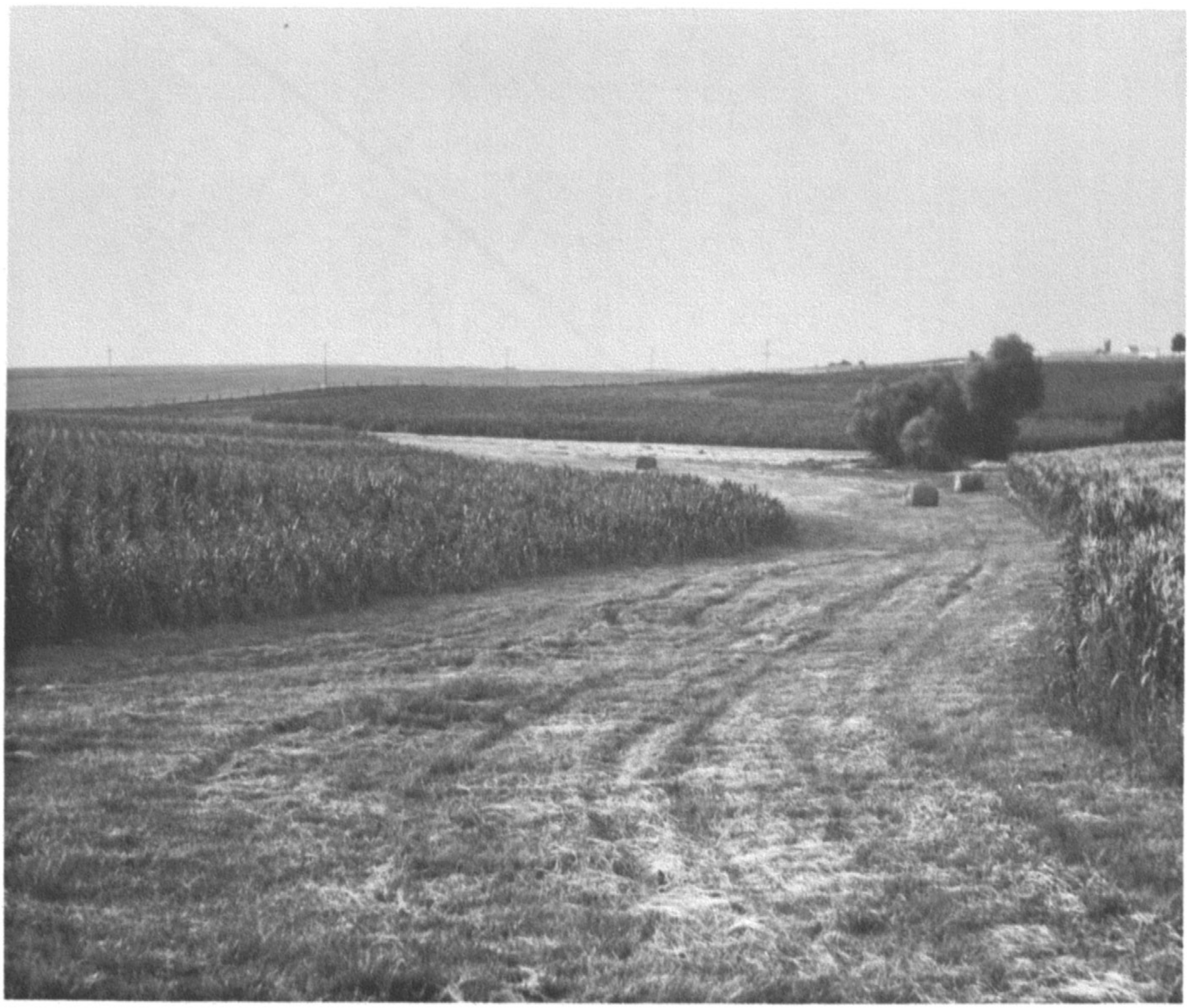
United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Buchanan County, Missouri



How To Use This Soil Survey

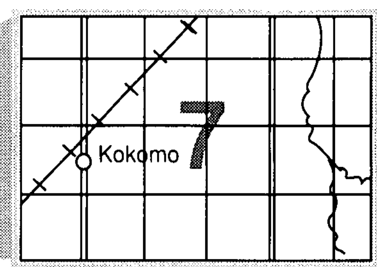
General Soil Map

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.

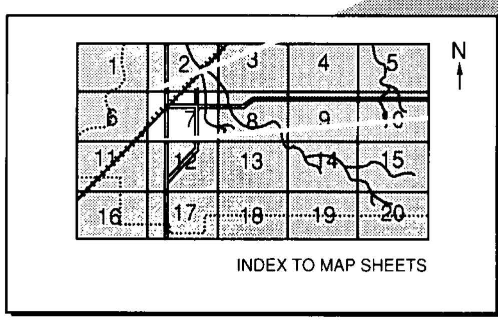
Detailed Soil Maps

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

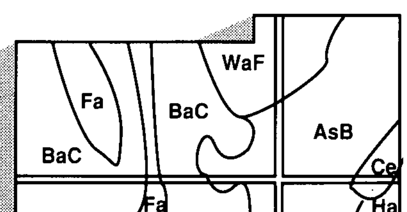
To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.



INDEX TO MAP SHEETS

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.

MAP SHEET



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. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, handicap, or age.

Major fieldwork for this soil survey was completed in 1982. Soil names and descriptions were approved in 1983. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1983. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Missouri Department of Natural Resources provided a soil scientist to assist with the fieldwork. The Buchanan County Court, through the Buchanan County Soil and Water Conservation District, provided funds for two soil scientists to assist with the fieldwork. The survey is part of the technical assistance furnished to the Buchanan County Soil and Water 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.

Cover: A grassed waterway in an area of the Marshall-Contrary association.

Contents

Soil Series

Issued September 1989

Index to Map Units

Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Buchanan County, Missouri. 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, 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 to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as 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.

Paul F. Larson
State Conservationist
Soil Conservation Service

Soil Survey of
Buchanan County, Missouri

By Earl D. Lockridge, Soil Conservation Service

Fieldwork by Earl D. Lockridge, Soil Conservation Service, Patricia A. Kowalewycz and Michael C. Painting, Missouri Department of Natural Resources, and Bryce L. Kelly, Buchanan County Soil and Water Conservation District

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

BUCHANAN COUNTY is in the northwestern part of Missouri (fig. 1). It has an area of 265,254 acres, or 414.46 square miles. St. Joseph is the county seat. It is in the northwest corner of the county. The population of the county was 87,888 in 1980.

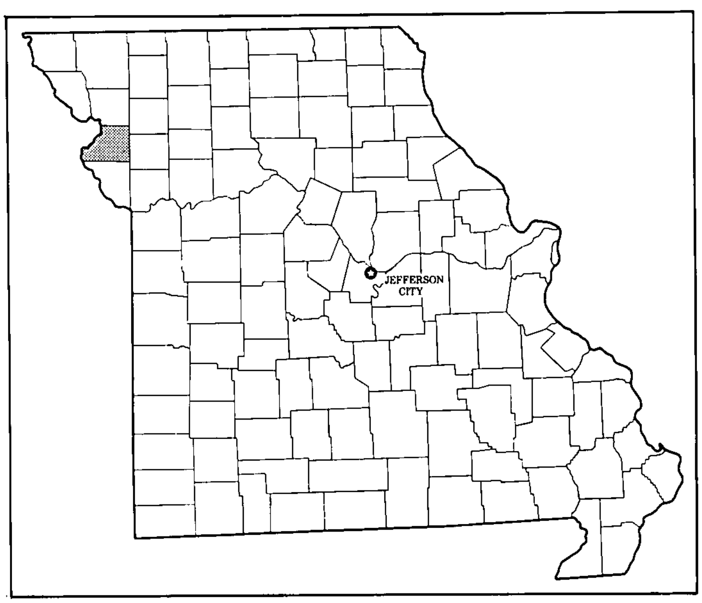


Figure 1.—Location of Buchanan County in Missouri.

Farming is the main enterprise in the county. About 50 percent of the farm income is derived from the sale of crops and 35 percent from the sale of livestock, poultry, and their products. About 15 percent of the farm family income is derived from off-farm sources (*18*).

Corn, soybeans, and wheat are the principal cash crops. Beef cattle, dairy cattle, and hogs are the main kinds of livestock. Most of the areas east of the bottom land along the Missouri River are used for mixed livestock enterprises and cash-grain farming. Nearly all of the bottom land along the river is used for cash-grain farming. Most of the timber in the county is grown on the deeply dissected river bluffs.

Erosion control on sloping cropland and in areas that are being developed for urban uses is the major management need in the county. Marshall, Sharpsburg, Higginsville, Contrary, and Knox soils are susceptible to severe sheet and gully erosion.

This soil survey updates the survey of Buchanan County published in 1917 (*14*). It provides additional information, larger maps, and more detailed interpretive information about the soils.

General Nature of the County

This section gives general information concerning the county. It describes climate; history and development; physiography, relief, and drainage; and transportation facilities.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

The climate in Buchanan County is one of cold winters and long, hot summers. Heavy rains occur mainly in spring and early in summer, when moist air from the Gulf of Mexico interacts with drier continental air. The annual rainfall is normally adequate for corn, soybeans, and all grain crops.

Table 1 gives data on temperature and precipitation for the survey area as recorded at St. Joseph in the period 1952 to 1979. 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 29 degrees F, and the average daily minimum temperature is 19 degrees. The lowest temperature on record, which occurred at St. Joseph on January 12, 1974, is -25 degrees. In summer the average temperature is 76 degrees, and the average daily maximum temperature is 87 degrees. The highest recorded temperature, which occurred at St. Joseph on July 13, 1954, is 107 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 34 inches. Of this, about 24 inches, or more than 70 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 19 inches. The heaviest 1-day rainfall during the period of record was 5.88 inches at St. Joseph on May 19, 1962. Thunderstorms occur on about 55 days each year. Tornadoes and severe thunderstorms occur occasionally but are local in extent and of short duration. They cause damage in scattered areas. Hailstorms sometimes occur in scattered small areas during the warmer part of the year.

The average seasonal snowfall is about 21 inches. The greatest snow depth at any one time during the period of record was 18 inches. On the average, 10 days of the year have at least 1 inch of snow on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 12 miles per hour, in spring.

History and Development

The area now known as Buchanan County was part of the land acquired from the Iowa, Fox, and Sac Indians through the Platte Purchase in 1836. The county was established in 1838. It was named after James Buchanan, a prominent diplomat who later became the 15th President of the United States, from 1857 to 1861 (*12*).

The early settlers came mostly from the neighboring counties and from Kentucky, Virginia, Tennessee, North Carolina, and South Carolina. Several industries were established along the Missouri River. This industrial activity attracted a number of foreign immigrants, mainly Germans, Swedes, and Irish. The 1849 California Gold Rush boosted the economy of the county. St. Joseph became a major jumping-off point for the Far West. A shipping company transported goods into the Sante Fe area, the Pacific Northwest, and the Upper Missouri River Valley. This company financed and organized the Pony Express, which originated at St. Joseph.

The Civil War was a turning point in the history of Buchanan County. It marked the transition of farming from hemp and tobacco to small grain and livestock. Railroads took over much of the shipping business from steamboats and barges.

In the 1900's, a significant population shift took place as people moved from the country to the city. As this shift occurred, small farms began to be consolidated into larger farms (*3*).

Physiography, Relief, and Drainage

Buchanan County has a diverse physiography. It is bounded on the west by the alluvial flood plain along the Missouri River. In Buchanan County, this flood plain is 0.25 to 6.0 miles wide. The county has two other major streams. These are the Hundred and Two River and the Platte River. The tributaries of these rivers are the Third Fork of the Platte River and Castile, Malden, and Bee Creeks. These streams drain the central and eastern parts of the county. Contrary and Sugar Creeks drain areas in the western part of the county near the Missouri River.

The uplands in the county generally are strongly sloping to steep and are highly dissected. They slope mainly to the southeast. The gradient of the slopes decreases somewhat from west to east.

The elevation of the uplands is about 950 feet above sea level, and that of the bottom land is about 765 feet above sea level (*14*).

Transportation Facilities

Located along the Missouri River, St. Joseph provides access to river ports on the Missouri, Mississippi, and

Ohio Rivers. Barge lines provide shipping services for industrial and agricultural products.

The county has several major highways. These are U.S. Interstate 29; U.S. Highways 71, 36, 6, and 169; and Missouri Highway 116.

Two railroads currently serve the county. Many of the spur lines in the county are abandoned. Rosecrans Memorial Airport is located at St. Joseph. It is a commercial-military facility.

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 biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the 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 considerable 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, acidity, 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 interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were 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 were 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 state with a fairly high degree of probability 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 several 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.

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.

The descriptions, names, and delineations of the soils identified on the general soil map of this county do not fully agree or join with those of the soils identified on the maps of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local variations. In some areas combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately.

Soil Descriptions

1. Marshall-Contrary Association

Gently sloping to strongly sloping, well drained soils formed in loess on uplands

This association consists of soils on rounded, continuous ridgetops and long side slopes. The side slopes are dissected by small gullies and short drainageways that flow into larger, more stable drainageways in small valleys.

This association makes up about 28 percent of the county. It is about 54 percent Marshall and similar soils, 21 percent Contrary soils, and 25 percent minor soils (fig. 2).

The gently sloping to strongly sloping Marshall soils are on ridgetops and convex side slopes. Typically, the surface layer is black, friable silt loam. The subsurface layer is very dark grayish brown and friable. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is friable silty clay loam. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown and mottled in the lower part. The substratum is yellowish brown, mottled, friable silty clay loam.

The strongly sloping Contrary soils are on side slopes and at the head of drainageways. Typically, the surface layer is dark brown, friable silt loam. The subsoil is mottled, friable silt loam. It is brown in the upper part and grayish brown in the lower part. The substratum is grayish brown, mottled, friable silt loam.

Minor in this association are the Armster, Colo, Gasconade, Gosport, Judson, and Lamoni soils. The moderately well drained Armster and somewhat poorly drained Lamoni soils are on the lower parts of side slopes. The poorly drained Colo and well drained Judson soils are in narrow drainageways. The shallow Gasconade and moderately deep Gosport soils are on the lowest parts of side slopes.

Most of this association is used for cultivated crops, hay, or pasture. The major soils are suited to corn, soybeans, grain sorghum, and small grain and to grasses and legumes for hay and pasture. The slope and the hazard of erosion are the main concerns in managing cropland. The hazard of erosion and overgrazing are the major concerns in managing pasture.

The major soils are suitable as sites for sanitary facilities and buildings. The slope is the main limitation.

2. Knox Association

Moderately sloping to very steep, well drained soils formed in a thick layer of loess on uplands

This association consists of soils on narrow, continuous ridgetops and long side slopes dissected by many small gullies and drainageways. It makes up about 24 percent of the county. It is about 81 percent Knox and similar soils and 19 percent minor soils (fig. 3).

The Knox soils typically have a surface layer of very dark grayish brown, friable silt loam or silty clay loam. The subsoil is friable. It is brown silty clay loam in the upper part, dark yellowish brown silty clay loam in the next part, and yellowish brown silt loam in the lower part. The substratum is yellowish brown, mottled, friable silt loam.

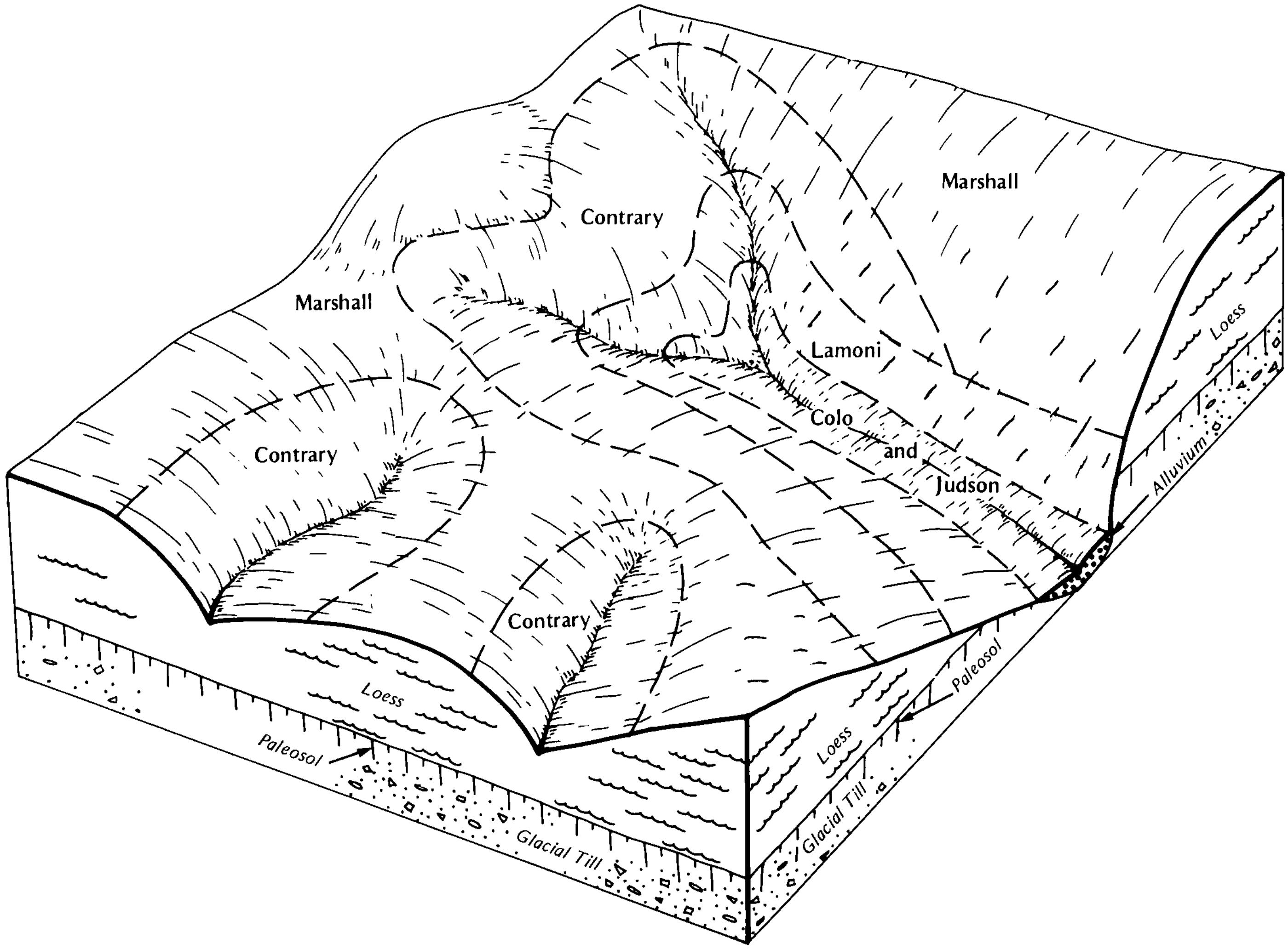


Figure 2.—Pattern of soils and parent material in the Marshall-Contrary association.

Minor in this association are the Colo, Gasconade, Gosport, Kennebec, and Wiota soils. The poorly drained Colo soils are on narrow flood plains. The somewhat excessively drained, shallow Gasconade and moderately well drained, moderately deep Gosport soils are on the steeper side slopes below the Knox soils. The moderately well drained Kennebec soils are on flood plains. The very gently sloping Wiota soils are on stream terraces.

Most of this association is used for cultivated crops, pasture, or woodland. A few small areas are used for orchards. A small part of the association, in and around St. Joseph, is used for urban development. The moderately steep to very steep soils are generally unsuited to cultivated crops because of the erosion hazard. Most of the association is suited to pasture. The slope and the hazard of erosion are the major concerns in managing orchards and pasture.

About 25 percent of this association is used as woodland. Oak, hickory, ash, and black walnut are the most common timber species. Most of the association is suited to trees. The slope and the erosion hazard are the main management concerns.

The moderately sloping and strongly sloping Knox soils are suitable as sites for sanitary facilities and buildings, but the moderately steep to very steep soils generally are unsuited. The slope and a moderate shrink-swell potential are the main limitations.

3. Haynie-Onawa-Waldron Association

Nearly level, moderately well drained and somewhat poorly drained soils formed in calcareous alluvium on

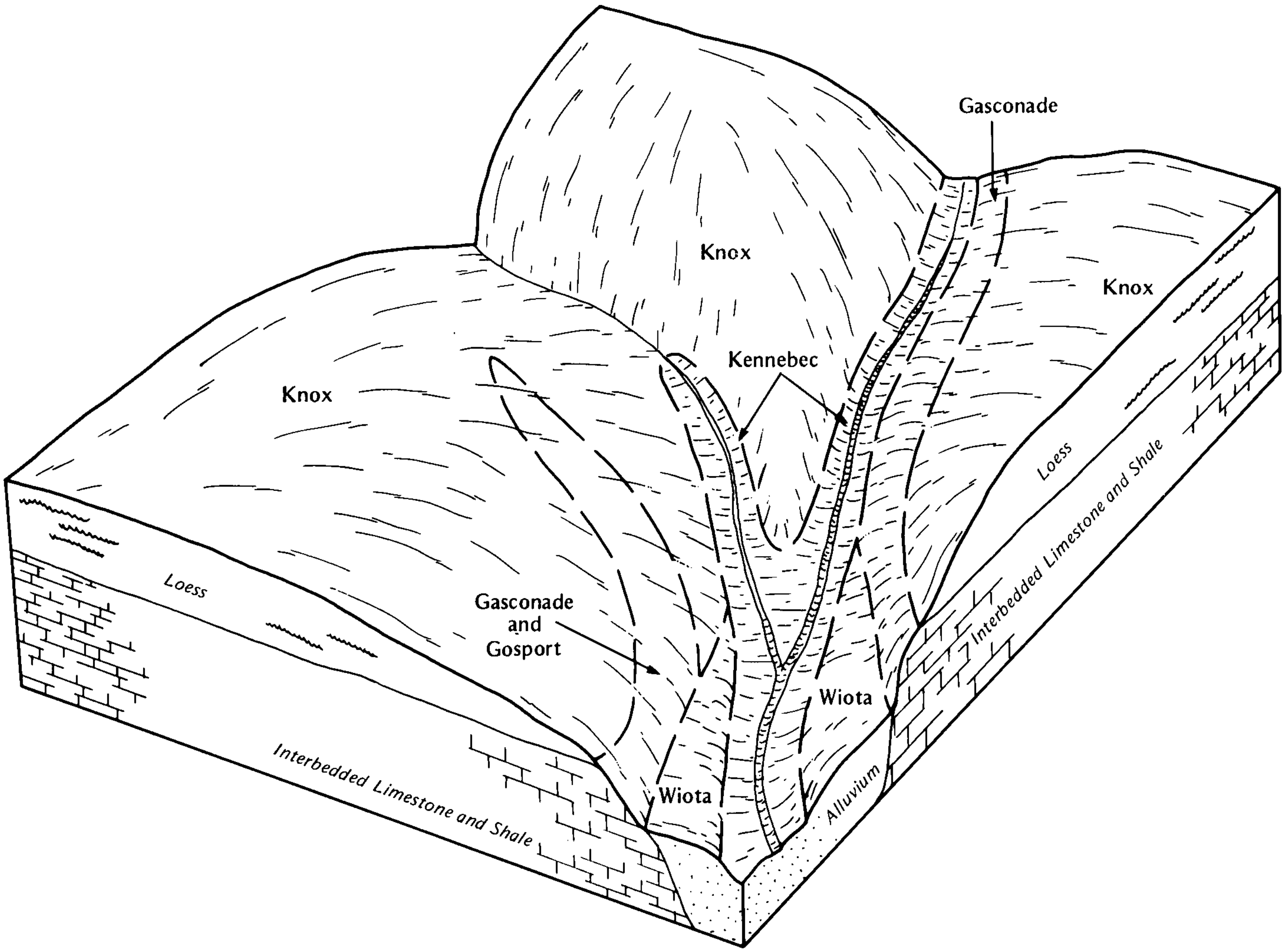


Figure 3.—Pattern of soils and parent material in the Knox association.

flood plains

This association consists of soils in slightly convex, slightly concave, and depressional areas on broad flood plains along the Missouri River. It makes up about 15 percent of the county. It is about 31 percent Haynie soils, 27 percent Onawa and similar soils, 11 percent Waldron soils, and 31 percent minor soils (fig. 4).

