-100	60-100	25-80	30-45	10-25
	30-34	Loamy coarse sand	SM, SP-SM	A-2, A-1	0	95-100	75-100	40-75	10-30	---	NP
	34-60	Coarse sand, sand, gravelly coarse sand.	SW, SW-SM, SP, SP-SM	A-3, A-1, A-2	0	85-100	45-100	35-65	3-10	---	NP
Mu--------------- Muir	0-33	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	20-35	4-15
	33-60	Silt loam, silty clay loam, loam.	CL, CL-ML	A-4, A-6, A-7-6	0	100	100	95-100	85-100	20-45	4-20
Sa--------------- Sarpy	0-8	Loamy fine sand	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	8-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
Tu, Ty----------- Tully	0-15	Silty clay loam	CL	A-6, A-7	0	100	75-100	75-100	70-95	35-50	15-25
	15-47	Silty clay, clay	CH, CL	A-7	0	90-100	75-100	70-100	60-95	40-60	20-35
	47-60	Silty clay, clay, silty clay loam.	CH, CL	A-7	0	90-100	75-100	70-100	60-95	40-60	20-35
We--------------- Wells	0-10	Loam-------------	CL-ML, CL	A-4, A-6	0	100	100	95-100	65-85	20-35	5-20
	10-46	Clay loam, sandy clay loam.	SC, CL	A-4, A-6, A-7	0	100	100	80-100	40-85	30-50	8-25
	46-60	Clay loam, sandy clay loam, sandy loam.	SC, CL, ML, SM	A-4, A-6	0	100	100	80-100	35-85	20-40	NP-15

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

(The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated)

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Be---------------- Benfield	0-5	27-35	1.30-1.40	0.2-0.6	0.21-0.24	6.1-7.8	<2	Moderate	0.37	3	7	1-4
	5-24	35-45	1.35-1.45	0.06-0.2	0.18-0.22	6.6-8.4	<2	High------	0.37			
	24	---	---	---	---	---	---	----------	----			
Cg, Ch----------- Cass	0-17	7-17	1.40-1.60	2.0-6.0	0.16-0.18	5.6-7.3	<2	Low-------	0.20	5	3	1-2
	17-48	5-15	1.40-1.60	2.0-6.0	0.15-0.17	6.1-8.4	<2	Low-------	0.20			
	48-60	2-10	1.50-1.70	6.0-20	0.08-0.10	6.1-8.4	<2	Low-------	0.20			
Co--------------- Colo	0-19	20-26	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.28	5	6	3-5
	19-36	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.28			
	36-60	25-35	1.35-1.45	0.6-2.0	0.1[illegible]-0.20	6.1-7.3	<2	Moderate	0.28			
Cr--------------- Crete	0-5	20-27	1.20-1.40	0.6-2.0	0.22-0.24	5.6-6.0	<2	Moderate	0.37	4	6	2-4
	5-12	27-35	1.20-1.40	0.2-0.6	0.21-0.23	5.6-6.0	<2	High------	0.37			
	12-32	42-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.3	<2	High------	0.37			
	32-60	25-40	1.20-1.40	0.2-2.0	0.16-0.22	7.4-8.4	<2	High------	0.37			
Cs, Ct----------- Crete	0-9	27-35	1.20-1.40	0.2-0.6	0.21-0.23	5.6-6.0	<2	High------	0.37	4	7	2-4
	9-32	42-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.3	<2	High------	0.37			
	32-60	25-40	1.20-1.40	0.2-2.0	0.18-0.22	7.4-8.4	<2	High------	0.37			
Cx--------------- Crete	0-5	27-35	1.20-1.40	0.2-0.6	0.21-0.23	5.6-6.0	<2	High------	0.37	4	7	1-2
	5-30	42-52	1.10-1.30	0.06-0.6	0.12-0.20	6.1-7.3	<2	High------	0.37			
	30-60	25-40	1.20-1.40	0.2-2.0	0.18-0.22	7.4-8.4	<2	High------	0.37			
Ed--------------- Edalgo	0-6	28-37	1.30-1.40	0.06-0.6	0.15-0.22	5.6-7.3	<2	Moderate	0.37	3	7	2-4
	6-10	28-37	1.35-1.50	0.06-0.6	0.15-0.22	5.6-7.3	<2	Moderate	0.37			
	10-30	35-65	1.40-1.60	<0.06	0.10-0.18	6.6-8.4	<2	High------	0.37			
	30	---	---	---	---	---	---	----------	----			
Eu--------------- Eudora	0-14	5-18	1.30-1.50	0.6-2.0	0.20-0.24	6.1-7.8	<2	Low-------	0.32	5	5	1-4
	14-60	5-18	1.35-1.50	0.6-2.0	0.17-0.22	6.6-8.4	<2	Low-------	0.43			
Ho--------------- Hobbs	0-6	15-27	1.20-1.40	0.6-2.0	0.21-0.24	6.1-7.8	<2	Low-------	0.32	5	6	2-4
	6-60	18-30	1.20-1.40	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low-------	0.32			
Kp--------------- Kipson	0-12	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	---
	12-18	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	18	---	---	---	---	---	---	----------	----			
Ks*:												
Kipson-----------	0-12	27-35	1.30-1.40	0.6-2.0	0.17-0.20	7.4-8.4	<2	Moderate	0.32	2	4L	---
	12-18	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-9.0	<2	Moderate	0.32			
	18	---	---	---	---	---	---	----------	----			
Sogn-------------	0-8	18-27	1.15-1.20	0.6-2.0	0.19-0.24	6.1-8.4	<2	Moderate	0.32	1	4L	2-4
	8-16	18-35	1.15-1.20	0.6-2.0	0.14-0.19	6.1-8.4	<2	Moderate	0.24			
	16	---	---	---	---	---	---	----------	----			
Lc--------------- Lancaster	0-9	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low-------	0.28	4	6	1-4
	9-24	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	24-29	12-30	1.40-1.55	0.6-2.0	0.15-0.19	6.1-7.3	<2	Low-------	0.28			
	29	---	---	---	---	---	---	----------	----			

See footnote at end of table.

TABLE 17.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH	mmhos/cm					Pct
Lh*:												
Lancaster	0-9	12-26	1.35-1.45	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low	0.28	4	6	1-4
	9-20	18-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	20-29	12-30	1.40-1.55	0.6-2.0	0.15-0.19	6.1-7.3	<2	Low	0.28			
	29	---	---	---	---	---	---	---	---			
Hedville	0-10	8-22	1.35-1.50	0.6-2.0	0.18-0.20	5.6-7.3	<2	Low	0.32	2	5	1-4
	10-15	8-22	1.35-1.50	0.6-2.0	0.08-0.18	5.6-7.3	<2	Low	0.32			
	15	---	---	---	---	---	---	---	---			
Lo Longford	0-11	15-27	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low	0.32	5	6	1-4
	11-39	35-45	1.35-1.50	0.2-0.6	0.14-0.20	6.1-7.3	<2	High	0.32			
	39-60	20-35	1.30-1.40	0.2-0.6	0.15-0.20	6.1-8.4	<2	Moderate	0.32			
Lx Longford	0-6	27-32	1.30-1.40	0.6-2.0	0.20-0.24	5.6-7.3	<2	Low	0.32	5	7	1-4
	6-31	35-45	1.35-1.50	0.2-0.6	0.14-0.20	6.1-7.3	<2	High	0.32			
	31-60	20-35	1.30-1.40	0.2-0.6	0.15-0.20	6.1-8.4	<2	Moderate	0.32			
Mc Mayberry	0-14	27-40	1.40-1.50	0.2-0.6	0.17-0.23	5.6-6.5	<2	Moderate	0.37	4	6	1-3
	14-45	40-50	1.50-1.65	0.06-0.2	0.10-0.11	5.6-7.8	<2	High	0.37			
	45-60	18-45	1.40-1.50	0.06-0.2	0.09-0.16	6.1-8.4	<2	Moderate	0.37			
Mh, Mm Morrill	0-8	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low	0.28	5	6	1-4
	8-43	25-35	1.35-1.45	0.2-0.6	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	43-60	10-29	1.40-1.55	0.2-2.0	0.15-0.18	5.1-7.3	<2	Low	0.37			
Mp*:												
Morrill	0-15	15-29	1.30-1.40	0.6-2.0	0.14-0.21	5.1-7.3	<2	Low	0.28	5	6	1-4
	15-40	25-35	1.35-1.45	0.2-0.6	0.15-0.19	5.1-7.3	<2	Moderate	0.28			
	40-60	10-29	1.40-1.55	0.2-2.0	0.15-0.18	5.1-7.3	<2	Low	0.37			
Jansen	0-8	12-22	1.20-1.30	0.6-2.0	0.20-0.24	5.1-7.3	<2	Low	0.28	4	5	1-3
	8-30	18-32	1.10-1.25	0.6-2.0	0.15-0.19	5.1-7.3	<2	Moderate	0.32			
	30-34	2-7	1.45-1.65	6.0-20	0.06-0.11	5.1-7.3	<2	Low	0.10			
	34-60	0-3	1.50-1.70	>20	0.02-0.04	5.1-7.3	<2	Low	0.10			
Mu Muir	0-33	18-27	1.30-1.45	0.6-2.0	0.20-0.23	5.6-7.8	<2	Low	0.32	5	6	2-4
	33-60	18-35	1.30-1.50	0.6-2.0	0.18-0.22	6.1-8.4	<2	Low	0.32			
Sa Sarpy	0-8	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low	0.17	5	2	<1
	8-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low	0.15			
Tu, Ty Tully	0-15	27-40	1.35-1.45	0.2-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.37	4	7	2-4
	15-47	40-55	1.40-1.50	0.06-0.2	0.10-0.15	5.6-7.8	<2	High	0.37			
	47-60	35-55	1.40-1.50	0.06-0.2	0.07-0.15	6.6-8.4	<2	High	0.37			
We Wells	0-10	18-27	1.35-1.50	0.6-2.0	0.20-0.22	5.6-6.5	<2	Low	0.28	5	5	1-4
	10-46	25-35	1.35-1.50	0.6-2.0	0.15-0.19	5.6-7.3	<2	Moderate	0.28			
	46-60	10-30	1.35-1.60	0.6-2.0	0.12-0.18	6.1-7.8	<2	Low	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--SOIL AND WATER FEATURES

("Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated)

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Be: Benfield	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	Low.
Cg: Cass	B	Occasional	Brief	Mar-Jun	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Ch: Cass	B	Frequent	Brief	Mar-Jun	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Co: Colo	B/D	Rare	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Cr, Cs, Ct, Cx: Crete	C	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Ed: Edalgo	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	Moderate	Low.
Eu: Eudora	B	Occasional	Very brief	Mar-Jun	>6.0	---	---	>60	---	High	Low	Low.
Ho: Hobbs	B	Occasional	Brief	Apr-Sep	>6.0	---	---	>60	---	Moderate	Low	Low.
Kp: Kipson	D	None	---	---	>6.0	---	---	7-20	Soft	Moderate	Low	Low.
Ks*:												
Kipson	D	None	---	---	>6.0	---	---	7-20	Soft	Moderate	Low	Low.
Sogn	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low	Low.
Lc: Lancaster	B	None	---	---	>6.0	---	---	20-40	Soft	Moderate	Low	Moderate.
Lh*:												
Lancaster	B	None	---	---	>6.0	---	---	20-40	Soft	Moderate	Low	Moderate.
Hedville	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	Low	Moderate.
Lo, Lx: Longford	C	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.

See footnote at end of table.

TABLE 18.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Mc----------------- Mayberry	D	None---------	---	---	1.0-3.0	Perched	Mar-May	>60	---	High------	High------	Low.
Mh, Mm------------ Morrill	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Mp*:												
Morrill-----------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Jansen------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Mu----------------- Muir	B	Rare---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Moderate.
Sa----------------- Sarpy	A	Rare---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
Tu, Ty------------- Tully	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High------	Low.
We----------------- Wells	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 19.--ENGINEERING INDEX TEST DATA

(LL means liquid limit; PI, plasticity index; MD, maximum dry density; and OM, optimum moisture)

Soil name, report number, horizon, and depth in inches	Classification		Grain-size distribution									Moisture density	
			Percentage passing sieve--				Percentage smaller than--						
	AASHTO	Unified	No. 4	No. 10	No. 40	No. 200	.02 mm	.005 mm	.002 mm	LL	PI	MD	OM
										Pct		Lb/ft3	Pct
Crete silt loam:													
(S85KS-201-023)													
Ap----- 0 to 5	A-6	CL	100	100	100	96	59	29	23	33	11	101	19
Bt2---- 19 to 26	A-7	CH	100	100	100	97	78	47	37	56	29	94	24
C------ 40 to 60	A-7	CL	100	100	99	96	56	21	7	42	18	98	21
Kipson silty clay loam:													
(S85KS-201-026)													
A------ 0 to 12	A-7	ML	100	100	85	78	60	22	9	45	17	98	21
C------ 12 to 18	A-6	CL	100	100	92	90	79	40	22	39	18	109	18
Lancaster loam:													
(S85KS-201-025)													
A------ 0 to 9	A-6	CL	100	100	99	55	34	18	14	32	12	101	19
Bt----- 12 to 24	A-4	SC	100	100	99	43	30	22	18	27	10	112	15
C------ 24 to 33	A-6	CL	100	100	100	59	38	28	24	30	14	113	13
Muir silt loam:													
(S85KS-201-001)													
Ap----- 0 to 7	A-6	CL	100	100	100	98	74	30	24	37	14	98	21
Bw----- 18 to 33	A-6	CL	100	100	100	96	66	24	16	37	14	99	19
C------ 33 to 60	A-6	CL	100	100	100	91	49	19	14	34	12	103	18