The moderately well drained Haynie soils are in slightly convex areas. Typically, the surface layer is very dark grayish brown, friable silt loam. The substratum is dark grayish brown, mottled, very friable very fine sandy loam.

The somewhat poorly drained Onawa soils are in slightly concave and depressional areas. Typically, the surface layer is very dark grayish brown, firm silty clay. The substratum is dark grayish brown. It is firm silty clay in the upper part and mottled, very friable very fine sandy loam in the lower part.

The somewhat poorly drained Waldron soils are in slightly concave and depressional areas. Typically, the surface layer is dark brown, firm silty clay loam. In sequence downward, the substratum is very dark grayish brown, firm silty clay; dark grayish brown and grayish brown, firm silty clay; dark grayish brown, friable very fine sandy loam; and dark grayish brown, firm silty clay loam.

Minor in this association are the Albaton, Levasy, Modale, and Sarpy soils. The poorly drained Albaton soils are in low areas. The poorly drained Levasy soils are in slightly concave or depressional areas. Modale soils are in broad nearly level areas. They are loamy in the upper part and clayey in the lower part. The

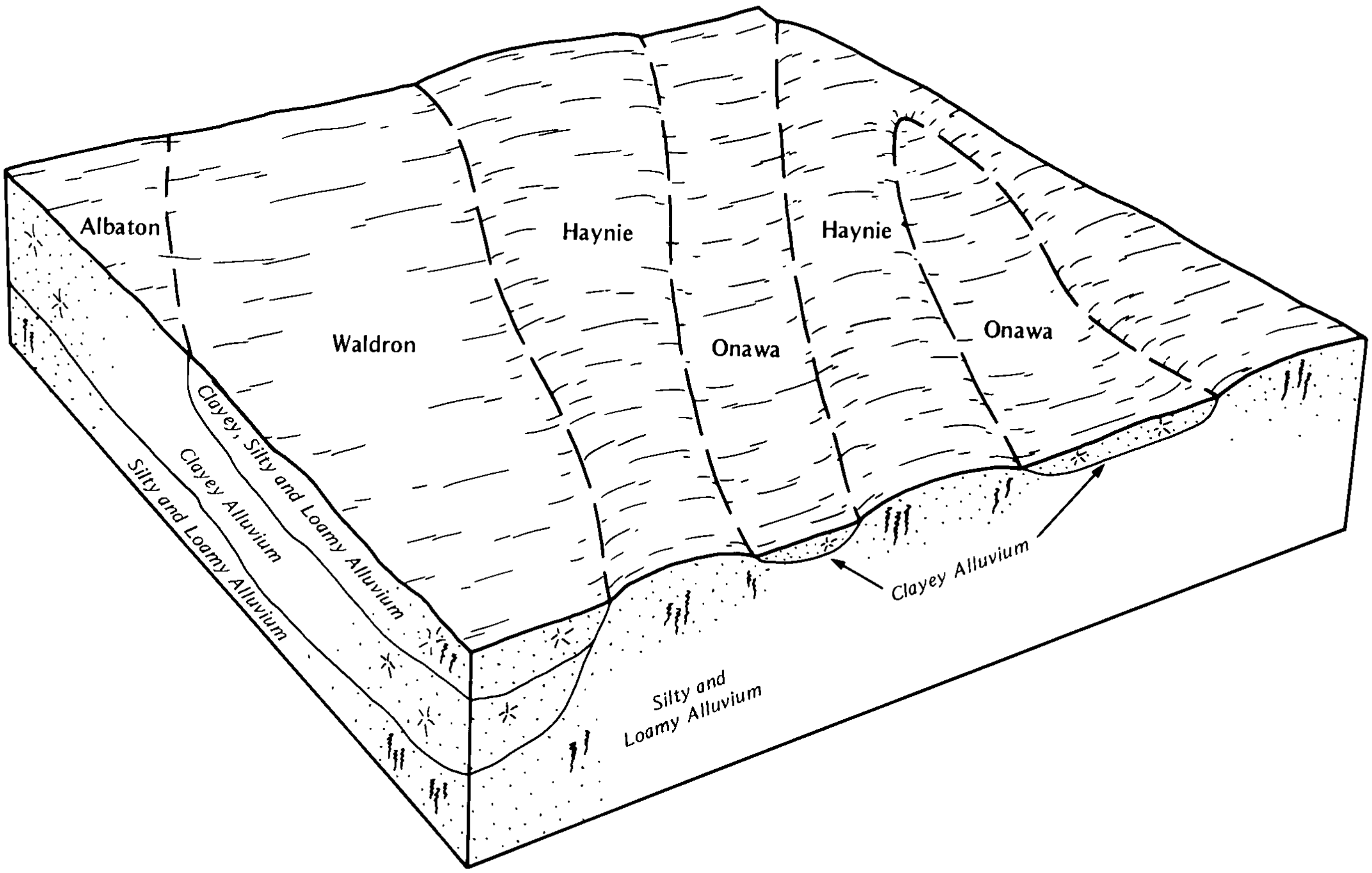


Figure 4.—Pattern of soils and parent material in the Haynie-Onawa-Waldron association.

excessively drained Sarpy soils are on the higher ridges. Also of minor extent are areas of Urban land.

The major soils are extensively cultivated. They generally are well suited to corn, soybeans, grain sorghum, small grain, and other cultivated crops. The wetness of Onawa and Waldron soils is the main limitation.

The major soils are protected by levees, but they are subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Dwellings on these soils should be constructed above known flood levels or on raised, well compacted fill material. If protected from flooding, the Haynie soils are only slightly limited as sites for buildings. The Onawa and Waldron soils are severely limited because of the wetness, low strength, and a high shrink-swell potential. Unless commercial facilities are available, detailed investigation is needed to determine the suitability for onsite waste disposal.

4. Lamoni-Sharpsburg-Higginsville Association

Gently sloping to strongly sloping, moderately well drained and somewhat poorly drained soils formed in loess or glacial till on uplands

This association consists of soils on broad, rounded, continuous ridgetops and long, smooth side slopes dissected by narrow, branching drainageways. It makes up about 8 percent of the county. It is about 26 percent Lamoni and similar soils, 24 percent Sharpsburg soils, 16 percent Higginsville soils, and 34 percent minor soils (fig. 5).

The somewhat poorly drained, moderately sloping and strongly sloping Lamoni soils are on convex side slopes. Typically, the surface layer is very dark grayish brown, friable silty clay loam. The subsoil is dark grayish brown, mottled, friable clay loam in the upper part; dark grayish brown and brown, mottled, firm clay in the next part; and multicolored, firm clay loam in the lower part. The substratum is firm clay loam. It is multicolored in the upper part and yellowish brown and mottled in the lower part.

The moderately well drained, gently sloping to strongly sloping Sharpsburg soils are on convex ridgetops. Typically, the surface layer is dark brown, friable silt loam

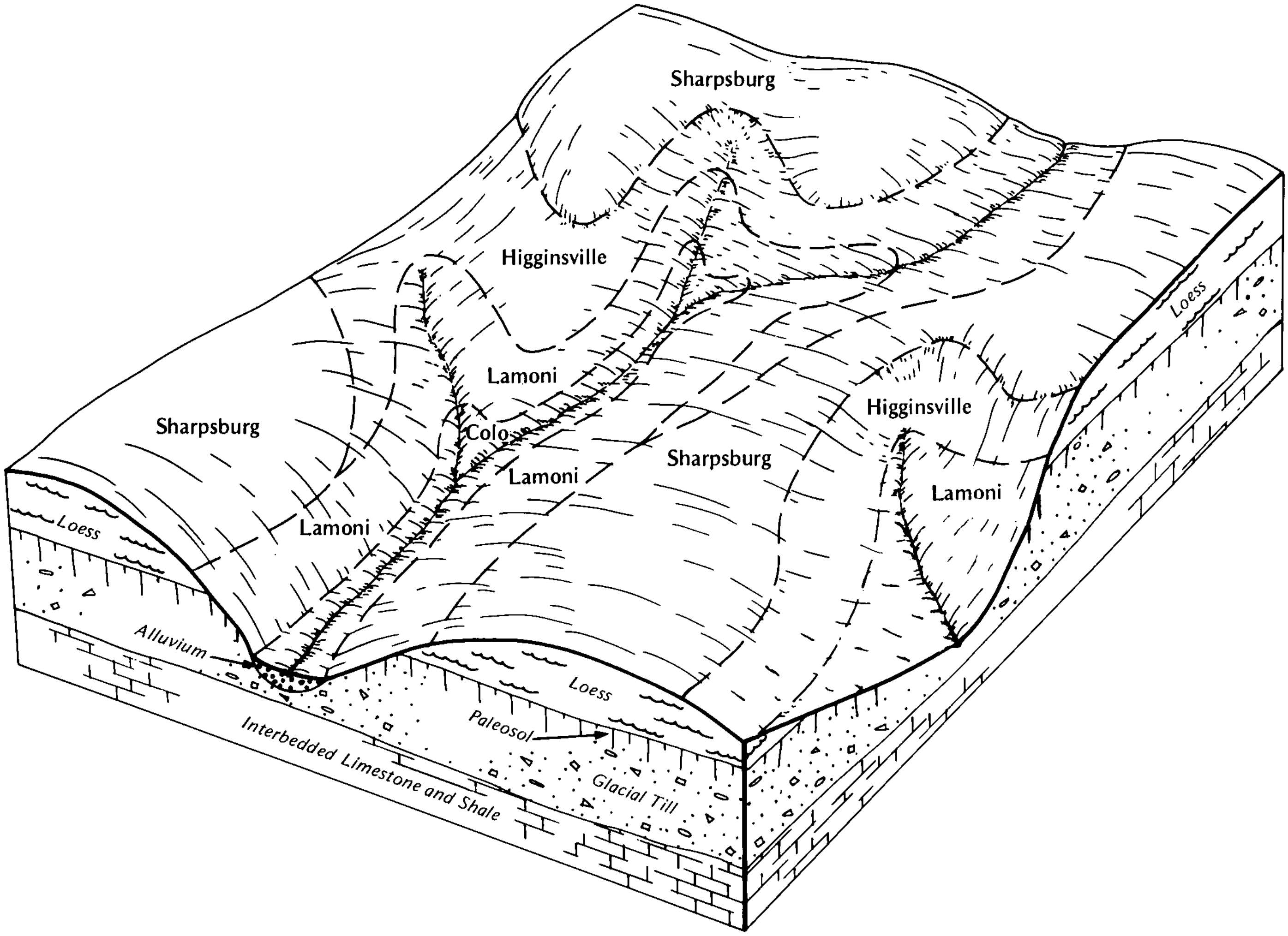


Figure 5.—Pattern of soils and parent material in the Lamoni-Sharpsburg-Higginsville association.

or silty clay loam. The subsoil is firm silty clay loam. It is brown and yellowish brown in the upper part and yellowish brown in the lower part. The substratum is brown, mottled, firm silty clay loam.

The somewhat poorly drained, moderately sloping and strongly sloping Higginsville soils are on concave side slopes, commonly at the head of drainageways. Typically, the surface layer is very dark grayish brown silty clay loam. The subsoil is mottled. It is brown silty clay loam in the upper part, grayish brown silty clay loam in the next part, and grayish brown silt loam in the lower part. The substratum is light brownish gray, mottled, friable silt loam.

Minor in this association are the Colo, Judson, and Shelby soils. The poorly drained Colo soils are on narrow flood plains and in narrow drainageways. The well drained Judson soils are on the lower foot slopes. The well drained Shelby soils are on side slopes below the Lamoni soils.

Most of this association is used for cultivated crops, hay, or pasture. The major soils are suited to corn, soybeans, grain sorghum, and small grain and to grasses and legumes for hay and pasture. The slope and the hazard of erosion are the main concerns in managing cropland. Surface wetness in areas of the Lamoni and Higginsville soils can hinder tillage and harvesting. The hazard of erosion is the main concern in managing pastured areas.

The major soils are suitable as sites for sanitary facilities and buildings. The slope, the wetness, moderate or slow permeability, and a moderate or high shrink-swell potential are the main limitations in areas of the Higginsville and Lamoni soils. The slope, a moderate shrink-swell potential, and moderately slow permeability are the main limitations in areas of the Sharpsburg soils.

5. Marshall-Lamoni-Higginsville Association

Gently sloping to strongly sloping, well drained and somewhat poorly drained soils formed in loess or glacial till on uplands

This association consists of soils on broad, rounded, continuous ridgetops and long, smooth side slopes dissected by narrow, branching drainageways. It makes up about 12 percent of the county. It is about 48 percent Marshall and similar soils, 16 percent Lamoni and similar soils, 15 percent Higginsville soils, and 21 percent minor soils.

The well drained, gently sloping to strongly sloping Marshall soils are on ridgetops and convex side slopes. Typically, the surface layer is black, friable silt loam. The subsurface layer is very dark grayish brown and friable. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is friable silty clay loam. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown and mottled in the lower part. The substratum is yellowish brown, mottled, friable silty clay loam.

The somewhat poorly drained, moderately sloping and strongly sloping Lamoni soils are on the lower convex side slopes. Typically, the surface layer is very dark grayish brown, friable silty clay loam. The subsoil is firm. It is dark grayish brown, mottled clay loam in the upper part; dark grayish brown and brown, mottled clay in the next part; and multicolored clay loam in the lower part. The substratum is firm clay loam. It is multicolored in the upper part and yellowish brown and mottled in the lower part.

The somewhat poorly drained, moderately sloping and strongly sloping Higginsville soils generally are on side slopes between the Marshall and Lamoni soils. Typically, the surface layer is very dark grayish brown, friable silty clay loam. The subsoil is brown, mottled, friable silty clay loam in the upper part and grayish brown, mottled, friable silty clay loam and silt loam in the lower part. The substratum is light brownish gray, mottled, friable silt loam.

Minor in this association are the poorly drained Colo soils on narrow flood plains and in narrow drainageways and the shallow Gasconade and moderately deep Gosport soils on the lower parts of side slopes.

Most of this association is used for cultivated crops, hay, or pasture. The major soils are suited to corn, soybeans, grain sorghum, and small grain and to grasses and legumes for hay and pasture. The slope and the hazard of erosion are the main concerns in managing cropland. Surface wetness in areas of the Higginsville and Lamoni soils can hinder tillage and harvesting. The hazard of erosion is the main concern in managing pastured areas.

The major soils are suitable as sites for sanitary facilities and buildings. The slope, the wetness, slow permeability, and a high shrink-swell potential are limitations in areas of the Lamoni soils. The slope, the wetness, a moderate shrink-swell potential, and moderate permeability are the limitations in areas of the Higginsville soils. The slope and a moderate shrink-swell potential are limitations in areas of the Marshall soils.

6. Colo-Nodaway-Zook Association

Nearly level, poorly drained and moderately well drained soils formed in alluvium on flood plains

This association consists of soils on flood plains along the intermediate and smaller streams. It makes up about 13 percent of the county. It is about 48 percent Colo soils, 16 percent Nodaway soils, 14 percent Zook soils, and 22 percent minor soils.

The poorly drained Colo soils are commonly in low, slightly concave areas adjacent to the stream channels. Typically, the surface layer is very dark gray, friable silty clay loam. The subsurface layer is black, friable and firm silty clay loam. The subsoil is very dark gray, firm and friable silty clay loam. The substratum is friable silty clay loam. It is very dark gray in the upper part and dark gray and mottled in the lower part.

The moderately well drained Nodaway soils are adjacent to the stream channels. Typically, the surface layer is very dark grayish brown, friable silt loam. The substratum is stratified dark grayish brown, very dark gray, and brown, mottled, friable silt loam that has thin strata of fine sandy loam. It is underlain by a buried surface layer of black, mottled, firm silty clay loam.

The poorly drained Zook soils are in low, plane or slightly concave slack-water areas adjacent to the stream channels. Typically, the surface layer is very dark grayish brown, friable silty clay loam. The subsurface layer is black, friable silty clay loam in the upper part; black, mottled, firm silty clay in the next part; and very dark gray, mottled, firm silty clay in the lower part. The subsoil is dark gray, mottled, firm silty clay.

Minor in this association are the Olmitz, Judson, Dockery, Kennebec, and Wabash soils. The gently sloping and moderately sloping Olmitz and gently sloping Judson soils are on foot slopes and alluvial fans adjacent to the uplands. The somewhat poorly drained Dockery soils are on slight rises on the flood plains. Kennebec soils have a thick, dark surface soil of silt loam. They are adjacent to stream channels. The clayey Wabash soils are in concave areas.

In most areas this association is used for cultivated crops. It is well suited to corn, soybeans, grain sorghum, and small grain. Flooding and wetness are the main management concerns.

The major soils generally are unsuited to sanitary facilities and building site development because of the flooding.

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, Knox silt loam, 5 to 9 percent slopes, is one of several phases in the Knox 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. Haynie-Onawa complex 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.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, quarries, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

The descriptions, names, and delineations of the soils identified on the detailed soil maps of this county do not fully agree or join with those of the soils identified on the maps of adjacent counties published at a different date. Differences are the result of additional soil data, variations in the intensity of mapping, and correlation decisions that reflect local variations. In some areas combining small acreages of similar soils that respond to use and management in much the same way is more practical than mapping these soils separately.

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

1B—Marshall silt loam, 2 to 5 percent slopes. This deep, gently sloping, well drained soil is on broad ridgetops. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is black, friable silt loam about 8 inches thick. The subsurface layer is about 10 inches thick. It is very dark grayish brown and friable. It is silt loam in the upper part and silty clay loam in the lower part. The subsoil is friable silty clay loam about 34 inches thick. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown and mottled in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silty clay loam. In places the dark surface soil is less than 10 inches thick.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

1B2—Marshall silt loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, well drained soil is on convex ridgetops and side slopes. Individual areas are irregular in shape and range from 15 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsoil is silty clay loam about 26 inches thick. The upper part is brown and friable and dark yellowish brown and firm; the next part is dark yellowish brown, mottled, and firm; and the lower part is yellowish brown, mottled, and friable. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In several places the dark surface soil is more than 10 inches thick.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. A few are used for hay. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

1C—Marshall silt loam, 5 to 9 percent slopes. This deep, moderately sloping, well drained soil is on ridgetops and convex side slopes. Individual areas are irregular in shape and range from 5 to more than 150 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is dark brown, friable silt loam about 4 inches thick. The subsoil to a depth of 60 inches or more is brown, friable silty clay loam. It is mottled in the lower part. In a few small areas, the upper part of the subsoil has grayish brown mottles. In places the dark surface soil is less than 10 inches thick.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

1C2—Marshall silt loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, well drained soil is on ridgetops and convex side slopes. Individual areas are irregular in shape and range from 10 to more than 200 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 8 inches thick. The subsoil is friable silty clay loam about 49 inches thick. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown and mottled in the lower part. The substratum to a depth of 71 inches or more is yellowish brown, mottled, friable silty clay loam. In a few small areas, the upper part of the subsoil has grayish brown mottles. In several places the dark surface soil is more than 10 inches thick.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

1D2—Marshall silt loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, well drained soil is on convex side slopes. Individual areas are irregular in shape and range from 10 to 120 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsoil is friable silty clay loam about 45 inches thick. It is dark yellowish brown in the upper part, dark yellowish brown and mottled in the next part, and yellowish brown and mottled in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In a few small areas, the upper part of the subsoil has grayish brown mottles. In several places the dark surface soil is more than 10 inches thick.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suitable for building site development and onsite waste disposal. Dwellings can be designed so that they conform to the natural slope of the land, or the site can be altered by land shaping. Adequately reinforcing basement walls, foundations, and footings minimizes the damage caused by shrinking and swelling of the subsoil. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action. Cutting and filling may be needed, depending on the slope.

The land capability classification is IIIe.

2D—Contrary silt loam, 9 to 14 percent slopes. This deep, strongly sloping, well drained soil is on side slopes and at the head of drainageways. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 8 inches thick. The subsoil is mottled, friable silt loam about 37 inches thick. It is brown in the upper part and grayish brown in the lower part. The substratum to a depth of 60 inches or more is grayish brown, mottled, friable silt loam.

Permeability is moderate, and surface runoff is medium. Available water capacity is very high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suitable for building site development and onsite waste disposal. Dwellings can be designed so that they conform to the natural slope of the land, or the site can be altered by land shaping. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action. Cutting and filling may be needed, depending on the slope.

The land capability classification is IIIe.

3C2—Higginsville silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is about 41 inches thick. It is mottled and friable. It is brown silty clay loam in the upper part, grayish brown silty clay loam in the next part, and grayish brown silt loam in the lower part. The substratum to a depth of 60 inches or more is light brownish gray, mottled, friable silt loam. In some areas the dark surface layer is more than 10 inches thick. In other areas the substratum contains more clay and has some sand and small pebbles. In a few areas the upper part of the subsoil does not have grayish mottles.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil. A perched water table commonly is at a depth of 1.5 to 3.0 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, and small grain. Further erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, timothy, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. The species that are tolerant of wetness grow best. Erosion is a hazard during seedbed preparation. It can be controlled by timely tillage and a quickly established ground cover.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Installing drainage tile around the footings helps to prevent the damage caused by excessive wetness.

Septic tank systems generally do not function adequately in this soil because of the moderate permeability in the subsoil and the perched water table. Some areas are suitable as sites for septic tank absorption fields if perimeter drains lower the water table and longer laterals are used to overcome the restricted permeability. The soil can be used as a site for sewage lagoons if commercial sewers are not available. The site should be leveled. Sealing the berms and bottom of the lagoon helps to prevent infiltration by ground water. Soils that are better suited to onsite waste disposal are generally nearby.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

3D2—Higginsville silty clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsoil is silty clay loam about 38 inches thick. It is mottled and friable. It is brown in the upper part and grayish brown in the lower part. The substratum to a depth of 60 inches or more is light brownish gray, mottled, friable silt loam. In a few areas the upper part of the subsoil does not have grayish mottles.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil. A perched water table commonly is at a depth of 1.5 to 3.0 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, and small grain. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, timothy, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. Erosion is the main problem. A good ground cover is necessary at all times if forage production is to be maintained. Nurse crops help to control erosion in newly seeded areas. Preparing a seedbed on the contour and in a timely manner and seeding by no-till methods also help to control erosion. Overgrazing should be avoided.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Installing drainage tile around the footings helps to prevent the damage caused by excessive wetness. The slope can be altered by land shaping.

Septic tank systems generally do not function adequately in this soil because of the moderate permeability in the subsoil, the slope, and the perched water table. Some areas are suitable as sites for septic tank absorption fields if perimeter drains lower the water table and longer laterals are used to overcome the restricted permeability. The soil can be used as a site for sewage lagoons if commercial sewers are not available. The site should be leveled. Sealing the berms and bottom of the lagoon helps to prevent infiltration by ground water. Soils that are better suited to onsite waste disposal are generally nearby.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope.