TABLE 20.--CLASSIFICATION OF THE SOILS

(An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series)

Soil name	Family or higher taxonomic class
Benfield	Fine, mixed, mesic Udic Argiustolls
Cass	Coarse-loamy, mixed, mesic Fluventic Haplustolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Crete	Fine, montmorillonitic, mesic Pachic Argiustolls
Edalgo	Fine, mixed, mesic Udic Argiustolls
Eudora	Coarse-silty, mixed, mesic Fluventic Hapludolls
Hedville	Loamy, mixed, mesic Lithic Haplustolls
Hobbs	Fine-silty, mixed, nonacid, mesic Mollic Ustifluvents
*Jansen	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Argiustolls
Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Lancaster	Fine-loamy, mixed, mesic Udic Argiustolls
Longford	Fine, montmorillonitic, mesic Udic Argiustolls
Mayberry	Fine, montmorillonitic, mesic Aquic Argiudolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Muir	Fine-silty, mixed, mesic Cumulic Haplustolls
Sarpy	Mixed, mesic Typic Udipsamments
Sogn	Loamy, mixed, mesic Lithic Haplustolls
Tully	Fine, mixed, mesic Pachic Argiustolls
Wells	Fine-loamy, mixed, mesic Udic Argiustolls

Interpretive Groups

INTERPRETIVE GROUPS

Map symbol	Map unit	Land capability*	Prime farmland*	Range site
Be	Benfield silty clay loam, 3 to 7 percent slopes	IVe	No	Loamy Upland.
Cg	Cass fine sandy loam, occasionally flooded	IIw	Yes	Sandy Lowland.
Ch	Cass fine sandy loam, frequently flooded	Vw	No	Sandy Lowland.
Co	Colo silt loam	IIw	Yes**	Subirrigated.
Cr	Crete silt loam, 0 to 1 percent slopes	IIs	Yes	Clay Upland.
Cs	Crete silty clay loam, 1 to 3 percent slopes	IIe	Yes	Clay Upland.
Ct	Crete silty clay loam, 3 to 7 percent slopes	IIIe	Yes	Clay Upland.
Cx	Crete silty clay loam, 3 to 7 percent slopes, eroded	IVe	No	Clay Upland.
Ed	Edalgo silty clay loam, 3 to 7 percent slopes	IVe	No	Clay Upland.
Eu	Eudora loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Ho	Hobbs silt loam, occasionally flooded	IIw	Yes	Loamy Lowland.
Kp	Kipson silty clay loam, 5 to 30 percent slopes	VIe	No	Limy Upland.
Ks	Kipson-Sogn complex, 5 to 30 percent slopes	VIe	No	
	Kipson			Limy Upland.
	Sogn			Shallow Limy.
Lc	Lancaster loam, 3 to 7 percent slopes	IVe	Yes	Loamy Upland.
Lh	Lancaster-Hedville loams, 5 to 30 percent slopes	VIe	No	
	Lancaster			Loamy Upland.
	Hedville			Shallow Sandstone.
Lo	Longford silt loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Lx	Longford silty clay loam, 3 to 7 percent slopes, eroded	IVe	No	Loamy Upland.
Mc	Mayberry clay loam, 3 to 7 percent slopes	IIIe	No	Clay Upland.
Mh	Morrill loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Mm	Morrill loam, 7 to 12 percent slopes	IVe	No	Loamy Upland.
Mp	Morrill-Jansen loams, 7 to 20 percent slopes	VIe	No	Loamy Upland.
Mu	Muir silt loam	I	Yes	Loamy Terrace.
Sa	Sarpy loamy fine sand, undulating	VIs	No	Sands.
Tu	Tully silty clay loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.
Ty	Tully silty clay loam, 5 to 12 percent slopes	IVe	No	Loamy Upland.
We	Wells loam, 3 to 7 percent slopes	IIIe	Yes	Loamy Upland.

* A soil complex is treated as a single management unit in the land capability classification and prime farmland columns.

** Where drained.

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