The land capability classification is IIIe.

4C—Knox silt loam, 5 to 9 percent slopes. This deep, moderately sloping, well drained soil is on ridgetops and side slopes in the strongly dissected uplands bordering the flood plains along the Missouri and Platte Rivers and their tributaries. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsoil is about 40 inches thick. It is friable. It is brown silty clay loam in the upper part; dark yellowish brown silty clay loam in the next part; and yellowish brown, mottled silt loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam.

Included with this soil in mapping are small areas of the well drained Judson soils on foot slopes and the moderately well drained Wiota soils on stream terraces. Wiota soils have a mottled subsoil. Both of the included soils have a dark surface layer that is thicker than that of the Knox soil. They make up 5 to 10 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is medium. Available water capacity is very high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content, but it tends to crust or puddle after hard rains. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. A few small areas are used as pasture or woodland. This soil is suited to corn, soybeans, small grain, and grain sorghum. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes and warm- and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. If alfalfa is grown, a high fertility level is needed. Hay should be cut by the early bloom stage, and the plants should be at least 6 inches tall as winter begins. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

A few small areas support native hardwoods. This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well. The hazards and limitations that affect planting and harvesting are slight.

This soil is suited to building site development and onsite waste disposal. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope. The less sloping areas should be selected as sites for sewage lagoons, or the site should be leveled. Sealing the lagoon with slowly permeable material helps to prevent seepage. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

4C2—Knox silt loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, well drained soil is on ridgetops and side slopes in the strongly dissected uplands bordering the flood plains along the Missouri and Platte Rivers and their tributaries. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is dark brown and brown, friable silt loam about 8 inches thick. The subsoil is firm silty clay loam about 38 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam.

Included with this soil in mapping are a few areas of shale outcrops on the lower side slopes. These areas make up less than 2 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface is friable and can be easily tilled, but it tends to puddle or crust after hard rains. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, small grain, and other cultivated crops. Further erosion is a hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes and warm- and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. If alfalfa is grown, a high fertility level is needed. Hay should be cut by the early bloom stage, and the plants should be at least 6 inches tall as winter begins. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

A few small areas support native hardwoods. This soil is well suited to trees. No serious hazards or limitations affect planting or harvesting.

This soil is suitable for building site development and onsite waste disposal. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope. The less sloping areas should be selected as sites for sewage lagoons, or the site should be leveled. Sealing the lagoon with slowly permeable material helps to prevent seepage. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

4D2—Knox silt loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, well drained soil is on ridgetops and side slopes in the strongly dissected uplands bordering the flood plains along the Missouri and Platte Rivers and their tributaries. Individual areas are irregular in shape and range from 10 to more than 200 acres in size.

Typically, the surface layer is brown, friable silt loam about 7 inches thick. The subsoil is firm silty clay loam about 41 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In some places, all of the original surface layer has been removed by erosion and the present surface layer is silty clay loam. In other places the subsoil is dominantly grayer.

Included with this soil in mapping are narrow bands of Gasconade soils at various elevations on the side slopes. These soils are shallow over bedrock. They make up 5 to 10 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled, but it tends to puddle or crust after hard rains. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, small grain, and other cultivated crops. Further erosion is a hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

A few small areas support native hardwoods. This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well. The hazards and limitations that affect planting and harvesting are slight.

This soil is suited to building site development and onsite waste disposal. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope. The less sloping areas should be selected as sites for sewage lagoons, or the site should be leveled. Sealing the lagoon with slowly permeable material helps to prevent seepage. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Adequately reinforcing basement walls, foundations, and footings minimizes the structural damage caused by shrinking and swelling of the subsoil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope.

The land capability classification is IIIe.

4D3—Knox silty clay loam, 9 to 14 percent slopes, severely eroded. This deep, strongly sloping, well drained soil is on ridgetops and side slopes in the strongly dissected uplands bordering the flood plains along the Missouri and Platte Rivers and their tributaries. Individual areas are irregular in shape and range from 30 to more than 200 acres in size.

Typically, the surface layer is dark yellowish brown, firm silty clay loam about 8 inches thick. The subsoil is about 24 inches thick. It is dark yellowish brown, firm silty clay loam in the upper part and yellowish brown, friable silt loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, friable silt loam. It is mottled in the lower part. In some areas the surface layer is dark brown.

Included with this soil in mapping are narrow bands of Gasconade soils at various elevations on the side slopes. These soils are shallow over bedrock. They make up about 2 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderately low. The surface layer is sticky when wet and can be easily tilled only within a narrow range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, small grain, and other cultivated crops. Further erosion is a hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well. The hazards and limitations that affect planting and harvesting are slight.

This soil is suited to building site development and onsite waste disposal. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope. The less sloping areas should be selected as sites for sewage lagoons, or the site should be leveled. Sealing the lagoon with slowly permeable material helps to prevent seepage. Dwellings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Adequately reinforcing basement walls, foundations, and footings minimizes the structural damage caused by shrinking and swelling of the subsoil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope.

The land capability classification is IVe.

4E3—Knox silty clay loam, 14 to 20 percent slopes, severely eroded. This deep, moderately steep, well drained soil is on side slopes in the strongly dissected uplands bordering the flood plains along the Missouri and Platte Rivers and their tributaries. Individual areas are irregular in shape and range from 10 to more than 150 acres in size.

Typically, the surface layer is dark yellowish brown, firm silty clay loam about 6 inches thick. The subsoil also is dark yellowish brown, firm silty clay loam. It is about 26 inches thick. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In places the surface layer is dark brown and is more than 6 inches thick.

Included with this soil in mapping are narrow bands of Gasconade soils at various elevations on the side slopes. These soils are shallow over bedrock. They make up about 5 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is rapid. Available water capacity is high. Natural fertility is medium, and organic matter content is moderately low. The surface layer is sticky when wet. The shrink-swell potential is moderate in the subsoil.

Most areas are cultivated. This soil is unsuited to cultivated crops because of a severe hazard of further erosion. Seeding recently cultivated areas to a permanent cover of pasture plants or hay reduces this hazard. The soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Because of the slope and the severe erosion hazard, care is needed in reestablishing a pasture. Renovating in strips that follow the contour reduces the erosion hazard. Plowing and seedbed preparation should be avoided. Overgrazing also should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

Many areas support native hardwoods. This soil is suited to trees. Because of the slope, timber harvesting is difficult and hand planting or direct seeding methods may be needed. Seeding disturbed areas after the timber is harvested reduces the hazard of erosion. Logging roads and skid trails should be established on the contour. Planting container-grown nursery stock increases the seedling survival rate.

This soil generally is unsuited to building site development and onsite waste disposal because of the slope.

The land capability classification is VIe.

4F—Knox silt loam, 20 to 35 percent slopes. This deep, steep and very steep, well drained soil is on side slopes in the deeply dissected uplands bordering the flood plains along the Missouri River and its tributaries. Individual areas are irregular in shape and range from 50 to more than 200 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 6 inches thick. The subsurface layer is brown, friable silt loam about 6 inches thick. The subsoil is brown, friable silty clay loam about 38 inches thick. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In some areas the slope is more than 35 percent. In a few areas the subsoil and substratum are calcareous.

Included with this soil in mapping are small areas of the very gently sloping Wiota soils on small stream terraces. Also included are areas of the shallow Gasconade and moderately deep Snead soils on side slopes below the Knox soil. Included soils make up about 10 percent of the unit.

Permeability is moderate in the Knox soil, and surface runoff is rapid. Available water capacity is very high. Natural fertility is low, and organic matter content is moderate.

Because of a severe erosion hazard, this soil generally is unsuited to cultivated crops. It is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Because of the slope and the erosion hazard, care is needed in reestablishing a pasture. Renovating in strips that follow the contour reduces the erosion hazard. Plowing and seedbed preparation should be avoided. Overgrazing also should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

Most areas are used as woodland. Many support low-quality native hardwoods. This soil is suited to trees. Because of the slope, harvesting is difficult and hand planting or direct seeding methods may be needed. Seeding disturbed areas after the timber is harvested reduces the hazard of erosion. Logging roads and skid trails should be established on the contour. Planting container-grown nursery stock increases the seedling survival rate.

This soil is generally unsuited to building site development and onsite waste disposal because of the slope.

The land capability classification is VIe.

7B2—Sharpsburg silt loam, 2 to 5 percent slopes, eroded. This deep, gently sloping, moderately well drained soil is on convex ridgetops. Individual areas are irregular in shape and range from 30 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsoil is silty clay loam about 42 inches thick. The upper part is brown and friable, the next part is dark yellowish brown and yellowish brown and is firm, and the lower part is mottled grayish brown, brown, and strong brown and is firm. The substratum to a depth of 60 inches or more is mottled grayish brown, strong brown, and brown, firm silty clay loam. In several of the less eroded areas, the dark surface soil is more than 10 inches thick.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Most areas can be terraced and farmed on the contour along with the adjacent areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank systems generally do not function adequately because of the moderately slow permeability in the subsoil. Some areas are suitable as sites for septic tank absorption fields if longer laterals are used to overcome the restricted permeability. The soil can be used as a site for sewage lagoons if commercial sewers are not available. The site should be leveled. Sealing the berms and bottom of the lagoon helps to prevent seepage.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

7C2—Sharpsburg silt loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, moderately well drained soil is on convex ridgetops and side slopes. Individual areas are irregular in shape and range from 20 to more than 200 acres in size.

Typically, the surface layer is dark brown, friable silt loam about 7 inches thick. The subsoil is firm silty clay loam about 40 inches thick. It is brown and yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum to a depth of 60 inches or more is brown, mottled, firm silty clay loam. In several of the less eroded areas, the dark surface soil is more than 10 inches thick. In some areas the upper part of the subsoil has grayish brown mottles. In several places the surface layer is silty clay loam.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Most areas can be terraced and farmed on the contour along with the adjacent areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping.

Septic tank systems generally do not function adequately in this soil because of the moderately slow permeability in the subsoil. Some areas are suitable as sites for septic tank absorption fields if longer laterals are used to overcome the restricted permeability. The distribution lines should be installed across the slope. The soil can be used as a site for sewage lagoons if commercial sewers are not available. The site should be leveled. Sealing the berms and bottom of the lagoon helps to prevent seepage.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

7D2—Sharpsburg silty clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, moderately well drained soil is on side slopes. Individual areas are irregular in shape and range from 20 to more than 200 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 9 inches thick. The subsoil is silty clay loam about 42 inches thick. The upper part is brown and dark yellowish brown and is friable, and the lower part is dark yellowish brown and yellowish brown, mottled, and firm. The substratum to a depth of 60 inches or more is mottled light brownish gray, strong brown, grayish brown, and yellowish brown, friable silty clay loam.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only within a somewhat narrow range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Most areas can be terraced and farmed on the contour along with the adjacent areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping.

Septic tank systems generally do not function adequately in this soil because of the moderately slow permeability in the subsoil. Some areas are suitable as sites for septic tank absorption fields if longer laterals are used to overcome the restricted permeability. The distribution lines should be installed across the slope. The soil can be used as a site for sewage lagoons if commercial sewers are not available. The site should be leveled. Sealing the berms and bottom of the lagoon helps to prevent seepage.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope. The roads can be designed so that they conform to the natural slope of the land.

The land capability classification is IIIe.

11B—Sibley silt loam, 1 to 5 percent slopes. This deep, gently sloping, well drained soil is on convex ridgetops and side slopes. Individual areas are irregular in shape and range from 10 to 120 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silt loam about 20 inches thick. The subsoil is friable silty clay loam about 20 inches thick. The upper part is dark brown, and the lower part is brown and mottled. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silty clay loam.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for cultivated crops. A few are used for hay. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank systems generally function adequately in this soil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

21B—Judson-Colo complex, 1 to 5 percent slopes. These deep, nearly level to gently sloping soils are in narrow drainageways that extend into the uplands. The well drained Judson soil is on foot slopes bordering the uplands. The poorly drained Colo soil is in the middle of the drainageways and is occasionally flooded. Individual areas are long and narrow and range from 10 to more than 200 acres in size. They are about 60 percent Judson soil and 35 percent Colo soil. The two soils occur as areas so narrow that they cannot be delineated as separate units on the maps.

Typically, the Judson soil has a surface layer of very dark brown, friable silt loam about 8 inches thick. The subsurface layer is about 24 inches thick. It is very dark grayish brown, friable silt loam in the upper part; very dark grayish brown, friable silty clay loam in the next part; and dark brown, friable silty clay loam in the lower part. The subsoil to a depth of 60 inches or more is friable silty clay loam. It is brown in the upper part and yellowish brown in the lower part.

Typically, the Colo soil has a surface layer of very dark gray, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 23 inches thick. The subsoil is very dark gray, firm silty clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is dark gray, mottled, friable silty clay loam.

Included with these soils in mapping are areas of gullies and channels on the steeper parts of the landscape. These areas make up less than 5 percent of the unit.

Permeability is moderate in the Judson and Colo soils. Surface runoff is medium on the Judson soil and slow on the Colo soil. Available water capacity is high in both soils. Natural fertility also is high. Organic matter content is moderate in the Judson soil and high in the Colo soil. The shrink-swell potential is moderate in the Judson soil and high in the Colo soil. The Colo soil has a seasonal high water table at a depth of 1 to 3 feet during extended wet periods. The Judson soil dries out more quickly than the Colo soil. Also, it can be easily tilled throughout a wider range in moisture content.

Most areas are used for cultivated crops, hay, or pasture. These soils are suited to corn, soybeans, and small grain. They generally are managed along with the adjacent soils. Many areas are dissected by gullies that stem from upland drainageways. Ditchbank erosion and runoff from the uplands are problems. A permanent cover of vegetation along stream channels helps to stabilize ditchbanks. Diversions protect these soils against excessive runoff from the adjacent uplands. Some land grading is beneficial in places. Returning crop residue to the soils or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

The Judson soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover. The Colo soil is best suited to water-tolerant, shallow-rooted legumes, such as alsike clover, and to cool-season grasses, such as reed canarygrass. It is poorly suited to hay. Wetness and flooding are the main problems. The grazing system should be adjusted to these problems. A seedbed can be easily prepared unless the soil is wet. A surface drainage system improves the growth of the deeper rooted species. Overgrazing reduces forage production and increases the extent of weeds on both soils.

The Judson soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank absorption fields can function properly in this soil. Providing adequate base material for local roads and streets, designing the roads so that they shed water, and providing adequate side ditches and culverts help to prevent the damage caused by low strength, frost action, and shrinking and swelling.

The Colo soil generally is unsuitable for building site development and onsite waste disposal because of the wetness and the occasional flooding.

The land capability classification is IIw.

22A—Wiota silt loam, 1 to 3 percent slopes. This deep, very gently sloping, well drained soil is on low stream terraces. It is subject to rare flooding of brief duration. Individual areas are irregular in shape and range from 10 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The subsurface layer is very dark grayish brown, friable silty clay loam about 12 inches thick. The subsoil is friable silty clay loam about 26 inches thick. It is dark brown in the upper part, brown in the next part, and brown and mottled in the lower part. The substratum to a depth of 60 inches or more is brown, mottled, friable silty clay loam. In some places the slope is less than 1 percent, and in other places it is as much as 5 percent.

Permeability is moderate, and surface runoff is medium. Available water capacity is very high. Natural fertility is high, and organic matter content is moderate. The surface layer is friable and can be easily tilled, but it tends to puddle or crust after hard rains. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. No significant limitations affect crop production if the soil is protected from flooding and the runoff from the adjacent uplands. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Timely seedbed preparation helps to ensure a good ground cover.

This soil generally is unsuited to building site development and onsite waste disposal because of the flooding.

The land capability classification is I.

25F—Gosport silty clay loam, 15 to 45 percent slopes. This moderately deep, moderately steep to very steep, moderately well drained soil is on the lower part of side slopes in the uplands. Coarse fragments and bedrock outcrops commonly cover 5 to 10 percent of the surface. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 3 inches thick. The subsoil is about 29 inches thick. It is light yellowish brown, firm silty clay loam in the upper part; yellowish brown, firm silty clay in the next part; and yellowish brown, mottled, firm silty clay loam in the lower part. Weathered shale bedrock is at a depth of about 32 inches. In a few areas, particularly near the bluffs bordering the flood plains along the Missouri River, the slope is more than 45 percent.

Included with this soil in mapping are small areas of the shallow, somewhat excessively drained Gasconade soils and the deep, well drained Knox soils. Gasconade soils are on the slightly higher slopes, and Knox soils are on ridgetops. Also included are a few small areas where the soil is calcareous in the lower part of the solum. Included soils make up about 15 percent of the unit.

Permeability is very slow in the Gosport soil, and surface runoff is rapid. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderately low. The shrink-swell potential is high in the subsoil.

Most areas are used for trees or pasture. Because of the erosion hazard, this soil is unsuited to cultivated crops. Growing grasses and legumes for pasture is effective in controlling erosion. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, big bluestem, little bluestem, and indiangrass. It is moderately suited to most other legumes and cool-season grasses. Shallow-rooted species that can withstand droughtiness should be selected for planting. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suited to trees. Because of the slope, harvesting is difficult and hand planting or direct seeding methods may be needed. Seeding disturbed areas after the timber is harvested reduces the hazard of erosion. Logging roads and skid trails should be established on the contour. Planting container-grown nursery stock increases the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil generally is unsuited to building site development and onsite waste disposal because of the slope and the depth to bedrock.

The land capability classification is VIIe.

29F—Gasconade flaggy silty clay loam, 20 to 40 percent slopes. This shallow, steep and very steep, somewhat excessively drained soil is on upland side slopes. Individual areas are irregular in shape or are long and narrow. They range from 5 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable flaggy silty clay loam about 9 inches thick. The subsoil is brown, firm flaggy silty clay loam about 8 inches thick. Hard, white limestone bedrock is at a depth of about 17 inches. The cracks and crevices in the bedrock are filled with dark brown silty clay loam.

Included with this soil in mapping are small areas of the moderately deep Gosport soils in the slightly lower landscape positions. Also included are small areas where bedrock outcrops and coarse fragments are on the surface. Included areas make up about 10 to 15 percent of the unit.

Permeability is moderately slow in the Gasconade soil, and surface runoff is rapid. Available water capacity is very low. Natural fertility is low, and organic matter content is moderate. Most areas cannot be tilled because of the limestone fragments and the shallow depth to bedrock. The shrink-swell potential is moderate.

Most areas are used as unimproved woodland or pasture (fig. 6). Brush and forbs grow in most places. Because of the slope and the flaggy surface layer, this soil is unsuited to cultivated crops. It is suited to pasture that is grazed on a limited basis. An adequate plant cover is needed in the pastured areas because the soil is highly susceptible to erosion. Measures that control weeds also are needed. Tall fescue and common lespedeza should be selected for planting. Seedbed preparation and brush control are difficult because of the coarse fragments on the surface and the slope.

Most areas support stands of oak, hickory, and ash. This soil is suited to trees. Because of low production, however, intensive timber management generally is not warranted. Because of the slope, the coarse fragments, and the included rock outcrops, the use of equipment is limited. Harvesting is difficult, and hand planting or direct seeding methods may be needed. Logging roads and

Figure 6.—A pastured area of Gasconade flaggy silty clay loam, 20 to 40 percent slopes.

skid trails should be established on the contour. Seedling mortality and the windthrow hazard are moderate. Planting container-grown nursery stock increases the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil generally is unsuited to building site development and onsite waste disposal because of the flagstones and the depth to bedrock.

The land capability classification is VIIs.

31D—Armster silt loam, 9 to 14 percent slopes. This deep, strongly sloping, moderately well drained soil typically is on side slopes adjacent to flood plains along large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 7 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 3 inches thick. The subsoil extends to a depth of 60 inches or more. In sequence downward, it is dark brown, firm clay loam; dark brown and strong brown, mottled, firm clay; mottled strong brown, grayish brown, and light brownish gray, firm clay loam; and strong brown, mottled, firm clay loam.

Included with this soil in mapping are a few small areas of the somewhat poorly drained, moderately sloping and strongly sloping Lamoni soils. These soils are in the higher landscape positions. They make up less than 5 percent of the unit.

Permeability is moderately slow in the Armster soil, and surface runoff is medium. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderately low. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table commonly is at a depth of 3 to 5 feet during extended wet periods.

Most areas are pastured. Erosion is a serious hazard if cultivated crops are grown. Row crops and small grain can be grown only on a limited basis and only if the soil is farmed on the contour or terraced or if the cropping sequence includes close-growing hay and pasture crops. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

A few small areas support native hardwoods. This soil is suited to trees. No major hazards or limitations affect planting or harvesting.

This soil is suitable for building site development and sewage lagoons. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Installing drainage tile around the footings helps to prevent the damage caused by excessive wetness. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Sewage lagoons function adequately if the site can be leveled and the berms and bottom of the lagoon are sealed with slowly permeable material. Also, sewage can be piped to the adjacent areas of less sloping soils that are better suited to lagoons.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope.

The land capability classification is IVe.

33D2—Armstrong loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, somewhat poorly drained soil is on side slopes adjacent to flood plains along large streams and their tributaries. Individual areas are irregular in shape and range from 5 to 40 acres in size.

Typically, the surface layer is dark brown, friable loam about 7 inches thick. The subsoil extends to a depth of 60 inches or more. It is mottled and firm. The upper part is reddish brown clay, the next part is yellowish red and strong brown clay, and the lower part is yellowish brown clay loam. In places the upper part of the subsoil has no grayish brown mottles.

Included with this soil in mapping are numerous small areas where the original surface layer has been completely eroded away and the present surface layer is brown clay. These areas make up about 10 percent of the unit.

Permeability is slow in the Armstrong soil, and surface runoff is medium. Available water capacity is moderate. Natural fertility is low, and organic matter content is moderately low. The surface layer is friable and can be easily tilled only within a fairly narrow range in moisture content. The shrink-swell potential is high in the subsoil.

A perched water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are pastured. A few are cultivated. Further erosion is a serious hazard if this soil is used for cultivated crops. Row crops and small grain can be grown only on a limited basis and only if the soil is farmed on the contour and the cropping sequence includes close-growing hay and pasture crops. Conservation tillage, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. A forage mixture that includes water-tolerant varieties grows well. This soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, timothy, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. Erosion is the main problem. A good ground cover is necessary at all times if forage production is to be maintained. Nurse crops help to control erosion in newly seeded areas. Tilling the soil on the contour and in a timely manner and seeding by no-till methods also help to control erosion. Overgrazing should be avoided.

This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown nursery stock increases the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping. Installing drainage tile around footings helps to prevent the damage caused by excessive wetness.

Septic tank systems generally do not function adequately in this soil because of the slow permeability in the subsoil and the perched water table. Sewage lagoons function adequately only if the site can be leveled. Otherwise, the sewage can be piped to less sloping areas that are better sites for lagoons.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action, shrinking and swelling, and wetness.

The land capability classification is IVe.

42C2—Lamoni silty clay loam, 5 to 9 percent slopes, eroded. This deep, moderately sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 5 to 160 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 9 inches thick. The subsoil is about 38 inches thick. It is dark grayish brown, mottled, friable clay loam in the upper part; dark grayish brown and brown, mottled, firm clay in the next part; and multicolored, firm clay loam in the lower part. The substratum to a depth of 60 inches or more is firm clay loam. It is multicolored in the upper part and yellowish brown and mottled in the lower part. In many of the less eroded areas, the dark surface layer is more than 10 inches thick.

Included with this soil in mapping are areas where all of the dark surface layer has been removed by erosion and the plow layer is mostly clayey material from the upper part of the subsoil. These areas are on shoulder slopes and convex ridgetops. They make up about 5 to 15 percent of the unit.

Permeability is slow in the Lamoni soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only within a narrow range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Further erosion is a hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Special management may be needed if the clayey subsoil is exposed by terrace cuts. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to birdsfoot trefoil, reed canarygrass, tall fescue, timothy, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion is a hazard during seedbed preparation. It can be controlled by timely tillage and a quickly established ground cover.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Installing drainage tile around the footings helps to prevent the damage caused by excessive wetness.

Septic tank systems generally do not function adequately in this soil because of the slow permeability in the subsoil and the perched water table. Sewage lagoons function adequately only if the site can be leveled. Otherwise, the sewage can be piped to less sloping areas that are better sites for lagoons.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

42D2—Lamoni silty clay loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, somewhat poorly drained soil is on side slopes and in concave areas on the upper part of drainageways. Individual areas are irregular in shape and range from 10 to 100 acres in size.

Typically, the surface layer is black, friable silty clay loam about 9 inches thick. The subsoil is about 36 inches thick. It is mottled and firm. The upper part is dark grayish brown clay loam, the next part is yellowish brown clay, and the lower part is light brownish gray clay. The substratum to a depth of 60 inches or more is light brownish gray, mottled, firm clay loam. In some of the less eroded areas, the dark surface layer is more than 10 inches thick. In a few large areas, the upper part of the subsoil has many red mottles.

Included with this soil in mapping are areas where all of the dark surface layer has been removed by erosion and the plow layer is mostly clayey material from the upper part of the subsoil. These areas are on convex ridgetops. They make up about 5 to 10 percent of the unit.

Permeability is slow in the Lamoni soil, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only within a narrow range in moisture content. The shrink-swell potential is high in the subsoil. A perched water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain grown on a limited basis in rotation with close-growing pasture and hay crops. Further erosion is a serious hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Special management may be needed if the clayey subsoil is exposed by terrace cuts. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to birdsfoot trefoil, reed canarygrass, tall fescue, timothy, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. The species that can withstand the wetness grow best. Erosion is a hazard during seedbed preparation. A good ground cover is necessary at all times if forage production is to be maintained. Nurse crops help to control erosion in newly seeded areas. Tilling the soil on the contour and in a timely manner and seeding by no-till methods also help to control erosion. Overgrazing should be avoided.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Installing drainage tile around the footings helps to prevent the damage caused by excessive wetness. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping.

Septic tank systems generally do not function adequately in this soil because of the slow permeability in the subsoil and the perched water table. Sewage lagoons function adequately only if the site can be leveled. Otherwise, the sewage can be piped to less sloping areas that are better sites for lagoons.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action, shrinking and swelling, and wetness. Cutting and filling may be needed, depending on the slope. The roads can be designed so that they conform to the natural slope of the land.

The land capability classification is IVe.

44D2—Shelby loam, 9 to 14 percent slopes, eroded. This deep, strongly sloping, well drained soil is on side slopes. Individual areas are irregular in shape and range from 5 to 50 acres in size.

Typically, the surface layer is very dark brown, friable loam about 7 inches thick. The subsoil is clay loam about 29 inches thick. The upper part is brown and friable, the next part is dark yellowish brown and firm, and the lower part is dark yellowish brown and brown, mottled, and firm. The substratum to a depth of about 60 inches or more is firm clay loam. It is yellowish brown and mottled in the upper part and multicolored in the lower part. In many areas the very dark brown surface soil is more than 10 inches thick. In places the upper part of the subsoil has grayish brown and red mottles and contains more clay. In several small areas the depth to calcareous clay loam is less than 30 inches.

Permeability is moderately slow, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for hay and pasture. A few are cultivated. This soil is suited to row crops and small grain grown on a limited basis in rotation with close-growing pasture and hay crops. Erosion is a serious hazard if the soil is cultivated. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed if a grassed waterway is established. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Many areas are smooth enough and large enough to be terraced and farmed on the contour. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to red clover, birdsfoot trefoil, reed canarygrass, tall fescue, and timothy. It is moderately well suited to alfalfa, orchardgrass, and smooth bromegrass. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Erosion is a hazard during seedbed preparation. Timely seedbed preparation helps to ensure a good ground cover. The seedbed should be prepared on the contour. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary in existing stands of grass.

This soil is suitable for building site development. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. The buildings can be designed so that they conform to the natural slope of the land, or the slope can be altered by land shaping.

Septic tank systems generally do not function adequately in this soil because of the moderately slow permeability in the subsoil. Some areas are suitable as sites for septic tank absorption fields if longer laterals are used to overcome the restricted permeability. The distribution lines should be installed across the slope. The soil can be used as a site for sewage lagoons if commercial sewers are not available. The site should be leveled. Sewage also can be piped to the less sloping adjacent areas that are better sites for lagoons.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope. The roads can be designed so that they conform to the natural slope of the land.

The land capability classification is IVe.

52—Kennebec silt loam. This deep, nearly level, moderately well drained soil is on flood plains and alluvial fans along the smaller streams. It is subject to rare flooding. Individual areas generally are long and narrow and range from 10 to 60 acres in size.

Typically, the surface layer is black, friable silt loam about 10 inches thick. The subsurface layer is very dark gray, friable silt loam about 34 inches thick. Below this is a transitional layer of very dark grayish brown, friable silty clay loam about 23 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, mottled, friable silt loam. In a few small areas, the slope is more than 2 percent. In a few areas the subsoil is browner.

Included with this soil in mapping are small areas of the poorly drained Colo soils. These soils have a higher content of clay than the Kennebec soil. They are in the lower areas between the Kennebec soil and the streams. They make up about 5 to 10 percent of the unit.

Permeability is moderate in the Kennebec soil, and surface runoff is slow. Available water capacity is very high. Natural fertility and organic matter content are high. The surface layer is friable and can be easily tilled, but it tends to puddle or crust after hard rains. The shrink-swell potential is moderate. A seasonal high water table commonly is at a depth of 4 to 6 feet from winter to early summer.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. No significant hazards or limitations affect crop production if the soil is protected against flooding and the runoff from the adjacent uplands. Land grading can facilitate farming in some uneven areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

If flooding is of short duration, this soil is well suited to alfalfa, birdsfoot trefoil, red clover, orchardgrass, tall fescue, and timothy. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Grazing management should accommodate wet periods.

This soil generally is unsuited to building site development and onsite waste disposal because of the rare flooding.

The land capability classification is I.

53B—Judson silt loam, 1 to 4 percent slopes. This deep, very gently sloping and gently sloping, well drained soil is on convex foot slopes bordering the uplands. Individual areas are irregular in shape and range from 10 to 80 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 8 inches thick. The subsurface layer is about 24 inches thick. It is friable. The upper part is very dark grayish brown silt loam, the next part is very dark grayish brown silty clay loam, and the lower part is dark brown silty clay loam. The subsoil to a depth of 60 inches or more is friable silty clay loam. The upper part is brown, and the lower part is yellowish brown.

Included with this soil in mapping are a few small areas of the poorly drained Colo soils. These soils are in the slightly lower areas. They make up less than 5 percent of the unit.

Permeability is moderate in the Judson soil, and surface runoff is slow. Available water capacity is very high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled, but it tends to puddle or crust after hard rains. The shrink-swell potential is moderate.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Because most areas receive extra runoff from the adjacent uplands, diversions may be necessary. Erosion is a hazard if the soil is intensively row cropped. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling. Septic tank systems generally function adequately in this soil.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIe.

54C—Olmitz loam, 3 to 9 percent slopes. This gently sloping and moderately sloping, moderately well drained soil is on foot slopes. Individual areas generally are long and narrow and range from 5 to more than 100 acres in size.

Typically, the surface layer is black, friable loam about 9 inches thick. The subsurface layer is about 26 inches thick. It is friable. The upper part is very dark brown loam, the next part is very dark brown clay loam, and the lower part is very dark grayish brown clay loam. The subsoil to a depth of 60 inches or more is brown and dark brown, firm clay loam.

Permeability is moderate, and surface runoff is medium. Available water capacity is high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is moderate in the subsoil.

Most areas are used for row crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain. Erosion is a hazard if the soil is used for cultivated crops. A system of conservation tillage that leaves a protective cover of crop residue on the surface throughout the year, stripcropping, winter cover crops, and grassed waterways help to prevent excessive soil loss. If left on the field throughout the winter, crop residue protects the soil from erosive rains. Most areas can be terraced and farmed on the contour along with the adjacent areas. In some areas diversions are needed to control the erosion caused by runoff from the adjacent uplands. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture and hay is very effective in controlling erosion. This soil is well suited to all of the commonly grown legumes, warm-season grasses, and cool-season grasses. No serious problems affect the use of this soil as pasture or hayland. Erosion is a hazard in newly seeded areas. Timely seedbed preparation helps to ensure a good ground cover.

This soil is suitable for building site development and onsite waste disposal. Adequately reinforcing basement walls, foundations, and footings minimizes the damage to buildings caused by shrinking and swelling of the subsoil. Septic tank absorption fields generally function adequately if the distribution lines are installed across the slope.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of this soil. Designing the roads so that they shed water and providing adequate side ditches and culverts help to prevent the damage caused by frost action and by shrinking and swelling.

The land capability classification is IIIe.

55—Colo silty clay loam. This deep, nearly level, poorly drained soil is in low areas in upland drainageways and on flood plains. It is occasionally flooded for brief periods. Individual areas are elongated, commonly branching toward the uplands. They range from 10 to more than 200 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 9 inches thick. The subsurface layer is black, friable silty clay loam about 23 inches thick. The subsoil is very dark gray, firm silty clay loam about 22 inches thick. The substratum to a depth of 60 inches or more is friable silty clay loam. It is very dark gray in the upper part and dark gray and mottled in the lower part.

Included with this soil in mapping are the steeper parts of streambanks and channels. These areas make up less than 10 percent of the unit. Also included are some small areas of the moderately well drained Nodaway soils at the lower elevations directly adjacent to the stream channels. These soils make up less than 5 percent of the unit.

Permeability is moderate in the Colo soil, and surface runoff is slow. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content. The shrink-swell potential is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, and small grain. Because of the stream channels, some areas cannot be crossed by farm equipment. Ditchbank erosion and runoff from the uplands are problems. Establishing a permanent cover of vegetation along the stream channels helps to stabilize ditchbanks. Diversions can protect this soil against excessive runoff from the adjacent uplands. Land grading can improve surface drainage in some areas. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

The best suited pasture species on this soil are water-tolerant, shallow-rooted legumes, such as alsike clover, and cool-season grasses, such as reed canarygrass. The soil is poorly suited to warm-season grasses and to hay. The wetness and the flooding are the main problems. A seedbed cannot be easily prepared during wet periods. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil generally is unsuited to building site development and onsite waste disposal because of the occasional flooding, the wetness, and the high shrink-swell potential.

The land capability classification is IIw.

56—Zook silty clay loam. This deep, nearly level, poorly drained soil is on the flood plains along small and large streams. It is frequently flooded. Individual areas are irregular in shape and range from 15 to several hundred acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 8 inches thick. The subsurface layer is about 36 inches thick. The upper part is black, friable silty clay loam; the next part is black, mottled, firm silty clay; and the lower part is very dark gray, mottled, firm silty clay. The subsoil to a depth of 60 inches or more is dark gray, mottled, firm silty clay. In several small areas the plow layer is silt loam.

Permeability is slow, and runoff is very slow. Available water capacity is high. Natural fertility and organic matter content also are high. The surface layer is sticky when wet and can be tilled only within a narrow range in moisture content. If tilled when wet, it becomes cloddy and cannot be easily worked. The shrink-swell potential is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops. This soil is suited to corn and soybeans. The occasional flooding and the wetness are the main problems. Poor surface drainage can be overcome by land grading and surface ditches. A protective cover of crop residue and deep tillage in the fall improve tilth and internal drainage and allow for earlier planting in the spring.

The best suited pasture species on this soil are water-tolerant, shallow-rooted legumes, such as alsike clover, and cool-season grasses, such as reed canarygrass. The soil is poorly suited to warm-season grasses and to hay. Maintaining stands of desirable species is difficult in depressional areas. The wetness and the flooding are the main limitations. Land grading and shallow ditches help to overcome these limitations. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil generally is unsuited to building site development and onsite waste disposal because of the frequent flooding, the wetness, and the high shrink-swell potential.

The land capability classification is IIIw.

57—Wabash silty clay. This deep, nearly level, very poorly drained soil is in low areas on the flood plains along large streams. It is frequently flooded. Individual areas are irregular in shape and range from 30 to several hundred acres in size.

Typically, the surface layer is very dark gray, firm silty clay about 8 inches thick. The subsurface layer also is very dark gray, firm silty clay. It is about 32 inches thick. It is mottled in the lower part. The subsoil to a depth of 60 inches or more is very dark grayish brown and dark grayish brown, mottled, firm silty clay. In several small areas the plow layer is silty clay loam.

Permeability and surface runoff are very slow. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. It becomes cloddy if it is worked when wet. The shrink-swell potential is very high. A seasonal high water table commonly is within a depth of 1 foot during extended wet periods.

Most areas are used for cultivated crops. This soil is suited to corn and soybeans. The frequent flooding, poor surface drainage, and the high water table are the main problems. The poor surface drainage can be overcome by land grading and surface ditches. A protective cover of crop residue and deep tillage in the fall improve tilth and internal drainage and allow for earlier planting in the spring. Planting and harvesting are delayed in some years because of the flooding.

The best suited pasture species on this soil are water-tolerant, shallow-rooted legumes, such as alsike clover, and cool-season grasses, such as reed canarygrass. The soil is poorly suited to warm-season grasses and to hay. Maintaining stands of desirable species is difficult in depressional areas. The wetness and the flooding are the main limitations. Land grading and shallow ditches help to overcome these limitations. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil is suited to trees. The equipment limitation, seedling mortality, and windthrow are the major management concerns. The trees should be harvested only when the ground is frozen or during extended dry periods. Ridging the soil and then planting water-tolerant species on the ridges increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is generally unsuited to building site development and onsite waste disposal because of the frequent flooding, the wetness, and the very high shrink-swell potential.

The land capability classification is IIIw.

58—Waldron silty clay loam. This deep, nearly level, somewhat poorly drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 30 to 200 acres in size.

Typically, the surface layer is dark brown, firm silty clay loam about 7 inches thick. The substratum extends to a depth of 60 inches or more. In sequence downward, it is very dark grayish brown, firm silty clay; dark grayish brown and grayish brown, mottled, firm silty clay; dark grayish brown, friable very fine sandy loam; and dark grayish brown, firm silty clay loam. In a few areas the upper part of the substratum is not stratified.

Included with this soil in mapping are a few small areas of the poorly drained Levasy and somewhat poorly drained Onawa soils. These soils are loamy within a depth of 40 inches. They are in the slightly higher areas. Also included, on the river side of the levees, are areas that are occasionally flooded. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow in the Waldron soil, and surface runoff is very slow. Available water capacity and organic matter content are moderate. Natural fertility is medium. The surface layer is firm when moist and sticky when wet. It becomes cloddy if it is worked when wet. The shrink-swell potential is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The wetness is a limitation. Open ditches, shallow surface drains, and land grading help to remove excess water. Timely tillage is needed. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to trees. The equipment limitation and seedling mortality are management concerns. The trees should be harvested only when the ground is frozen or during extended dry periods. Ridging the soil and then planting water-tolerant species on the ridges increase the seedling survival rate.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness, the slow permeability, and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is IIw.

60—Colo silt loam, overwash. This deep, nearly level, poorly drained soil is in low areas in upland drainageways and on flood plains. It is occasionally flooded for brief periods. Individual areas are elongated, commonly branching toward the uplands. They range from 10 to more than 100 acres in size.

Typically, the surface layer is stratified dark brown and brown, friable silt loam about 12 inches thick. The subsurface layer is black, friable silty clay loam about 19 inches thick. It is mottled in the lower part. The subsoil to a depth of 60 inches or more is very dark gray, mottled, firm silty clay loam. In places the surface layer is silty clay loam.

Included with this soil in mapping are the steeper parts of streambanks and channels. Also included are areas of the moderately well drained Nodaway and poorly drained Zook soils. Nodaway soils are in the slightly higher areas directly adjacent to the stream channels. Zook soils are in swales and the lower areas farther from the channels.

They are more clayey than the Colo soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Colo soil, and surface runoff is slow. Available water capacity is high. Natural fertility is medium, and organic matter content is high. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content, but it tends to puddle or crust after hard rains. The shrink-swell potential is high. A seasonal high water table commonly is at a depth of 1 to 3 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, and small grain. Because of the stream channels, some areas cannot be crossed by farm equipment. Ditchbank erosion and runoff from the uplands are problems. Establishing a permanent cover of vegetation along the stream channels helps to stabilize ditchbanks. Diversions can protect this soil against excessive runoff from the adjacent uplands. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

The best suited pasture species on this soil are water-tolerant, shallow-rooted legumes, such as alsike clover, and cool-season grasses, such as reed canarygrass. The soil is poorly suited to warm-season grasses and to hay. The wetness and the flooding are the main problems. A seedbed cannot be easily prepared during wet periods. A surface drainage system is beneficial, especially if the deeper rooted species are grown.

This soil generally is unsuited to building site development and onsite waste disposal because of the occasional flooding, the wetness, and the high shrink-swell potential.

The land capability classification is IIw.

61—Nodaway silt loam. This deep, nearly level, moderately well drained soil is on the flood plains along large streams. It is frequently flooded for very brief periods. Individual areas are irregular in shape and range from 10 to 150 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 8 inches thick. The substratum is about 35 inches of stratified dark grayish brown, very dark gray, brown, and very dark grayish brown, mottled, friable silt loam that has thin strata of fine sandy loam. Below this to a depth of 60 inches or more is black, mottled, firm silty clay loam.

Included with this soil in mapping are areas of Colo, Dockery, and Zook soils. Colo and Zook soils are poorly drained and are in the slightly lower areas on the flood plains. Their dark surface soil is thicker than that of the Nodaway soil. Dockery soils are somewhat poorly drained and are mottled in the upper part. They are farther from the stream channels than the Nodaway soil. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Nodaway soil, and surface runoff is slow. Available water capacity is very high. Natural fertility is medium, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content, but it tends to puddle or crust after hard rains. The shrink-swell potential is moderate. A seasonal high water table commonly is at a depth of 3 to 5 feet during winter.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain, but the flooding can be a problem. Spring flooding delays tillage in most years. Fall plowing increases the susceptibility of the soil to scouring by floodwater.

This soil is well suited to alfalfa, birdsfoot trefoil, orchardgrass, tall fescue, and timothy. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. The flooding is the main problem. The grazing system should be adjusted to this problem.

This soil is suited to trees. No significant hazards or limitations affect planting or harvesting.

Because of the flooding, this soil generally is unsuited to building site development and onsite waste disposal.

The land capability classification is IIIw.

64B—Sarpy loamy fine sand, 1 to 4 percent slopes. This deep, very gently sloping and gently sloping, excessively drained soil is on low ridges on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are long and narrow and range from 5 to 60 acres in size.

Typically, the surface layer is dark brown, very friable loamy fine sand about 14 inches thick. The substratum to a depth of 60 inches or more is loose loamy fine sand. It is dark grayish brown in the upper part and grayish brown in the lower part.

Included with this soil in mapping are small areas of the well drained Haynie and somewhat poorly drained Onawa soils. Haynie soils are on the lower ridges. They are less sandy than the Sarpy soil. Onawa soils are in depressional areas. Also included, on the river side of the levees, are areas that are occasionally flooded. Included soils make up about 5 percent of the unit.

Permeability is rapid in the Sarpy soil, and surface runoff is slow. Available water capacity is low. Natural fertility and organic matter content also are low.

Much of the acreage is idle land. Some areas are used for soybeans or wheat. Many areas adjacent to the Missouri River are wooded. This soil is suited to some cultivated crops and pasture and hay crops grown on a limited basis. Droughtiness is the main problem. Also, wind erosion is a hazard. It can be controlled by a protective cover of vegetation or mulch.

This soil is suited to trees. Seedling mortality is a management concern. Planting container-grown nursery stock when the soil is wet increases the seedling survival rate.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The soil is severely limited as a site for septic tank absorption fields because of a poor filtering capacity. Sewage systems should be connected to a central sewer system, or a better suited alternative site should be selected.

The land capability classification is IVs.

66—Haynie silt loam. This deep, nearly level, moderately well drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 10 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown, very friable silt loam about 9 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, mottled, very friable very fine sandy loam. In some places the soil is slightly acid or neutral throughout. In other places the dark surface layer is more than 10 inches thick.

Included with this soil in mapping are small areas of the somewhat poorly drained Onawa and excessively drained Sarpy soils. Onawa soils have a clayey surface layer. They are in the lower areas. Sarpy soils are sandy throughout. They are in the slightly higher areas. Also included, on the river side of the levees, are occasionally flooded areas. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the Haynie soil, and surface runoff is slow. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is low.

Most areas are used for cultivated crops. A few are used for hay. A few areas adjacent to the Missouri River are wooded. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay. Wind erosion is a hazard, but it can be controlled by a protective cover of vegetation or mulch or by tillage methods that leave the surface rough. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

If flooding is of short duration, this soil is well suited to alfalfa, birdsfoot trefoil, orchardgrass, tall fescue, and timothy. It is well suited to switchgrass and moderately well suited to most other warm-season grasses. Water-tolerant species grow best. The grazing system should be adjusted to the hazard of flooding.

This soil is suited to trees. No significant hazards or limitations affect planting or harvesting.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. Designing local roads and streets so that they shed water helps to prevent the damage caused by frost action. Adding crushed rock or other suitable base material helps to prevent the damage caused by low strength.

The land capability classification is I.

70—Modale silt loam. This deep, nearly level, somewhat poorly drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 20 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 10 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown. It is friable silt loam in the upper part; mottled, friable very fine sandy loam in the next part; and mottled, firm silty clay in the lower part.

Included with this soil in mapping are small areas of the moderately well drained Haynie and somewhat poorly drained Onawa soils. Haynie soils are in landscape positions similar to those of the Modale soil. They are not underlain by clayey material. Onawa soils have more clay in the upper part of the solum and less clay in the lower part than the Modale soil. They are in the lower areas. Also included are areas where the subsoil is darker than that of the Modale soil and some occasionally flooded areas on the river side of the levees. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Modale soil and slow in the lower part. Surface runoff is slow. Available water capacity is high. Natural fertility is also high, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. The shrink-swell potential is moderate in the upper part of the soil and high in the lower part. A seasonal high water table is at a depth of 1.5 to 3.0 feet in most years.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Wind erosion is a hazard, but it can be controlled by a protective cover of vegetation or mulch or by tillage methods that leave the surface rough. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness, the slow permeability, and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is I.

74—Percival silty clay. This deep, nearly level, somewhat poorly drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 5 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay about 9 inches thick. The substratum to a depth of 60 inches or more is mottled. It it dark grayish brown firm silty clay in the upper part; stratified dark grayish brown and dark gray, firm silty clay in the next part; and dark grayish brown, loose fine sand in the lower part. In a few areas the depth to sandy material is less than 15 inches.

Included with this soil in mapping are small areas of Onawa soils. These soils have less sand and more silt in the substratum than the Percival soil. Their positions on the landscape are similar to those of the Percival soil. Also included, on the river side of the levees, are small areas that are occasionally flooded. Included soils make up about 10 percent of the unit.

Permeability is slow in the upper part of the Percival soil and rapid in the lower part. Surface runoff is very slow. Available water capacity is low. Natural fertility is medium, and organic matter content is moderate. The surface layer is firm when moist and sticky when wet. It becomes cloddy if it is worked when wet. The shrink-swell potential is high in the upper part of the soil and low in the lower part. A seasonal high water table is at a depth of 2 to 4 feet in most years.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The wetness is a limitation. Open ditches, shallow surface drains, and land grading help to remove excess water. Timely tillage is needed. The low available water capacity limits crop growth to some extent during most years. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness, seepage, and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is IIw.

77—Dockery silty clay loam. This deep, nearly level, somewhat poorly drained soil is on low ridges on flood plains. It is occasionally flooded for brief periods. Individual areas range from 5 to 50 acres in size.

Typically, the surface layer is very dark grayish brown, friable silty clay loam about 9 inches thick. The subsurface layer is dark grayish brown, friable silt loam about 11 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, mottled, friable silt loam.

Included with this soil in mapping are areas of the poorly drained Colo and moderately well drained Nodaway soils. Colo soils are in the lower areas. They have more clay in the subsoil than the Dockery soil. Nodaway soils are in the slightly lower areas adjacent to the stream channels. Included soils make up about 5 to 10 percent of the unit.

Permeability is moderate in the Dockery soil, and surface runoff is slow. Available water capacity is high. Natural fertility also is high, and organic matter content is moderate. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. The shrink-swell potential is moderate in the subsoil. A seasonal high water table commonly is at a depth of 2 to 3 feet during extended wet periods.

Most areas are used for cultivated crops, hay, or pasture. A few areas are wooded. This soil is suited to corn, soybeans, and small grain. Because of stream channels, some areas cannot be crossed by farm equipment. Diversions can protect the soil against excessive runoff from the adjacent uplands. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is well suited to reed canarygrass and moderately well suited to birdsfoot trefoil, red clover, tall fescue, timothy, and switchgrass. It is moderately suited to alfalfa, orchardgrass, smooth bromegrass, big bluestem, and indiangrass. The seasonal high water table and the occasional flooding are the main problems. They affect the selection of suitable species. A seedbed can be easily prepared. A drainage system is beneficial, especially if the deeper rooted species are grown.

This soil is suited to trees. The hazards and limitations that affect planting and harvesting are slight.

Because of the occasional flooding and the wetness, this soil is generally unsuited to building site development and onsite waste disposal.

The land capability classification is IIw.

79—Onawa silty clay. This deep, nearly level, somewhat poorly drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 20 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown. It is firm silty clay in the upper part and mottled, very friable very fine sandy loam in the lower part. In a few areas the depth to loamy material is less than 18 inches.

Included with this soil in mapping are small areas of the moderately well drained Haynie and poorly drained Levasy soils. Haynie soils have less clay in the upper part of the solum than the Onawa soil. They are in the slightly higher areas. Levasy soils are in the slightly lower areas. Their dark surface soil is thicker than that of the Onawa soil. Also included, on the river side of the levees, are areas that are occasionally flooded. Included soils make up about 10 to 15 percent of the unit.

Permeability is slow in the upper part of the Onawa soil and moderate or moderately rapid in the lower part. Surface runoff is very slow. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer is firm when moist and sticky when wet. It becomes cloddy if it is worked when wet. The shrink-swell potential is high in the upper part of the soil and low in the lower part. A seasonal high water table is at a depth of 2 to 4 feet in most years.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The wetness is a limitation. Open ditches, shallow surface drains, and land grading help to remove excess water. Timely tillage is needed. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is IIw.

81—Albaton silty clay. This deep, nearly level, poorly drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 30 to 80 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is mottled silty clay. The upper part is stratified dark grayish brown and dark gray and is firm, and the lower part is dark grayish brown and very firm. In a few areas the surface layer is silty clay loam. In a few places the soil is loamy below a depth of 50 inches.

Included with this soil in mapping are a few small areas of Levasy and Onawa soils. These soils are loamy within a depth of 40 inches. They are in the slightly higher areas. Also included, on the river side of the levees, are areas that are occasionally flooded. Included soils make up about 5 to 15 percent of the unit.

Permeability is slow in the Albaton soil, and surface runoff is very slow. Available water capacity is moderate. Natural fertility is medium, and organic matter content is moderate. The surface layer is firm when moist and sticky when wet. It becomes cloddy if it is tilled when wet. The shrink-swell potential is high. A seasonal high water table is at a depth of 1 to 3 feet in most years.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The wetness is a limitation. Open ditches, shallow surface drains, and land grading help to remove excess water. Timely tillage is needed. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is IIIw.

83—Levasy silty clay loam. This deep, nearly level, poorly drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. The soil is subject to ponding. Individual areas are irregular in shape and range from 30 to 100 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 8 inches thick. The subsurface layer is very dark gray, firm silty clay about 5 inches thick. The subsoil is dark grayish brown, mottled, firm silty clay about 10 inches thick. The substratum to a depth of 60 inches or more is grayish brown, mottled, very friable, stratified silt loam and very fine sandy loam. In a few areas the depth to loamy material is less than 20 inches.

Included with this soil in mapping are small areas of the somewhat poorly drained Onawa soils. These soils are in the slightly higher areas. Their dark surface soil is thinner than that of the Levasy soil. Also included, on the river side of the levees, are areas that are occasionally flooded. Included soils make up less than 10 percent of the unit.

Permeability is slow in the upper part of the Levasy soil and moderate in the lower part. Surface runoff is very slow or ponded. Available water capacity is high. Organic matter content is moderate, and natural fertility is medium. The surface layer is firm when moist and sticky when wet. It becomes cloddy if it is tilled when wet. The shrink-swell potential is high in the upper part of the soil and low in the substratum. A seasonal high water table is near or above the surface in most years.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, and small grain. The wetness is a limitation. The ponding results in poor stands and lower yields. Open ditches, shallow surface drains, and land grading help to remove excess water. Timely tillage is needed. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

This soil is suited to trees. The equipment limitation, seedling mortality, and windthrow are the major management concerns. The trees should be harvested only when the ground is frozen or during extended dry periods. Ridging the soil and then planting water-tolerant species on the ridges increase the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is IIIw.

93—Grable very fine sandy loam. This deep, nearly level, well drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 5 to 60 acres in size.

Typically, the surface layer is very dark grayish brown, friable very fine sandy loam about 9 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown. It is friable very fine sandy loam in the upper part and loose fine sand in the lower part.

Included with this soil in mapping are small areas of the moderately well drained Haynie and somewhat poorly drained Percival soils. Haynie soils have more silt and less sand in the lower part of the solum than the Grable soil. They are in the slightly lower areas. Percival soils have more clay in the upper part of the solum than the Grable soil. They are in the lower areas. Also included are a few small areas of soils that are shallower to sandy material than the Grable soil and some occasionally flooded areas on the river side of the levees. Included soils make up about 10 to 15 percent of the unit.

Permeability is moderate in the upper part of the Grable soil and rapid in the lower part. Surface runoff is slow. Available water capacity is low. Natural fertility also is low, and organic matter content is moderate. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Wind erosion and drought are hazards. Maintaining a cover of vegetation or crop residue or regularly adding other organic material improves fertility, conserves moisture, and minimizes wind erosion.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The soil is severely limited as a site for septic tank absorption fields because of a poor filtering capacity. Sewage systems should be connected to a central sewer system, or a better suited alternative site should be selected.

The land capability classification is IIs.

98—Udifluvents-Water complex. This map unit consists of borrow pits intermingled with areas of open water. It parallels the Missouri River. It is occasionally flooded. The material excavated from the pits was used in the construction of large levees. Individual areas are about 20 to 30 percent water. They typically are square or rectangular and range from 5 to 40 acres in size.

The Udifluvents are sandy to clayey, alluvial soils in the borrow pits. Permeability and available water capacity vary widely in these soils. Organic matter content and natural fertility are low or very low.

Included in this unit in mapping are small areas of the somewhat poorly drained Onawa and moderately well drained Haynie soils. These soils are in areas between the borrow pits. They make up less than 5 percent of the unit.

Most of the acreage is idle. The vegetation on the Udifluvents is water-tolerant weeds and trees. The extreme variability of the soil material and the areas of open water are the major management concerns affecting most uses.

No land capability classification is assigned.

99—Pits, quarries. This map unit consists of open excavations from which soil material has been removed so that the underlying limestone bedrock can be mined. A typical quarry has a vertical face or exposure of the rock formation being mined. The floor of the pit generally is nearly level. The exposures are 20 to more than 40 feet high. The overburden of glacial material and loess above the vertical rock face is 15 to 40 feet thick in most places.

Included in this unit in mapping are small areas where the overburden has been piled. These areas support a cover of weeds and brush. Also included are areas where water covers the lowest part of the quarry. Included areas make up about 5 to 10 percent of the unit.

This unit is not suitable as cropland or pasture because nearly all of the soil material has been removed and slopes are too steep.

No land capability classification is assigned.

101—Kenmoor loamy fine sand. This deep, nearly level, moderately well drained soil is on the flood plains along the Missouri River. It is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas are irregular in shape and range from 50 to 200 acres in size.

Typically, the surface layer is dark brown, very friable loamy fine sand about 10 inches thick. The substratum is brown, very friable loamy fine sand about 15 inches thick. Next is a buried surface layer of very dark grayish brown, mottled, firm silty clay loam about 7 inches thick. The buried subsoil to a depth of 60 inches or more is grayish brown, mottled, firm silty clay. In a few areas the depth to clayey material is less than 20 inches.

Included with this soil in mapping are small areas of the moderately well drained Haynie, excessively drained Sarpy, and somewhat poorly drained Waldron soils. Haynie soils have more sand and less clay in the lower part of the solum than the Kenmoor soil. They are in the slightly higher areas. Sarpy soils are sandy throughout. They are in the higher areas. Waldron soils have more clay and less sand in the upper part of the solum than the Kenmoor soil. They are in the lower areas. Also included, on the river side of the levees, are areas that are occasionally flooded. Included soils make up about 10 to 15 percent of the unit.

Permeability is rapid in the upper part of the Kenmoor soil and slow in the lower part. Surface runoff is slow. Available water capacity is moderate. Organic matter content and natural fertility are low. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is low in the upper part of the soil and high in the lower part. A seasonal high water table is at a depth of 2.5 to 3.0 feet in most years.

Most areas are used for cultivated crops. This soil is suited to corn, soybeans, grain sorghum, and small grain. Maintaining a cover of vegetation or crop residue or regularly adding other organic material conserves moisture and improves fertility.

This soil is suited to trees. Seedling mortality is a management concern. Planting container-grown nursery stock increases the seedling survival rate. No other hazards or limitations affect planting or harvesting.

Buildings on this soil should be constructed above known flood levels or on raised, well compacted fill material. The wetness, the slow permeability, and the high shrink-swell potential are severe limitations affecting building site development and onsite waste disposal. A better suited alternative site should be selected.

The land capability classification is IIIs.

102—Haynie-Onawa complex. These deep, nearly level soils are on the flood plains along the Missouri River. The somewhat poorly drained Onawa soil is in swales, and the moderately well drained Haynie soil is in the higher areas between the swales. Both soils are protected by levees, but they are subject to rare flooding because the tributary streams can overflow their banks and the levees can break. Individual areas range from 50 to more than 200 acres in size. They are about 65 percent Haynie soil and 30 percent Onawa soil. The two soils occur as areas so narrow that they cannot be delineated as separate units on the maps.

Typically, the Haynie soil has a surface layer of very dark grayish brown, very friable silt loam about 9 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown, mottled, very friable very fine sandy loam. In some places the solum is slightly acid or neutral throughout. In other places the very dark grayish brown surface layer is more than 10 inches thick.

Typically, the Onawa soil has a surface layer of very dark grayish brown, firm silty clay about 8 inches thick. The substratum to a depth of 60 inches or more is dark grayish brown. It is firm silty clay in the upper part and mottled, very friable very fine sandy loam in the lower part. In a few areas the depth to loamy material is less than 18 inches.

Included with these soils in mapping are small areas of the poorly drained Levasy soils in depressions and the excessively drained Sarpy soils on the higher parts of the landscape. Included soils make up about 5 percent of the unit.

Permeability is moderate in the Haynie soil. It is slow in the upper part of the Onawa soil and moderately rapid in the lower part. Surface runoff is slow on the Haynie soil and very slow on the Onawa soil. Available water capacity is high in both soils. Organic matter content is moderate. Natural fertility is high in the Haynie soil and medium in the Onawa soil. The surface layer of the Onawa soil is firm when moist and sticky when wet. It can be easily tilled only under optimum moisture conditions. The surface layer of the Haynie soil is very friable and can be easily tilled throughout a wide range in moisture content. The shrink-swell potential is low in the Haynie soil. It is high in the upper part of the Onawa soil and low in the lower part. The Onawa soil has a seasonal high water table at a depth of 2 to 4 feet in most years.

Most areas are used for cultivated crops. These soils are suited to corn, soybeans, and small grain. The wetness of the Onawa soil is a limitation. Open ditches, shallow surface drains, and land grading help to remove excess water. Timely tillage is needed. Returning crop residue to the soils or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

The Haynie soil is suited to trees. No significant hazards or limitations affect planting or harvesting on this soil.

Buildings on these soils should be constructed above known flood levels or on raised, well compacted fill material. If protected from flooding, the Haynie soil is only slightly limited as a site for buildings and waste disposal systems. It is better suited to these uses than the Onawa soil.

The land capability classification is IIw.

104E—Knox-Urban land complex, 9 to 20 percent slopes. This map unit occurs as areas of a moderately steep and strongly sloping, well drained Knox soil intermingled with areas of Urban land. The unit is on ridgetops and side slopes in the uplands. The natural topography has not been altered appreciably by urban development. Individual areas are irregular in shape and range from 50 to more than 200 acres in size. They are about 60 percent Knox soil and 35 percent Urban land. The Knox soil and Urban land occur as areas so closely intermingled that separating them in mapping is not practical.

Typically, the surface layer of the Knox soil is brown, friable silt loam about 7 inches thick. The subsoil is firm silty clay loam about 41 inches thick. It is dark yellowish brown in the upper part and yellowish brown in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, friable silt loam. In some places the upper part of the soil has been removed. In other places the soil is covered with as much as 15 inches of fill material, generally from excavations for basements.

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

Included in this unit in mapping are small areas of the gently sloping Judson soils in narrow drainageways. These soils have a dark surface soil that is more than 24 inches thick. They make up about 5 percent of the unit.

Permeability is moderate in the Knox soil. The Urban land is impervious to water. Surface runoff is rapid in all areas. In the Knox soil, natural fertility is medium and organic matter content is moderate. The surface layer of this soil is friable.

The Knox soil is in yards, in open areas between buildings, and in parks, gardens, and undeveloped tracts.

If the Knox soil is used for building site development or onsite waste disposal, land shaping is necessary in some areas because of the slope. Properly designing and reinforcing footings, foundations, and basement walls can help to prevent the damage to buildings caused by shrinking and swelling. Properly landscaping the site helps to keep water away from foundations. Community sewers are the chief means of waste disposal in areas of this unit. Septic tank absorption fields should be installed on the contour because of the slope.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of the Knox soil. Designing the roads so that they shed water and providing adequate side ditches and culverts or tile drains and storm sewers help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope. Detailed onsite investigation is needed in areas that are being considered for high-density development.

No land capability classification is assigned.

104F—Knox-Urban land complex, 20 to 30 percent slopes. This map unit occurs as areas of a steep, well drained Knox soil intermingled with areas of Urban land. The unit is on side slopes in the uplands. The natural topography has not been altered appreciably by urban development. Individual areas are irregular in shape and range from 50 to more than 200 acres in size. They are about 60 percent Knox soil and 35 percent Urban land. The Knox soil and Urban land occur as areas so closely intermingled that separating them in mapping is not practical.

Typically, the surface layer of the Knox soil is dark yellowish brown, firm silty clay loam about 6 inches thick. The subsoil is about 40 inches thick. It is dark yellowish brown, firm silty clay loam in the upper part and yellowish brown, mottled, friable silt loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In some places the upper part of the soil has been removed. In other places the soil is covered with as much as 15 inches of fill material, generally from excavations for basements.

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

Included in this unit in mapping are small areas of the gently sloping Judson soils in narrow drainageways. These soils have a dark surface soil that is more than 24 inches thick. They make up about 5 percent of the unit.

Permeability is moderate in the Knox soil. The Urban land is impervious to water. Surface runoff is rapid in all areas. In the Knox soil, natural fertility is medium and organic matter content is moderate. The surface layer of this soil is friable.

The Knox soil is in yards, in open areas between buildings, and in parks, gardens, and undeveloped tracts.

If the Knox soil is used for building site development or onsite waste disposal, land shaping is necessary in some areas because of the slope. Properly designing and reinforcing footings, foundations, and basement walls can help to prevent the damage to buildings caused by shrinking and swelling. Properly landscaping the site helps to keep water away from foundations. Community sewers are the chief means of waste disposal in areas of this unit.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of the Knox soil. Designing the roads so that they shed water and providing adequate side ditches and culverts or tile drains and storm sewers help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope. Detailed onsite investigation is needed in areas that are being considered for high-density development.

No land capability classification is assigned.

105C—Marshall-Urban land complex, 4 to 9 percent slopes. This map unit occurs as areas of a gently sloping and moderately sloping, well drained Marshall soil intermingled with areas of Urban land. The unit is on ridgetops and side slopes in the uplands. The natural topography has not been altered appreciably by urban development. Individual areas are irregular in shape and range from 50 to more than 200 acres in size. They are about 60 percent Marshall soil and 30 percent Urban land. The Marshall soil and Urban land occur as areas so closely intermingled that separating them in mapping is not practical.

Typically, the surface layer of the Marshall soil is dark brown, friable silt loam about 8 inches thick. The subsoil is friable silty clay loam about 45 inches thick. It is brown in the upper part, dark yellowish brown in the next part, and yellowish brown and mottled in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silty clay loam. In a few small areas, the upper part of the subsoil has grayish brown mottles. In several places the dark surface soil is more than 10 inches thick. In some areas the upper part of the soil has been removed. In other areas the soil is covered with as much as 15 inches of fill material, generally from excavations for basements.

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

Included in this unit in mapping are small areas of the somewhat poorly drained Higginsville soils at the head of drainageways. These soils make up about 10 percent of the unit.

Permeability is moderate in the Marshall soil. The Urban land is impervious to water. Surface runoff is medium in all areas. In the Marshall soil, natural fertility is medium and organic matter content is moderate. The surface layer of this soil is friable.

The Marshall soil is in yards, in open areas between buildings, and in parks, gardens, and undeveloped tracts.

If the Marshall soil is used for building site development or onsite waste disposal, land shaping is necessary in some areas because of the slope. Properly designing and reinforcing footings, foundations, and basement walls can help to prevent the damage to buildings caused by shrinking and swelling. Properly landscaping the site helps to keep water away from foundations. Community sewers are the chief means of waste disposal in areas of this unit. Septic tank absorption fields should be installed on the contour because of the slope.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of the Marshall soil. Designing the roads so that they shed water and providing adequate side ditches and culverts or tile drains and storm sewers help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope. Detailed onsite investigation is needed in areas that are being considered for high-density development.

No land capability classification is assigned.

105E—Marshall-Urban land complex, 9 to 20 percent slopes. This map unit occurs as areas of a strongly sloping and moderately steep, well drained Marshall soil intermingled with areas of Urban land. The unit is on side slopes in the uplands. The natural topography has not been altered appreciably by urban development. Individual areas are irregular in shape and range from 50 to more than 200 acres in size. They are about 60 percent Marshall soil and 30 percent Urban land. The Marshall soil and Urban land occur as areas so closely intermingled that separating them in mapping is not practical.

Typically, the surface layer of the Marshall soil is very dark grayish brown, friable silt loam about 8 inches thick. The subsoil is friable silty clay loam about 45 inches thick. It is dark yellowish brown in the upper part, dark yellowish brown and mottled in the next part, and yellowish brown and mottled in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled, friable silt loam. In a few small areas, the upper part of the subsoil has grayish brown mottles. In several places the dark surface soil is more than 10 inches thick. In some areas the upper part of the soil has been removed. In other areas the soil is covered with as much as 15 inches of fill material, generally from excavations for basements.

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

Included in this unit in mapping are small areas of the somewhat poorly drained Higginsville soils at the head of the drainageways. These soils make up about 10 percent of the unit.

Permeability is moderate in the Marshall soil. The Urban land is impervious to water. Surface runoff is medium in all areas. In the Marshall soil, natural fertility is medium and organic matter content is moderate. The surface layer of this soil is friable.

The Marshall soil is in yards, in open areas between buildings, and in parks, gardens, and undeveloped tracts.

If the Marshall soil is used for building site development or onsite waste disposal, land shaping is necessary in some areas because of the slope. Properly designing and reinforcing footings, foundations, and basement walls can help to prevent the damage to buildings caused by shrinking and swelling. Properly landscaping the site helps to keep water away from foundations. Community sewers are the chief means of waste disposal in areas of this unit. Septic tank absorption fields should be installed on the contour because of the slope.

Providing adequate base material helps to prevent the damage to local roads and streets caused by the low strength of the Marshall soil. Designing the roads so that they shed water and providing adequate side ditches and culverts or tile drains and storm sewers help to prevent the damage caused by frost action and by shrinking and swelling. Cutting and filling may be needed, depending on the slope. Detailed onsite investigation is needed in areas that are being considered for high-density development.

No land capability classification is assigned.

106A—Urban land, bottom land, 0 to 3 percent slopes. This map unit is on flood plains and terraces in and around the city of St. Joseph, near the Missouri River. More than 85 percent of the surface is covered by buildings, asphalt, concrete, or other impervious material. Examples of these areas are parking lots, shopping and business centers, railroad yards, industrial parks, and residential developments. The unit is protected by levees, but it is subject to rare flooding because the tributary streams can overflow their banks and the levees can break.

The composition of the soil material capable of supporting vegetation varies. Ornamental trees, shrubs, and lawn grasses are the chief plants. Detailed onsite investigation is needed prior to changes in the kind or intensity of use in any given area.

No land capability classification is assigned.

229F—Gosport-Gasconade complex, 20 to 45 percent slopes. These moderately steep to very steep soils are on side slopes in the uplands. The Gosport soil is moderately deep and moderately well drained, and the Gasconade soil is shallow and somewhat excessively drained. Coarse fragments and bedrock outcrops commonly cover 5 to 10 percent of the surface. Individual areas are irregular in shape and range from 5 to more than 100 acres in size. They are about 50 percent Gosport soil and 35 percent Gasconade soil. The two soils occur as areas so narrow that they cannot be delineated as separate units on the maps.

Typically, the Gosport soil has a surface layer of very dark grayish brown, friable silty clay loam about 3 inches thick. The subsoil is about 29 inches thick. It is light yellowish brown, firm silty clay loam in the upper part; yellowish brown, firm silty clay in the next part; and yellowish brown, mottled, firm silty clay loam in the lower part. Weathered shale bedrock is at a depth of about 32 inches.

Typically, the Gasconade soil has a surface layer of very dark grayish brown, friable flaggy silty clay loam about 9 inches thick. The subsoil is brown, firm flaggy silty clay loam about 8 inches thick. Hard, white limestone bedrock is at a depth of about 17 inches. The cracks and crevices in the bedrock are filled with dark brown silty clay loam. In places the surface layer and subsoil are silt loam.

Included with these soils in mapping are small areas of the deep, well drained Knox soils. These included soils generally are higher on the landscape than the Gosport and Gasconade soils, but in some areas they are lower. Also included are a few small areas of soils that are calcareous in the lower part. Included soils make up about 15 percent of the unit.

Permeability is very slow in the Gosport soil and moderately slow in the Gasconade soil. Surface runoff is rapid on both soils. Available water capacity is moderate in the Gosport soil and very low in the Gasconade soil. Organic matter content is moderately low in the Gosport soil and moderate in the Gasconade soil. Natural fertility is low in both soils. The shrink-swell potential is high in the Gosport soil and moderate in the Gasconade soil. The Gasconade soil cannot be tilled because of the coarse fragments and the limited depth to bedrock.

Most areas are used as unimproved woodland or pasture. The vegetation consists of sparse trees and native grasses. The main tree species are low-quality hardwoods. Brush and forbs grow in most areas. Mainly because of the slope and the hazard of erosion, these soils are unsuited to cultivated crops. They are suited to pasture that is grazed on a limited basis. An adequate plant cover is needed in the pastured areas because the soils are highly susceptible to erosion. Measures that control weeds also are needed. Tall fescue and common lespedeza should be selected for planting. Seedbed preparation and brush control are difficult because of the coarse fragments on the surface and the slope.

Most areas support oak, hickory, and ash. These soils are suited to trees. Because of low production, however, intensive timber management generally is not warranted. Because of the slope, the coarse fragments, and rock outcrops, the use of equipment is limited. Harvesting is difficult, and hand planting or direct seeding methods may be needed. Planting container-grown nursery stock increases the seedling survival rate. The stands should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely. Seeding disturbed areas after the timber is harvested reduces the hazard of erosion on the Gosport soil.

These soils generally are unsuitable for building site development and onsite waste disposal because of the slope and the depth to bedrock.

The land capability classification is VIIe.

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 and 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 inputs 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 31,000 acres in Buchanan County, or nearly 12 percent of the total acreage, meets the soil requirements for prime farmland. An additional 61,600 acres meets the requirements in areas where the soils are drained or protected from flooding. Approximately 88,000 acres of the prime farmland is used for crops, mainly corn, soybeans, wheat, and grain sorghum. The crops grown on this land account for an estimated 60 percent 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 and all soils that are frequently flooded during the growing season qualify for prime farmland only in areas where these limitations have been overcome by drainage measures or flood control. The need for these measures is indicated after the map unit name in table 5. Onsite evaluation is needed to determine whether or not these limitations have been overcome by corrective measures. The naturally wet soils in Buchanan County generally have been drained through the application of drainage measures or the incidental drainage that results from farming or other kinds of land development.

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 behavior 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 and pasture; as 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 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.

Crops and Pasture

Bennie F. Leflore, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants 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 and hay and pasture plants 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.

Approximately 165,000 acres in Buchanan County, or 62 percent of the total acreage, was used for crops and pasture in 1967 (*7*). Of this total, about 106,000 acres was used for cultivated crops, mainly corn, soybeans, sorghum, and wheat; 28,000 acres for permanent pasture; and 20,000 acres for rotation and hay and pasture. The remaining 11,000 acres was used mainly for conservation purposes, orchards, or tobacco or was idle cropland. In 1981, about 123,000 acres was used for cultivated crops (*5*). Because of fluctuations in the livestock market during the 1970's, the acreage used for row crops has increased and the acreage used for permanent pasture has correspondingly decreased.

The potential of the soils in Buchanan County for sustained production of food is good. Only about 4 percent of the cropland and pasture in the county is adequately treated for conservation purposes (*7*). The inadequately treated cropland is mainly on uplands that are farmed in a manner that causes excessive erosion. Because of this excessive soil loss, crop production cannot be sustained for a long period. On most of the cropland, erosion can be held within tolerable limits by conservation practices designed for specific sites. Some of the marginal land used for row crops should be converted to pasture and hayland.

The main management concerns on the cropland and pasture in the county are water erosion, wetness and flooding, fertility and tilth, and the need for irrigation.

Water erosion is the major problem on nearly all of the sloping cropland and overgrazed pasture in Buchanan County. It is a hazard on all soils that have a slope of more than 2 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils that have a clayey subsoil, such as Armstrong and Lamoni soils. Erosion also reduces the productivity of Gasconade, Gosport, and other soils that tend to be droughty because they are shallow or moderately deep over bedrock. Second, erosion on farmland results in sedimentation in streams, lakes, and ponds. Control of erosion minimizes this pollution and improves the quality of water for municipal use, for recreation, and for fish and wildlife.

Seedbed preparation and tillage are difficult in many fields that have clayey spots where the original friable surface soil has been eroded away. Such spots are common in areas of the eroded Armstrong and Lamoni soils.

Erosion-control measures provide a protective cover, reduce the runoff rate, and increase the rate of water infiltration. A cropping system that maintains a cover of crop residue can hold erosion losses to amounts that will not reduce the productive capacity of the soils. Growing grasses and legumes for pasture and hay is very effective in controlling erosion. When used in crop rotations, clover, alfalfa, and other legumes also improve tilth and provide nitrogen for the following crop.

Terraces reduce the length of slopes and thus the runoff rate and the hazard of erosion. Conventional terraces are most practical on uneroded upland soils that have long, smooth slopes of less than 8 percent. Special construction and management techniques are necessary if terrace systems are to be effective in most areas of the strongly sloping Armstrong, Contrary, Higginsville, Knox, Lamoni, Marshall, and Shelby soils. Grassed back-slope terraces reduce the gradient of the slopes. In contrast, conventional terraces increase the gradient. As a result, additional erosion-control measures are crucial.

On the strongly sloping soils, cropping systems that provide a substantial vegetative cover are needed unless erosion is controlled by a system of conservation tillage that leaves large amounts of crop residue on the surface. Minimizing tillage and leaving large quantities of crop residue on the surface increase the rate of water infiltration and reduce the runoff rate and the hazard of erosion. They can be effective on many of the soils that have a clayey surface layer. On Armstrong and Lamoni soils, special management may be needed if terracing exposes the clayey subsoil.

If the soil is not suitable for terracing, other erosion-control measures can be used. Contour stripcropping, for example, helps to control erosion by including contoured strips of grasses or legumes in short rotations. The grasses or legumes generally are harvested for hay. The areas between the strips are used for row crops, which are planted on the contour. A system of conservation tillage, such as no-till farming is effective in controlling erosion on sloping land. It is becoming more common in the county. It can be used on many of the soils. Special management is needed, however, in severely eroded areas where a system of conservation tillage is applied.

Wetness and *flood control* are management concerns on about 13 percent of the acreage used for crops and pasture in the county. Albaton, Levasy, and Wabash soils are naturally so wet that crop production is reduced during some part of the year. Land grading or a surface drainage system may be needed on these soils. Occasional flooding on Colo and Dockery soils and frequent flooding on Nodaway, Zook, and Wabash soils can hinder crop production. The flooding commonly occurs during the period November through June.

Soil fertility is naturally lower in most of the eroded or shallow soils in the county than in other soils. On all soils, however, additional plant nutrients are needed before maximum production can be achieved. The soils on the bottom land along the Missouri River generally are mildly alkaline or moderately alkaline. Most of the other soils in the county are naturally acid in the upper part of the root zone. As a result, applications of ground limestone are needed to raise the pH and calcium levels sufficiently for the optimum growth of legumes. On all soils additions of lime and fertilizer should be based on the results of soil tests, on the needs of the crop, and on the desired level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to be applied.

Soil tilth is an important factor affecting the germination of seeds and the infiltration of water into the soil. Soils with good tilth are granular and porous. Most of the uneroded upland soils used for crops in the county have a silt loam or silty clay loam surface layer that is dark and has a moderate or high content of organic matter. Generally, the structure of the silt loams is weakened by tillage and compaction. A crust forms on the surface of these soils during periods of heavy rainfall. Because it is hard when dry, the crust reduces the rate of water infiltration and increases the runoff rate. Regular additions of crop residue, manure, and other organic material improve soil structure and tilth.

In all of the eroded upland soils in the county, the content of clay in the surface layer is higher than that in the surface layer of the uneroded soils. As a result, tilth is poorer, the infiltration rate is slower, and the runoff rate is more rapid. Conservation practices are needed to control further erosion.

Fall plowing is common in the county, but it is not a suitable means of improving the tilth of most upland soils. Most of the cropland in the county occurs as sloping soils that are subject to erosion if they are plowed in the fall.

Tilth is a problem in the clayey Albaton, Onawa, Percival, and Wabash soils, which often stay wet until late in spring. If they are plowed when wet, they tend to be cloddy when dry. Because of the cloddiness, preparing a seedbed is difficult. Fall plowing generally improves the tilth of these soils. It does not result in erosion because the soils are nearly level.

A few *irrigation* systems are used in the county. Currently, only the center-pivot and rain-gun systems are used. These systems increase yields by supplying supplemental water during critical periods of crop growth.

They also make double cropping an alternative. Soybeans can be planted directly into wheat stubble in irrigated areas. The irrigation system supplies enough water to ensure germination and crop growth. The large amount of crop residue on the surface is helpful in protecting the soil against erosion.

If an irrigation system is used, soil and water conservation practices are needed. Immediately after irrigation, the saturated topsoil is extremely vulnerable to erosion if heavy rainfall occurs. Such accelerated erosion can drastically reduce natural fertility and can cause rapid sedimentation of any downstream bodies of water. Since most systems are supplied by reservoirs in the irrigated watershed and no wells currently produce enough water for irrigation, such sedimentation reduces the irrigation capacity. Therefore, protection of the topsoil against erosion is especially crucial. Another management concern is careful maintenance of terraces. If ruts are allowed to form where the wheels of the irrigation equipment pass over the saturated terrace berm, the effectiveness of the terrace is reduced.

Corn and soybeans are the best suited *field crops* in the county. In 1981, they were grown on about 93,000 acres. Grain sorghum was grown on about 6,000 acres. Wheat is the most common *close-growing crop*. It was grown on about 24,000 acres in 1981. Oats and rye can be grown, and grass seed could be produced from bromegrass, tall fescue, and orchardgrass.

Pasture and hay crops suited to the soils and climate in the county include several legumes, cool-season grasses, and warm-season native grasses. Alfalfa and red clover are the most common legumes grown for hay. They are also included in mixtures with bromegrass, orchardgrass, or timothy grown for hay or pasture.

The warm-season native grasses adapted to the county are big bluestem, little bluestem, indiangrass, and switchgrass. These grasses grow well during the hot summer months. Their management requirements differ from those of cool-season grasses.

Alfalfa is best suited to deep, moderately well drained or well drained soils, such as Contrary, Judson, Kennebec, Knox, Marshall, Nodaway, Olmitz, Sharpsburg, Shelby, Sibley, and Wiota soils. The other legumes and all of the grasses grow well on most of the upland soils in the county. Water-tolerant species should be selected for planting on the poorly drained Albaton, Colo, and Zook and very poorly drained Wabash soils.

The major management concerns in most of the pastured areas in the county are overgrazing and gully erosion. Controlled grazing is needed. Also, keeping grasses at a desirable height reduces the hazards of runoff and gully erosion.

Specialty crops are of considerable importance in the county. In 1967, a total of 431 acres was used for orchards, vineyards, and bush fruits (*7*). Deep soils that are characterized by good natural drainage and that warm up early in the spring are especially well suited to these crops. Examples are Marshall, Sibley, Contrary, and Knox soils. Soils in low areas where frost is frequent generally are poorly suited to these crops.

In 1981, about 465 acres in the county was used for tobacco (fig. 7). In general, tobacco grows well on the soils that are well suited to orchards and bush fruits. Erosion is a major hazard on soils having a slope of more than 2 percent.

The latest information about growing specialty crops can be obtained from local offices of the Cooperative Extension Service and 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 are also 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

Figure 7.—An area in Buchanan County used for tobacco.

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 woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*16*). 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.

There are no class V or class VIII soils in Buchanan County.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony. In class I there are no subclasses because the soils of this class have few limitations.

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

Woodland Management and Productivity

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

In 1972, about 8 percent of the acreage in Buchanan County was forested (*4*). The forested acreage has decreased, mainly because of the conversion to more intensive agricultural uses and urban development. Measures that improve the timber stands are needed on most of the woodland.

Most of the timber in the county grows in areas of the Knox soil association, which is described under the heading "General Soil Map Units." The most common trees in these areas are white oak, black oak, northern red oak, black walnut, and hickory. Black walnut, northern red oak, and white oak are the most common species harvested for high-value wood products. The areas of this association on the "Bluff Hills" commonly support species more typical of northern hardwood forests, such as northern red oak, basswood, sugar maple, and white ash. Some areas support lower quality species, which indicate less productive soils, such as Gasconade soils, or past abuse, such as intensive grazing.

The Haynie-Onawa-Waldron and Colo-Nodaway-Zook associations are on the flood plains in Buchanan County. Forested areas are in the riparian strips along the rivers and streams. These areas are too wet or too isolated for farming. The most common timber species are pure stands or mixtures of cottonwood, silver maple, boxelder, hackberry, green ash, sycamore, black willow, and black walnut. These areas generally are highly productive timber sites. The Nodaway soils have very good potential soil for black walnut.

The Marshall-Contrary, Lamoni-Sharpsburg-Higginsville, and Marshall-Lamoni-Higginsville associations are used primarily for cultivated crops, hay, or pasture. Some areas along the drainageways are forested. Most of these areas are small. The forest type ranges from good bottom-land timber to an oak-hickory forest along the steeper drainageways in the uplands. Abandoned fields commonly are invaded by woody vegetation, such as osageorange, honeylocust, shingle oak, black locust, plum, and dogwood. These species have little potential for commerical production. Some are valuable as firewood.

Table 7 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; *F*, a high content of rock fragments in the soil; and *L*, low strength. 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, F, and L.

In table 7, *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, fire lanes, and log-handling areas. Forests that have been burned or overgrazed are also 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.

Windthrow hazard is the likelihood that trees will be uprooted by the wind because the soil is not deep enough for adequate root anchorage. The main restrictions that affect rooting are a seasonal high water table and the depth to bedrock, a fragipan, or other limiting layers. A rating of *slight* indicates that under normal conditions no trees are blown down by the wind. Strong winds may damage trees, but they do not uproot them. A rating of *moderate* indicates that some trees can be blown down during periods when the soil is wet and winds are moderate or strong. A rating of *severe* indicates that many trees can be blown down during these periods.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index* and as a *volume* number. 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 *volume*, a number, is the yield likely to be produced by the most important trees. This number, expressed as cubic feet per acre per year, indicates the amount of fiber produced on 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

James L. Robinson, forester, Soil Conservation Service, helped prepare this section.

Well designed farmstead and feedlot windbreaks are needed in areas of the Marshall-Contrary, Lamoni-Sharpsburg-Higginsville, and Marshall-Lamoni-Higginsville associations, which are described under the heading "General Soil Map Units." Windbreaks can significantly reduce the energy required to heat a home and can moderate the effect of cold winter winds. Animals protected by a windbreak are healthier than those not protected from the winter winds.

The Haynie soils in the Haynie-Onawa-Waldron association are subject to wind erosion. Well planned field windbreaks help to control this erosion, minimize the crop damage caused by windblown sand particles, and moderate the effects of hot, dry summer winds.

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 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 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

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

In 1980, a total of 5,617 acres was developed for recreational uses in Buchanan County (*13*). Ownership of these areas is about 14 percent federal, 47 percent state, 13 percent municipal, 19 percent school, 5 percent private, and 2 percent county and other. The facilities include swimming areas, hunting and fishing areas, golf courses, camping trails, game courts, ball fields, picnic areas, play areas, historical sites, and wildlife-viewing areas. The demand for these facilities is not likely to increase significantly in the near future. The county population is expected to increase by only 1 percent by 1990 (*6*).

Bluffwoods State Forest, which is more than 2,000 acres in size, is the largest public recreational area in the county. This state-owned area offers opportunities for picnicking, hiking, fishing, hunting, and wildlife viewing. The only other public areas more than 100 acres in size are the Parkways Area, 1,400 acres; Krug Park, 162 acres; and the state-owned Pigeon Hill Wildlife Area, 336 acres. Lewis and Clark State Park, Saxton Fisherman Access Site, and two lake areas also provide the general public opportunities for recreational activities.

The county has a number of private and semiprivate commercial recreation enterprises (*9*). These include boat marinas, golf courses, historical sites, shooting ranges, campgrounds, and pay fishing lakes. The priority recreational needs in the county are the needs for campgrounds and facilities for water sports. The Smithville Lake project will meet these and many other recreational needs.

The soils of the survey area are rated in table 9 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 water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, 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 9 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 12 and interpretations for dwellings without basements and for local roads and streets in table 11.

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.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

Edward A. Gaskins, biologist, Soil Conservation Service, helped prepare this section.

Buchanan County is among the 12 counties that make up the Northwest Prairie Zoogeographic Region in Missouri. Prior to settlement, about 65 percent of this region was prairie and 35 percent was woodland (*8*). Currently, only a trace of the original prairie remains. About 63 percent of the county is classified as cropland, 11 percent as grassland, and 17 percent as woodland, which includes areas of the smaller woody species, such as shrubs and brush. The remaining 9 percent is classified as urban land. The conversion of woodland and grassland to cropland and urban land is the most important factor affecting the wildlife resource.

The game animals in the county are primarily those species that favor an openland habitat. The population of songbirds is excellent in each of the soil associations described under the heading "General Soil Map Units." This population is expected to increase by 0.8 percent from 1970 to 1990 (*6*).

About 25 percent of the Knox association is woodland. Some areas of the other associations also provide habitat for woodland wildlife. The deer population in the county is currently fair and is increasing. The loss of woodland to other land uses will slow this expansion. The population of turkeys is fair. This species was stocked in the early 1970's. The population has not increased at the rate that was first predicted. Some birds have moved into selected areas of bottom land, and some immigration is expected from DeKalb County. The squirrel population is good, considering the available habitat. A small population of woodcocks inhabits the county. This species makes very few migratory flights into the county.

The furbearer population is good. The best habitat for furbearers is on the bottom land along the Platte River. A decline in fur values has resulted in a downward trend in the activity of local trappers. Raccoon, muskrat, opossum, coyote, beaver, striped skunk, fox, and mink are the principal species trapped in the county. An experimental stocking of ruffed grouse occurred in 1981. The purpose of this experiment was to establish a small population of these game birds in the more extensive wooded areas.

Cropland and grassland make up more than 190,000 acres in the county. Most areas of the Lamoni-Sharpsburg-Higginsville, Marshall-Contrary, Haynie-Onawa-Waldron, Marshall-Lamoni-Higginsville, and Colo-Nodaway-Zook associations provide habitat for openland wildlife. Openland habitat should be interspersed with small areas of timber, waterways, hedgerows, fence rows, and other areas that have a woody or brushy cover. These areas provide a needed kind of habitat that is fast disappearing in many of the intensively cultivated parts of the county.

The population of bobwhite quail is good in the eastern half of the county and fair in the western half. The population of rabbits is good during summer but becomes poor or fair by fall or early winter. Both quail and rabbit require an abundant supply of food in close proximity to good woody cover. The loss of fence rows and other cover areas has resulted in a decrease in the number of both species. The resident dove population is good. It is augmented each year by migratory flights. The county has a fair to good population of pheasants, which are expanding their range into the hill country. The county has a few badgers, jackrabbits, and marsh hawks but apparently has no prairie chickens. The typical prairie wildlife species are very scarce in the county.

The wetland habitat in the county is in areas of the Haynie-Onawa-Waldron and Colo-Nodaway-Zook associations. The bottom land along the Missouri River has several excellent wetland areas. In the fall the population of ducks and geese is fair to good in these two associations. Wood ducks inhabit selected areas that meet their strict habitat requirements.

Fishing opportunities are provided by rivers, streams, lakes, and farm ponds. The county has 57 miles of permanently flowing streams (*6*). The most important fishing areas are the Missouri River, the Platte River, the Third Fork of the Platte River, the Hundred and Two River, and Castile Creek. These waters are inhabited by channel catfish, flathead catfish, black and yellow bullheads, paddlefish, bass, carp, buffalofish, walleye, and sunfish. Commercial fishermen on the Missouri River, which borders the county for approximately 44 miles, catch carp, carpsucker, buffalofish, catfish, and a few walleye, sauger, northern pike, paddlefish, crappie, and white bass. The public generally fishes the river for catfish, carp, and sturgeon. Several of the larger lakes in the county provide opportunities for the public to fish for bass, bluegill, channel catfish, carp, buffalofish, and crappie.

About 800 farm ponds and small lakes in the county have been stocked with fish, including largemouth bass, channel catfish, and bluegill. Though not open to the general public, these waters provide many fishing opportunities for the landowner and guests.

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 10, 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 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 flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, barley, millet, soybeans, and grain sorghum.

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, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, lovegrass, 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 flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, foxtail, croton, and partridge pea.

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, poplar, cherry, sweetgum, apple, hawthorn, dogwood, hickory, blackberry, and sumac. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

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, fir, cedar, and juniper.

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, wild millet, wildrice, cattail, 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. The wildlife attracted to these areas include bobwhite quail, pheasant, 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 wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and 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, mink, and beaver.

Engineering

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 need to 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, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 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 kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) 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 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. 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 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 the 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, large stones, slope, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 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, 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), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 12 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 12 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, and flooding affect absorption of the effluent. Large stones and bedrock 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 12 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, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of 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 and bedrock 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 needs to be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, 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 wind erosion.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock 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 13 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 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, 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 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 the depth to the water table is less than 1 foot. They 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. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, 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 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 14 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 of 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 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 potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, 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. 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 reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind 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 affect the construction of grassed waterways. A hazard of wind erosion, 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.

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 characterize key soils.

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

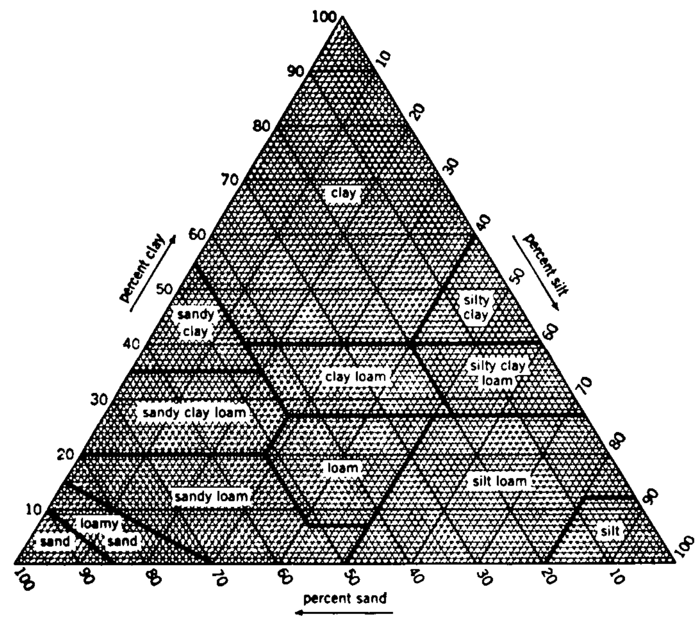


Figure 8.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

Engineering Index Properties

Table 15 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. 8). "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, "flaggy." 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 range 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 16 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 clay content of 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, and 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 1/3 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.

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 wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion. Soils are grouped according to the following distinctions:

1. Sands, coarse 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 sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, 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 wind erosion are used.

5. Loamy soils that are less than 20 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 20 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

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

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 16, 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 of 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 17 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 intake 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 17, 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, or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 17 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; November-May, for example, means that flooding can occur during the period November through May.

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 17 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 17.

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.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

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

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*17*). 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 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten 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 Udoll (*Ud*, meaning humid, 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 Argiudolls (*Argi*, meaning argillic horizon, plus *udoll*, the suborder of the Mollisols that has a udic 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 *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly 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-silty, mixed, mesic Typic Argiudolls.

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. The soil is compared with similar soils and with nearby soils of other 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* (*15*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*17*). Unless otherwise stated, colors in the descriptions are for moist 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."

Albaton Series

The Albaton series consists of deep, poorly drained, slowly permeable soils on flood plains along the Missouri River. These soils formed in calcareous alluvium. Slopes range from 0 to 2 percent.

Albaton soils are commonly adjacent to Haynie, Onawa, and Sarpy soils. Haynie and Sarpy soils have a subsoil that is browner than that of the Albaton soils and contain more sand and less clay in the solum. They are in the higher areas. Onawa soils are loamy in the lower part of the control section. They are in the slightly higher areas.

Typical pedon of Albaton silty clay, about 3,000 feet north and 900 feet east of the southwest corner of sec. 11, T. 56 N., R. 36 W.

Ap—0 to 8 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; very slightly effervescent; mildly alkaline; clear smooth boundary.

Cg1—8 to 41 inches; stratified dark grayish brown (2.5Y 4/2) and dark gray (5Y 4/1) silty clay; many medium prominent strong brown (7.5YR 4/6), few fine faint yellowish brown (10YR 5/6), and common fine distinct olive brown (2.5Y 4/4) mottles in some strata; moderate fine and medium angular blocky structure; firm; slightly effervescent; moderately alkaline; clear wavy boundary.

Cg2—41 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay; common medium prominent dark brown (7.5YR 4/4) mottles; moderate medium angular blocky structure; very firm; strongly effervescent; moderately alkaline.

The solum is 6 to 10 inches thick. The A horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is typically silty clay, but silty clay loam is within the range. The Cg horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay, clay, or silty clay loam.

Armster Series

The Armster series consists of deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in a thin mantle of loess and in the underlying Sangamon paleosol. Slopes range from 9 to 14 percent.

Armster soils are similar to Armstrong and Lamoni soils and are commonly adjacent to Knox soils. Armstrong and Lamoni soils have mottles with chroma of 2 or less in the upper part of the argillic horizon. Also, Lamoni soils have a mollic epipedon. Knox soils have less clay than the Armster soils. They are on side slopes and ridgetops above the Armster soils.

Typical pedon of Armster silt loam, 9 to 14 percent slopes, about 350 feet east and 2,010 feet north of the center of sec. 7, T. 55 N., R. 34 W.

A—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; moderate fine and very fine granular structure; friable; many fine roots; slightly acid; clear smooth boundary.

E—7 to 10 inches; dark grayish brown (10YR 4/2) silt loam; weak thin platy structure parting to moderate fine granular; friable; common fine roots; slightly acid; clear smooth boundary.

2Bt1—10 to 14 inches; dark brown (7.5YR 4/4) clay loam; moderate fine subangular blocky structure; firm; few faint brown (10YR 4/3) clay films on faces of peds; discontinuous dark brown (10YR 3/3) organic coatings on faces of peds; few fine roots; strongly acid; clear smooth boundary.

2Bt2—14 to 23 inches; dark brown (7.5YR 4/4) clay; common fine distinct yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; few distinct brown (10YR 4/3) clay films on faces of peds; few fine roots; very strongly acid; gradual smooth boundary.

2Bt3—23 to 38 inches; strong brown (7.5YR 5/6) clay; common fine distinct gray (N 5/0) and few fine prominent yellowish red (5YR 5/8) mottles; moderate medium subangular blocky structure; firm; few distinct dark brown (7.5YR 4/4) clay films on faces of peds; strongly acid; gradual smooth boundary.

2Bt4—38 to 52 inches; mottled strong brown (7.5YR 5/6), grayish brown (2.5Y 5/2), and light brownish gray (2.5Y 6/2) clay loam; moderate medium subangular blocky structure; firm; few distinct dark brown (7.5YR 4/2) clay films on faces of peds; slightly acid; gradual smooth boundary.

2Bt5—52 to 60 inches; strong brown (7.5YR 5/8) clay loam; common medium prominent light brownish gray (2.5Y 6/2) mottles; moderate medium subangular blocky structure; firm; few distinct dark brown (7.5YR 4/2) clay films on faces of peds; neutral.

The solum ranges from 48 to more than 60 inches in thickness. The A horizon has value and chroma of 2 or 3. It is typically silt loam, but loam is within the range. The E horizon has value of 4 or 5. The 2Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 8.

Armstrong Series

The Armstrong series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in a thin mantle of loess or loamy sediments and in the underlying paleosol, which formed in glacial till. Slopes range from 9 to 14 percent.

Armstrong soils are similar to Lamoni soils and are commonly adjacent to Contrary, Colo, Higginsville, and Marshall soils. Contrary soils do not have an argillic horizon or reddish mottles in the B horizon. They are on side slopes above the Armstrong soils. Colo soils are poorly drained and are on flood plains. Higginsville, Lamoni, and Marshall soils have a mollic epipedon. Higginsville and Marshall soils are on side slopes and ridgetops above the Armstrong soils.

Typical pedon of Armstrong loam, 9 to 14 percent slopes, eroded, about 1,810 feet east and 2,400 feet south of the center of sec. 35, T. 57 N., R. 35 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) loam, brown (10YR 5/3) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; medium acid; abrupt smooth boundary.

2Bt1—7 to 16 inches; reddish brown (5YR 4/4) clay; few medium prominent grayish brown (10YR 5/2) mottles; moderate fine and medium subangular blocky structure; firm; few distinct dark brown (10YR 3/3) clay films on faces of peds; slightly acid; gradual smooth boundary.

2Bt2—16 to 28 inches; yellowish red (5YR 4/6) clay; few fine prominent grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few distinct dark brown (7.5YR 4/2) clay films on faces of peds; few pebbles; slightly acid; gradual smooth boundary.

2Bt3—28 to 35 inches; strong brown (7.5YR 4/6) clay; few fine distinct brown (10YR 5/3) mottles; moderate medium prismatic structure parting to moderate fine and medium subangular blocky; firm; few distinct dark brown (7.5YR 4/2) clay films on faces of peds; few pebbles; slightly acid; gradual smooth boundary.

2Bt4—35 to 42 inches; yellowish brown (10YR 5/4) clay loam; few medium distinct light brownish gray (10YR 6/2) mottles; moderate fine and medium subangular blocky structure; firm; few faint dark reddish gray (5YR 4/2) clay films on faces of peds; few pebbles; neutral; clear smooth boundary.

2Bt5—42 to 52 inches; yellowish brown (10YR 5/4) clay loam; few medium distinct pale brown (10YR 6/3) and few fine distinct light gray (10YR 6/1) mottles; moderate fine and medium subangular blocky structure; firm; few distinct dark yellowish brown (10YR 4/4) clay films on faces of peds; few pebbles; neutral; clear smooth boundary.

2BC—52 to 60 inches; yellowish brown (10YR 5/4) clay loam; few coarse distinct light brownish gray (10YR 6/2) mottles; moderate fine and medium subangular blocky structure; firm; few pebbles; neutral.

The A horizon has chroma of 2 or 3. It typically is loam, but silt loam and clay loam are within the range. The depth to the 2B horizon ranges from 6 to 15 inches.

Colo Series

The Colo series consists of deep, poorly drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Colo soils are commonly adjacent to Dockery, Judson, Olmitz, Wabash, and Zook soils. Dockery, Judson, and Olmitz soils have a subsoil that is browner than that of the Colo soils. Also, Dockery soils have less clay and Olmitz soils more sand in the 10- to 40-inch control section. Dockery soils are in the slightly higher areas. Judson and Olmitz soils are on foot slopes above the Colo soils. Wabash and Zook soils contain more clay in the control section than the Colo soils. They are at the lower elevations.

Typical pedon of Colo silty clay loam, about 2,195 feet south and 1,385 feet west of the northeast corner of sec. 4, T. 56 N., R. 33 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—9 to 18 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A2—18 to 26 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak medium prismatic structure parting to moderate medium subangular blocky; friable; neutral; gradual smooth boundary.

A3—26 to 32 inches; black (N 2/0) silty clay loam, very dark gray (N 3/0) dry; weak medium prismatic structure parting to moderate medium subangular blocky; firm; neutral; gradual smooth boundary.

BA—32 to 42 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; firm; thin discontinuous black (10YR 2/1) organic coatings; neutral; gradual smooth boundary.

Bg—42 to 54 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; moderate fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Cg—54 to 60 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 6/1) dry; common fine distinct light brownish gray (10YR 6/2) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; neutral.

The solum ranges from 40 to more than 60 inches in thickness. The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 1 or less. The Ap horizon is typically silty clay loam, but silt loam is within the range. The Cg horizon has value of 4 or 5.

Contrary Series

The Contrary series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 9 to 14 percent.

Contrary soils are similar to Knox and Marshall soils and are commonly adjacent to Armstrong, Knox, Lamoni, and Marshall soils. Armstrong and Lamoni soils are on the lower side slopes. They have more clay and sand in the B horizon than the Contrary soils. Also, Armstrong soils are redder in the upper part of the B horizon. Knox soils have a B horizon that is more clayey than that of the Contrary soils. Marshall soils have a mollic epipedon and have a B horizon that is browner than that of the Contrary soils.

Typical pedon of Contrary silt loam, 9 to 14 percent slopes, 1,100 feet west and 1,230 feet north of the center of sec. 33, T. 56 N., R. 35 W.

Ap—0 to 8 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; weak fine granular structure; friable; many fine roots; thin discontinuous very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; abrupt smooth boundary.

BA—8 to 14 inches; brown (10YR 4/3) silt loam; few fine faint grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure parting to weak fine granular; friable; common fine roots; thin discontinuous very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly acid; clear smooth boundary.

Bw1—14 to 21 inches; brown (10YR 4/3) silt loam; few fine prominent strong brown (7.5YR 5/6) and common fine distinct grayish brown (2.5Y 5/2) mottles; weak fine subangular blocky structure; friable; few fine roots; thin discontinuous very dark grayish brown (10YR 3/2) organic coatings on faces of peds; neutral; clear smooth boundary.

Bw2—21 to 27 inches; grayish brown (2.5Y 5/2) silt loam; common fine prominent strong brown (7.5YR 5/6) and distinct light gray (10YR 6/1) mottles; moderate medium subangular blocky structure; friable; few fine roots; neutral; gradual smooth boundary.

Bw3—27 to 32 inches; grayish brown (2.5Y 5/2) silt loam; many medium distinct brown (10YR 5/3), common medium prominent yellowish brown (10YR 5/6), and common fine distinct light gray (10YR 6/1) mottles; moderate fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw4—32 to 37 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct light olive brown (2.5Y 5/4), many fine prominent strong brown (7.5YR 5/6), and common fine distinct light gray (10YR 6/1) mottles; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

BC—37 to 45 inches; grayish brown (2.5Y 5/2) silt loam; few fine distinct light olive brown (2.5Y 5/4), common fine distinct light gray (10YR 6/1), and few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C—45 to 60 inches; grayish brown (2.5Y 5/2) silt loam; many medium distinct light olive brown (2.5Y 5/4), common fine distinct light brownish gray (10YR 6/2), and few fine prominent strong brown (7.5YR 5/6) mottles; massive with some vertical cleavage planes; friable; neutral.

The thickness of the solum is typically 32 to 48 inches but ranges to 60 inches. The Ap or A horizon has value and chroma of 2 or 3. It is dominantly silt loam, but the range includes silty clay loam. The Bw horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is silt loam or silty clay loam. The C horizon also is silt loam or silty clay loam. It has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 to 4.

Dockery Series

The Dockery series consists of deep, somewhat poorly drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Dockery soils are commonly adjacent to Colo, Nodaway, and Zook soils. Colo and Zook soils have more clay than the Dockery soils. They are in the lower areas on the flood plains. Nodaway soils have a subsoil that is browner than that of the Dockery soils. They are adjacent to stream channels.

Typical pedon of Dockery silty clay loam, about 2,500 feet south and 1,690 feet east of the northwest corner of sec. 36, T. 55 N., R. 34 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; very dark gray (10YR 3/1) organic coatings on faces of peds; few fine roots; neutral; abrupt smooth boundary.

A—9 to 20 inches; dark grayish brown (10YR 4/2) silt loam; weak fine granular structure; friable; very dark gray (10YR 3/1) organic coatings on faces of peds; few fine roots; neutral; clear smooth boundary.

C1—20 to 25 inches; dark grayish brown (10YR 4/2) silt loam; few thin grayish brown (2.5Y 5/2) strata; few fine faint yellowish brown (10YR 5/8) mottles; appears massive but has distinct bedding planes; friable; discontinuous dark gray (10YR 4/1) organic coatings on faces of peds; few fine roots; neutral; abrupt wavy boundary.

C2—25 to 37 inches; dark grayish brown (10YR 4/2) silt loam; few thin grayish brown (2.5Y 5/2) strata; few fine faint yellowish brown (10YR 5/6) mottles; appears massive but has distinct bedding planes; friable; discontinuous dark gray (10YR 4/1) organic coatings on faces of peds; few fine roots; neutral; clear wavy boundary.

C3—37 to 60 inches; dark grayish brown (10YR 4/2) silt loam; few thin grayish brown (2.5Y 5/2) strata; few fine faint yellowish brown (10YR 5/6) mottles; appears massive but has distinct bedding planes; friable; neutral.

The solum ranges from 8 to 20 inches in thickness. The A horizon has value of 3 or 4 and chroma of 2 or 3. It is typically silty clay loam, but silt loam is within the range. The C horizon has hue of 10YR or 2.5Y and value of 4 or 5. Lenses of coarser or finer textured material less than 6 inches thick are common in this horizon.

Gasconade Series

The Gasconade series consists of shallow, somewhat excessively drained, moderately slowly permeable soils on uplands. These soils formed in limestone bedrock residuum. Slopes range from 20 to 45 percent.

Gasconade soils are commonly adjacent to Gosport, Kennebec, and Knox soils. Gosport soils are moderately deep and are more acid throughout than the Gasconade soils. They are on side slopes below the Gasconade soils. Kennebec soils have a mollic epipedon that is thicker than that of the Gasconade soils. They do not have bedrock within a depth of 60 inches. They are on flood plains. Knox soils formed in thick deposits of loess. They are generally on side slopes above the Gasconade soils. In some areas, however, they are on foot slopes below the Gasconade soils.

Typical pedon of Gasconade flaggy silty clay loam, 20 to 40 percent slopes, about 2,550 feet west and 100 feet south of the northeast corner of sec. 12, T. 55 N., R. 36 W.

A—0 to 9 inches; very dark grayish brown (10YR 3/2) flaggy silty clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; about 20 percent coarse fragments; mildly alkaline; clear wavy boundary.

Bw—9 to 17 inches; brown (10YR 4/3) very flaggy silty clay loam; weak medium subangular blocky structure parting to moderate fine granular; firm; about 50 percent coarse fragments; mildly alkaline; abrupt irregular boundary.

R—17 inches; hard limestone bedrock; clayey material in weathered cracks and crevices in the upper part.

The thickness of the solum ranges from 8 to 20 inches and is the same as the depth to hard limestone bedrock. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically flaggy silty clay loam, but flaggy clay loam is within the range. The B horizon has value of 3 or 4 and chroma of 2 to 4. It is typically very flaggy silty clay loam, but flaggy clay loam and flaggy silty clay are within the range.

Gosport Series

The Gosport series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in acid shale residuum. Slopes range from 15 to 45 percent.

Gosport soils are commonly adjacent to Armster, Gasconade, Judson, Kennebec, and Knox soils. Armster and Gasconade soils are on side slopes above the Gosport soils. Armster soils formed in glacial till. They are redder than the Gosport soils and have less clay in the B horizon. Gasconade soils have a solum that is thinner than that of the Gosport soils. They are underlain by limestone bedrock. Judson and Kennebec soils have a thick mollic epipedon and have less clay throughout than the Gosport soils. They are on foot slopes and flood plains below the Gosport soils. Knox soils are deep and have less clay throughout than the Gosport soils. They are on ridgetops and side slopes above the Gosport soils.

Typical pedon of Gosport silty clay loam, 15 to 45 percent slopes, about 1,280 feet east and 1,545 feet north of the center of sec. 23, T. 56 N., R. 35 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; neutral; clear smooth boundary.

Bw1—3 to 9 inches; light yellowish brown (2.5Y 6/4) silty clay; moderate fine subangular blocky structure; firm; few faint clay films on faces of peds; about 5 percent fragments of dark yellowish brown (10YR 4/4) weathered shale; very dark grayish brown (2.5Y 3/2) material filling old root channels; strongly acid; gradual smooth boundary.

Bw2—9 to 23 inches; yellowish brown (10YR 5/4) silty clay; moderate fine subangular blocky structure; firm; few faint clay films on faces of peds; about 5 percent fragments of dark yellowish brown (10YR 4/4) weathered shale; very strongly acid; gradual smooth boundary.

Bw3—23 to 32 inches; yellowish brown (10YR 5/4) silty clay; common medium faint grayish brown (10YR 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate medium blocky structure; firm; few faint clay films on faces of peds; about 15 percent fragments of dark yellowish brown and yellowish brown (10YR 4/4 and 5/8) weathered shale; medium acid; clear smooth boundary.

Cr—32 to 60 inches; mottled grayish brown (10YR 5/2), light olive brown (2.5Y 5/4), and strong brown (7.5YR 5/8), soft micaceous shale; slightly acid.

The thickness of the solum and the depth to weathered shale bedrock range from 20 to 40 inches. The A horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. It is typically silty clay loam, but silt loam is within the range. The Bw horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 or 4.

Grable Series

The Grable series consists of deep, well drained soils on flood plains along the Missouri River. These soils formed in calcareous, loamy alluvium over sandy alluvium. Permeability is moderate in the upper part of the profile and rapid in the lower part. Slopes range from 0 to 2 percent.

Grable soils are commonly adjacent to Haynie, Onawa, Percival, and Waldron soils. Haynie soils are moderately well drained and are in landscape positions similar to those of the Grable soils. They have less sand in the lower part than the Grable soils. Onawa and Percival soils are clayey in the upper part. They are at the slightly lower elevations on the flood plains. Waldron soils have more clay throughout than the Grable soils. They are in the lower areas.

Typical pedon of Grable very fine sandy loam, about 2,200 feet west and 590 feet north of the southeast corner of sec. 14, T. 56 N., R. 37 W.

Ap—0 to 9 inches; very dark grayish brown (2.5Y 3/2) very fine sandy loam, grayish brown (2.5Y 5/2) dry; weak fine granular structure; friable; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C—9 to 16 inches; dark grayish brown (10YR 4/2) very fine sandy loam; weak fine subangular blocky structure; friable; slightly effervescent; mildly alkaline; abrupt wavy boundary.

2C—16 to 60 inches; dark grayish brown (10YR 4/2) fine sand; single grain; loose; strongly effervescent; moderately alkaline.

The A horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2. It is commonly very fine sandy loam but is silt loam in some pedons. The depth to the 2C horizon ranges from 12 to 16 inches. The C and 2C horizons have hue of 10YR or 2.5Y and value of 4 or 5. In some pedons they have strata of finer or coarser material as much as 2 inches thick. The 2C horizon is loamy fine sand, fine sand, or loamy very fine sand.

Haynie Series

The Haynie series consists of deep, moderately well drained, moderately permeable soils on flood plains along the Missouri River. These soils formed in calcareous alluvium. Slopes range from 0 to 2 percent.

Haynie soils are commonly adjacent to Albaton, Modale, Onawa, and Sarpy soils. Albaton soils are poorly drained and are in the lower areas on the flood plains. They have more clay throughout than the Haynie soils. Modale and Onawa soils are somewhat poorly drained and are in the slightly lower areas on the flood plains. Sarpy soils are excessively drained and are in positions on the flood plains similar to those of the Haynie soils or in the slightly higher areas. They contain more sand in the control section than the Haynie soils.

Typical pedon of Haynie silt loam, about 2,590 feet east and 545 feet south of the center of sec. 33, T. 57 N., R. 36 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to moderate fine granular; very friable; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C—9 to 60 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; few medium prominent dark brown (7.5YR 4/4) and common medium prominent light olive gray (5Y 6/2) mottles starting at a depth of about 37 inches; appears massive but has weak bedding planes; very friable; strongly effervescent; moderately alkaline.

The Ap horizon has chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is silt loam or very fine sandy loam.

Higginsville Series

The Higginsville series consists of deep, somewhat poorly drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 5 to 14 percent.

These soils have a dark surface layer that is slightly thinner than is definitive for the Higginsville series. This difference, however, does not significantly affect the usefulness or behavior of the soils.

Higginsville soils are commonly adjacent to Lamoni, Marshall, and Sharpsburg soils. Lamoni soils have more clay in the B horizon than the Higginsville soils and have pebbles throughout. They are in the lower areas. Marshall soils do not have mottles with chroma of 2 in the upper part of the B horizon. They are on the higher ridgetops and on convex side slopes. Sharpsburg soils have more clay in the B horizon than the Higginsville soils. They are on ridgetops above the Higginsville soils.

Typical pedon of Higginsville silty clay loam, 5 to 9 percent slopes, eroded, 775 feet west and 90 feet south of the northeast corner of sec. 8, T. 56 N., R. 33 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; thin continuous very dark gray (10YR 3/1) organic coatings on faces of peds; many fine roots; neutral; abrupt smooth boundary.

BA—9 to 15 inches; brown (10YR 4/3) silty clay loam; few fine faint yellowish brown (10YR 5/6) mottles; weak fine granular structure; friable; thin continuous very dark gray (10YR 3/1) organic coatings on faces of peds; many fine roots; slightly acid; gradual smooth boundary.

Bt1—15 to 23 inches; brown (10YR 5/3) silty clay loam; few fine faint yellowish brown (10YR 5/6) and few fine distinct light olive gray (5Y 6/2) mottles; weak fine subangular blocky structure; friable; few faint brown (10YR 4/3) clay films on faces of peds; many fine roots; neutral; clear smooth boundary.

Bt2—23 to 28 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct yellowish brown (10YR 5/6) and many fine faint light gray (5Y 6/1) mottles; weak medium subangular blocky structure; friable; few faint brown (10YR 4/3) clay films on faces of peds; many fine roots; neutral; clear smooth boundary.

Bt3—28 to 35 inches; grayish brown (10YR 5/2) silty clay loam; few fine distinct light olive gray (5Y 6/2) and yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few faint brown (10YR 4/3) clay films on faces of peds; neutral; gradual smooth boundary.

BC—35 to 50 inches; grayish brown (10YR 5/2) silt loam; few fine distinct light olive gray (5Y 6/2) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C—50 to 60 inches; light brownish gray (10YR 6/2) silt loam; few fine distinct light gray (5Y 6/1) and many fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; neutral.

The thickness of the solum ranges from 45 to more than 60 inches. The Ap horizon has chroma of 2 or 3. The B horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 or 3. It typically is silt loam, but silty clay loam is within the range.

Judson Series

The Judson series consists of deep, well drained, moderately permeable soils on foot slopes and alluvial fans adjacent to small flood plains. These soils formed in silty local alluvium. Slopes range from 1 to 5 percent.

Judson soils are similar to Marshall, Sibley, and Wiota soils and are commonly adjacent to Colo, Lamoni, Marshall, and Shelby soils. Colo soils have a subsoil that is grayer than that of the Judson soils. They are in the lower areas on the flood plains. Lamoni soils contain more clay than the Judson soils and have a thinner mollic epipedon. They are on side slopes above the Judson soils. Marshall soils have a dark surface layer that is thinner than that of the Judson soils. Shelby soils contain more sand and pebbles than the Judson soils and have a thinner mollic epipedon. They are on side slopes above the Judson soils. Sibley and Wiota soils have an argillic horizon.

Typical pedon of Judson silt loam, 1 to 4 percent slopes, 1,380 feet south and 1,275 feet west of the northeast corner of sec. 6, T. 55 N., R. 35 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; thin continuous black (10YR 2/1) organic coatings on faces of peds; slightly acid; abrupt smooth boundary.

A1—8 to 13 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; very dark brown (10YR 2/2) organic coatings on faces of peds; neutral; abrupt smooth boundary.

A2—13 to 25 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine angular and subangular blocky structure; friable; thin discontinuous very dark brown (10YR 2/2) organic coatings on faces of peds; neutral; gradual smooth boundary.

AB—25 to 32 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; friable; thin discontinuous very dark brown (10YR 2/2) organic coatings on faces of peds; neutral; gradual smooth boundary.

Bw1—32 to 42 inches; brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) organic coatings on faces of peds; slightly acid; clear smooth boundary.

Bw2—42 to 48 inches; yellowish brown (10YR 5/4) silty clay loam; moderate medium subangular blocky structure; friable; thin discontinuous dark brown (10YR 3/3) coatings on faces of peds; slightly acid; gradual smooth boundary.

Bw3—48 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; few fine distinct light brownish gray (10YR 6/2) mottles; moderate fine subangular blocky structure; friable; neutral.

The A horizon ranges from 24 to 35 inches in thickness. It has value of 2 or 3 and chroma of 1 to 3. The Bw and C horizons have value of 4 or 5 and chroma of 3 or 4.

Kenmoor Series

The Kenmoor series consists of deep, moderately well drained soils on flood plains along the Missouri River. These soils formed in sandy and loamy alluvium and in the underlying clayey and silty material. Permeability is rapid in the upper part of the profile and slow in the lower part. Slopes range from 0 to 2 percent.

Kenmoor soils are commonly adjacent to Modale, Onawa, Sarpy, and Waldron soils. Modale soils have more silt and less sand in the upper part of the control section than the Kenmoor soils. They are in the slightly lower areas. Onawa soils have more sand and less clay in the lower part than the Kenmoor soils. They are in the lower areas. Sarpy soils are sandy throughout. They are in the slightly higher areas. Waldron soils have more clay throughout than the Kenmoor soils. They are in the lower areas.

Typical pedon of Kenmoor loamy fine sand, about 3,690 feet north and 732 feet west of the southeast corner of sec. 3, T. 57 N., R. 36 W.

Ap—0 to 10 inches; dark brown (10YR 3/3) loamy fine sand, pale brown (10YR 6/3) dry; weak fine granular structure; very friable; slightly effervescent; mildly alkaline; clear smooth boundary.

C—10 to 25 inches; brown (10YR 5/3) loamy fine sand; massive; very friable; slightly effervescent; mildly alkaline; abrupt wavy boundary.

2Ab—25 to 32 inches; very dark grayish brown (2.5Y 3/2) silty clay loam; common medium prominent dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; many thin strata of silt loam; slightly effervescent; mildly alkaline; gradual wavy boundary.

2Bgb—32 to 60 inches; grayish brown (10YR 5/2) silty clay; few medium prominent dark brown (7.5YR 4/4) mottles; strong fine subangular blocky structure; firm; many thin strata of silt loam; slightly effervescent; mildly alkaline.

The depth to the 2Ab horizon ranges from 22 to 35 inches. The Ap horizon has value of 3 or 4 and chroma of 2 to 4. It is typically loamy fine sand, but sandy loam and fine sandy loam are within the range. The C horizon has value of 4 or 5 and chroma of 2 or 3. It is loamy fine sand or loamy sand. The 2Ab and 2Bgb horizons have hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 2 to 4. They are clay, silty clay, or silty clay loam.

Kennebec Series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Kennebec soils are similar to Judson soils and are commonly adjacent to Colo, Gasconade, and Knox soils. Colo soils are poorly drained and are in the lower areas on the flood plains. Gasconade soils are underlain by limestone bedrock at a depth of 8 to 20 inches. They are on side slopes above the Kennebec soils. Judson and Knox soils have a subsoil that is browner than that of the Kennebec soils. Also, Judson soils have a thinner mollic epipedon. Knox soils do not have a mollic epipedon and have an argillic horizon. They are on side slopes above the Kennebec soils.

Typical pedon of Kennebec silt loam, about 2,990 feet north and 1,590 feet west of the southeast corner of sec. 1, T. 55 N., R. 36 W.

Ap—0 to 10 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; neutral; clear smooth boundary.

A—10 to 21 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; thin discontinuous black (10YR 2/1) organic coatings on faces of peds; neutral; gradual smooth boundary.

AC—21 to 44 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; friable; thin discontinuous very dark gray (10YR 3/1) organic coatings on faces of peds; neutral; clear smooth boundary.

C—44 to 60 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent dark brown (7.5YR 4/4) mottles; weak fine subangular blocky structure; friable; neutral.

The solum ranges from 40 to more than 60 inches in thickness. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2.

Knox Series

The Knox series consists of deep, well drained, moderately permeable soils on strongly dissected uplands bordering the flood plains along the Missouri River and its tributaries. These soils formed in a thick layer of loess. Slopes range from 5 to 35 percent.

Knox soils are similar to Contrary and Marshall soils and are commonly adjacent to Gasconade, Kennebec, and Wiota soils. Contrary soils have less clay in the subsoil than the Knox soils. Gasconade soils are shallow over bedrock. They occur as bands at various elevations on side slopes. Kennebec and Marshall soils have a mollic epipedon and do not have an argillic horizon. Kennebec soils are on flood plains. Wiota soils have a mollic epipedon. They are on low terraces.

Typical pedon of Knox silt loam, 5 to 9 percent slopes, about 2,650 feet south and 700 feet west of the northeast corner of sec. 29, T. 55 N., R. 36 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; neutral; abrupt smooth boundary.

BA—8 to 13 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; thin discontinuous very dark grayish brown (10YR 3/2) organic coatings on faces of peds; neutral; clear smooth boundary.

Bt1—13 to 26 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; neutral; clear smooth boundary.

Bt2—26 to 38 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; few faint brown (10YR 4/3) clay films on faces of peds; neutral; clear smooth boundary.

Bt3—38 to 48 inches; yellowish brown (10YR 5/4) silt loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; friable; few manganese accumulations; neutral; clear smooth boundary.

C—48 to 60 inches; yellowish brown (10YR 5/4) silt loam; common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; neutral.

The A or Ap horizon is typically silt loam, but the range includes silty clay loam.

The severely eroded Knox soils in this county have a surface layer that is browner and contains more clay than is definitive for the series. These differences, however, do not significantly affect the usefulness or behavior of the soils.

Lamoni Series

The Lamoni series consists of deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in a thin mantle of loess and in the underlying paleosol. Slopes range from 5 to 14 percent.

These soils have a dark surface layer that is slightly thinner than is definitive for the Lamoni series. This difference, however, does not significantly affect the usefulness or behavior of the soils.

Lamoni soils are commonly adjacent to Colo, Contrary, Higginsville, Sharpsburg, and Shelby soils. Colo soils are nearly level and are on narrow flood plains. Contrary, Higginsville, and Sharpsburg soils do not have glacial pebbles in the subsoil. They are on side slopes above the Lamoni soils. Shelby soils have less clay than the Lamoni soils and do not have grayish mottles in the upper part of the B horizon. They are on side slopes below the Lamoni soils.

Typical pedon of Lamoni silty clay loam, 5 to 9 percent slopes, eroded, 1,780 feet south and 405 feet west of the northeast corner of sec. 4, T. 56 N., R. 33 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to moderate fine granular; friable; thin discontinuous black (10YR 2/1) coatings on faces of peds; slightly acid; abrupt smooth boundary.

2Bt1—9 to 16 inches; dark grayish brown (10YR 4/2) clay loam; few fine prominent strong brown (7.5YR 4/6) mottles; moderate fine subangular blocky structure; friable; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; few fine concretions of manganese oxide; medium acid; clear smooth boundary.

2Bt2—16 to 23 inches; dark grayish brown (2.5Y 4/2) clay; common fine prominent yellowish brown (10YR 5/8) and light gray (10YR 6/1) mottles; moderate fine subangular blocky structure; firm; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; few fine concretions of manganese oxide; slightly acid; clear smooth boundary.

2Bt3—23 to 33 inches; brown (10YR 5/3) clay; common medium distinct yellowish brown (10YR 5/8) and common fine distinct gray (10YR 5/1) mottles; moderate medium and fine subangular and angular blocky structure; firm; few distinct grayish brown (10YR 5/2) clay films on faces of peds; few fine concretions of manganese oxide; neutral; gradual smooth boundary.

2BC—33 to 47 inches; mottled yellowish brown (10YR 5/6), light brownish gray (2.5Y 6/2), light olive gray (5Y 6/2), and light olive brown (2.5Y 5/4) clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; firm; few fine concretions of manganese oxide; mildly alkaline; clear smooth boundary.

2C1—47 to 51 inches; mottled yellowish brown (10YR 5/6), light brownish gray (2.5Y 6/2), and light olive brown (2.5Y 5/4) clay loam; massive; firm; common manganese accumulations; slightly effervescent; mildly alkaline; abrupt smooth boundary.

2C2—51 to 55 inches; light brownish gray (2.5Y 6/2) and light yellowish brown (2.5Y 6/3) clay loam; few fine prominent yellowish brown (10YR 5/8) mottles; massive; firm; common manganese accumulations; slightly effervescent; moderately alkaline; abrupt smooth boundary.

2C3—55 to 60 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct light brownish gray (2.5Y 6/2) and common fine distinct light gray (5Y 6/1) mottles; massive; firm; common manganese accumulations; slightly effervescent; moderately alkaline.

The solum ranges from 39 to more than 60 inches in thickness. The dark surface layer is 7 to 10 inches thick. The depth to the 2B horizon ranges from 7 to 18 inches.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is typically silty clay loam, but clay loam, loam, and silt loam are within the range. The 2B horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 6.

Levasy Series

The Levasy series consists of deep, poorly drained soils on flood plains along the Missouri River. These soils formed in calcareous, clayey and silty alluvium over loamy alluvium. Permeability is slow in the upper part of the profile and moderate in the lower part. Slopes are 0 to 1 percent.

Levasy soils are similar to Onawa soils and are commonly adjacent to Haynie and Onawa soils. Haynie soils are moderately well drained and are on rises on the flood plains. Onawa soils are somewhat poorly drained. They do not have a mollic epipedon.

Typical pedon of Levasy silty clay loam, about 100 feet west and 1,100 feet south of the northeast corner of sec. 30, T. 55 N., R. 37 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure; firm; moderately alkaline; abrupt smooth boundary.

A—8 to 13 inches; very dark gray (10YR 3/1) silty clay, grayish brown (10YR 5/2) dry; moderate medium subangular blocky structure; firm; moderately alkaline; abrupt wavy boundary.

Bg—13 to 23 inches; dark grayish brown (2.5Y 4/2) silty clay; common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (10YR 3/2) organic coatings on faces of peds; slightly effervescent; moderately alkaline; abrupt wavy boundary.

2Cg—23 to 60 inches; grayish brown (2.5Y 5/2), stratified silt loam and very fine sandy loam; many medium prominent yellowish brown (10YR 5/6) mottles; massive; very friable; slightly effervescent; moderately alkaline.

The depth to loamy material ranges from 20 to 34 inches. The Ap and A horizons have hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 or 2. The Bg and Cg horizons have hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon is silt loam, very fine sandy loam, or fine sandy loam.

Marshall Series

The Marshall series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 20 percent.

Marshall soils are similar to Contrary, Judson, Knox, Sharpsburg, Sibley, and Wiota and are commonly adjacent to Contrary, Higginsville, Judson, Lamoni, and Sibley soils. Contrary and Higginsville soils are grayer in the upper part of the B horizon than the Marshall soils. Contrary soils do not have a mollic epipedon. Higginsville soils are in concave areas on the lower side slopes. Judson soils have an A horizon that is thicker than that of the Marshall soils. They are on foot slopes and alluvial fans below the Marshall soils. Knox soils have a dark A horizon that is thinner than that of the Marshall soils and have an argillic horizon. Lamoni soils have glacial pebbles and more clay in the B horizon than the Marshall soils. They are on the lower side slopes. Sharpsburg, Sibley, and Wiota soils have an argillic horizon. Sharpsburg soils have more clay in the subsoil than the Marshall soils, and Sibley and Wiota soils have a thicker mollic epipedon.

Typical pedon of Marshall silt loam, 2 to 5 percent slopes, 600 feet west and 550 feet south of the northeast corner of sec. 9, T. 55 N., R. 33 W.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—8 to 12 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; moderately thick continuous black (10YR 2/1) organic coatings on faces of peds; neutral; gradual smooth boundary.

A2—12 to 18 inches; very dark grayish brown (10YR 3/2) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; friable; moderately thick continuous black (10YR 2/1) organic coatings on faces of peds; neutral; clear smooth boundary.

BA—18 to 27 inches; brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; thin continuous black (10YR 2/1) organic coatings on faces of peds; neutral; clear smooth boundary.

Bt1—27 to 33 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine and medium subangular blocky structure; friable; few faint clay films on faces of peds; neutral; clear smooth boundary.

Bt2—33 to 45 inches; yellowish brown (10YR 5/4) silty clay loam; few fine prominent strong brown (7.5YR 5/6) and common fine distinct light brownish gray (2.5Y 6/2) mottles; weak fine and medium subangular blocky structure; friable; few faint clay films on faces of peds; medium acid; clear smooth boundary.

BC—45 to 52 inches; yellowish brown (10YR 5/4) silty clay loam; common fine prominent strong brown (7.5YR 5/6) and many medium distinct light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

C—52 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; common medium prominent strong brown (7.5YR 5/6) and common medium distinct light brownish gray (2.5Y 6/2) mottles; massive; friable; slightly acid.

The solum ranges from 40 to more than 60 inches in thickness. Reaction ranges from medium acid to neutral throughout the profile.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is typically silt loam, but silty clay loam is within range. The Bt horizon has value of 4 or 5 and chroma of 3 or 4. The depth to mottles with chroma of 2 ranges from 26 to 60 inches.

The eroded Marshall soils in this county have a dark surface layer that is slightly thinner than is definitive for the series. This difference, however, does not significantly affect the usefulness or behavior of the soils.

Modale Series

The Modale series consists of deep, somewhat poorly drained soils on flood plains along the Missouri River. These soils formed in calcareous alluvium. Permeability is moderate in the upper part of the profile and slow in the lower part. Slopes range from 0 to 2 percent.

Modale soils are commonly adjacent to Albaton, Haynie, and Onawa soils on flood plains. Albaton soils are clayey throughout. They are in the lower areas. Haynie soils are moderately well drained and are on rises. Onawa soils are more clayey in the upper part than the Modale soils and are more sandy in the lower part. They are at the slightly lower elevations.

Typical pedon of Modale silt loam, 290 feet west and 2,000 feet south of the northeast corner of sec. 26, T. 56 N., R. 37 W.

Ap—0 to 10 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; mildly alkaline; abrupt smooth boundary.

C1—10 to 24 inches; dark grayish brown (2.5Y 4/2) silt loam; massive with some horizontal cleavage planes; friable; some thin strata of fine sandy loam; slightly effervescent; moderately alkaline; gradual wavy boundary.

C2—24 to 30 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; common medium distinct light brownish gray (2.5Y 6/2) and few fine prominent dark brown (7.5YR 4/4) mottles; massive with some horizontal cleavage planes; friable; strongly effervescent; moderately alkaline; abrupt wavy boundary.

2C—30 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay; common fine distinct light brownish gray (2.5Y 6/2) and common fine prominent dark brown (7.5YR 4/4) mottles; moderate fine angular and subangular blocky structure; firm; few thin strata of silt loam and silty clay loam; strongly effervescent; moderately alkaline.

The solum is 7 to 10 inches thick. The depth to clayey material ranges from 18 to 30 inches.

The A horizon is typically silt loam, but silty clay loam is within the range. This horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. The 2C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 1 or 2. It is silty clay or clay.

Nodaway Series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. Slopes range from 0 to 2 percent.

Nodaway soils are commonly adjacent to Colo, Dockery, and Zook soils on flood plains. Colo and Zook soils are poorly drained and are in the lower areas. They have a mollic epipedon. Dockery soils are somewhat poorly drained and are farther from the stream channels than the Nodaway soils. They are mottled in the upper part.

Typical pedon of Nodaway silt loam, about 2,850 feet east and 100 feet south of the northwest corner of sec. 3, T. 56 N., R. 34 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

C—8 to 43 inches; stratified dark grayish brown (10YR 4/2), very dark gray (10YR 3/1), and brown (10YR 5/3) silt loam; few fine distinct dark yellowish brown (10YR 4/4) and light brownish gray (10YR 6/2) mottles; massive; friable; few thin strata of fine sandy loam; neutral; clear smooth boundary.

Ab—43 to 60 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; firm; neutral.

The depth to the Ab horizon ranges from 40 to more than 60 inches. The Ap or A horizon has value of 2 or 3 and chroma of 1 to 3. The Ab horizon has value of 2 or 3 and chroma of 1 or 2.

Olmitz Series

The Olmitz series consists of deep, moderately well drained, moderately permeable soils on foot slopes and alluvial fans. These soils formed in loamy alluvium. Slopes range from 3 to 9 percent.

Olmitz soils are commonly adjacent to Colo, Shelby, and Zook soils. Colo and Zook soils are poorly drained and are in low areas on flood plains. Shelby soils are on side slopes above the Olmitz soils. They have an A horizon that is thinner than that of the Olmitz soils.

Typical pedon of Olmitz loam, 3 to 9 percent slopes, about 1,050 feet north and 1,780 feet east of the southwest corner of sec. 27, T. 58 N., R. 34 W.

A1—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; many medium and fine roots; neutral; gradual smooth boundary.

A2—9 to 19 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; weak medium and fine subangular blocky structure; friable; common medium and fine roots; neutral; gradual smooth boundary.

A3—19 to 29 inches; very dark brown (10YR 2/2) clay loam, very dark grayish brown (10YR 3/2) kneaded, dark brown (10YR 3/3) dry; moderate medium and fine subangular blocky structure; friable; few medium and fine roots; neutral; gradual smooth boundary.

A4—29 to 35 inches; very dark grayish brown (10YR 3/2) clay loam, dark brown (10YR 3/3) kneaded, brown (10YR 5/3) dry; moderate medium subangular blocky structure; friable; few fine roots; slightly acid; gradual smooth boundary.

Bw1—35 to 42 inches; brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; firm; few fine roots; discontinuous very dark grayish brown (10YR 3/2) organic coatings on faces of peds; medium acid; gradual smooth boundary.

Bw2—42 to 56 inches; dark brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; firm; medium acid; gradual smooth boundary.

BC—56 to 60 inches; dark brown (10YR 4/3) clay loam; weak coarse subangular blocky structure; firm; slightly acid.

The solum ranges from 40 to more than 60 inches in thickness. The A horizon has value of 2 or 3 and chroma of 1 to 3. The Bw horizon has value of 4 or 5 and chroma of 3 or 4.

Onawa Series

The Onawa series consists of deep, somewhat poorly drained soils on flood plains along the Missouri River. These soils formed in calcareous, clayey alluvium over loamy alluvium. Permeability is slow in the upper part of the profile and moderately rapid in the lower part. Slopes are 0 to 1 percent.

Onawa soils are commonly adjacent to Albaton, Haynie, Modale, and Sarpy soils on the flood plains. Albaton soils are clayey throughout. They are in the slightly lower areas. The moderately well drained Haynie and excessively drained Sarpy soils are on rises. Modale soils are silty in the upper part and clayey in the lower part. They are in the slightly higher areas.

Typical pedon of Onawa silty clay, about 920 feet south and 2,500 feet east of the center of sec. 33, T. 57 N., R. 36 W.

Ap—0 to 8 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate medium angular blocky structure; firm; few fine roots; mildly alkaline; gradual smooth boundary.

Cg—8 to 24 inches; dark grayish brown (2.5Y 4/2) silty clay; few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; few fine roots; slightly effervescent; moderately alkaline; gradual smooth boundary.

2Cg—24 to 60 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; common medium prominent yellowish brown (10YR 5/8) and light brownish gray (10YR 6/2) mottles; appears massive but has distinct bedding planes; very friable; strongly effervescent; moderately alkaline.

The depth to loamy material ranges from 18 to 30 inches. The A horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is typically silty clay, but silty clay loam is within the range. The Cg and 2Cg horizons have hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. The Cg horizon is silty clay or clay. The 2Cg horizon is silt loam or very fine sandy loam.

Percival Series

The Percival series consists of deep, somewhat poorly drained soils on flood plains along the Missouri River. These soils formed in clayey alluvium over sandy alluvium. Permeability is slow in the upper part of the profile and rapid in the lower part. Slopes are 0 to 1 percent.

Percival soils are commonly adjacent to Grable, Haynie, Onawa, and Sarpy soils. The well drained Grable, moderately well drained Haynie, and excessively drained Sarpy soils are in the slightly higher areas on the flood plains. Grable soils are loamy in the upper part, and Sarpy soils are sandy throughout. Onawa soils are not sandy in the lower part. They are in positions on the flood plains similar to those of the Percival soils or are in the slightly lower positions.

Typical pedon of Percival silty clay, about 1,640 feet north and 1,520 feet east of the southwest corner of sec. 13, T. 56 N., R. 37 W.

Ap—0 to 9 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; weak medium subangular blocky structure; firm; strongly effervescent; moderately alkaline; clear smooth boundary.

Cg1—9 to 15 inches; dark grayish brown (2.5Y 4/2) silty clay; few fine prominent dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; firm; strongly effervescent; moderately alkaline; clear wavy boundary.

Cg2—15 to 24 inches; stratified dark gray (5Y 4/1) and dark grayish brown (2.5Y 4/2) silty clay; common medium prominent dark brown (7.5YR 4/4) mottles; moderate medium angular blocky structure; firm; discontinuous very dark gray (5Y 3/1) coatings on faces of peds; strongly effervescent; moderately alkaline; clear wavy boundary.

2Cg—24 to 60 inches; dark grayish brown (2.5Y 4/2) fine sand; few fine prominent yellowish brown (10YR 5/6) mottles; single grain; loose; strongly effervescent; moderately alkaline.

The depth to the 2C horizon ranges from 15 to 28 inches. The A horizon has hue of 10YR or 2.5Y and chroma of 1 or 2. It is typically silty clay, but silty clay loam is within the range. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay or clay. The 2C horizon has value of 4 to 6. It is dominantly fine sand or loamy fine sand. In some pedons, however, it has lenses of silty clay loam or silt loam less than 6 inches thick.

Sarpy Series

The Sarpy series consists of deep, excessively drained, rapidly permeable soils on flood plains along the Missouri River. These soils formed in sandy alluvium. Slopes range from 1 to 4 percent.

Sarpy soils are commonly adjacent to Albaton, Haynie, and Onawa soils. The poorly drained Albaton and somewhat poorly drained Onawa soils are in the lower areas on the flood plains. Haynie soils have a lower content of fine sand and a higher content of silt in the 10- to 40-inch control section than the Sarpy soils. They are in the less undulating areas on the flood plains.

Typical pedon of Sarpy loamy fine sand, 1 to 4 percent slopes, about 2,200 feet south and 250 feet west of the center of sec. 3, T. 56 N., R. 36 W.

Ap—0 to 14 inches; dark brown (10YR 3/3) loamy fine sand, grayish brown (2.5Y 5/2) dry; weak coarse subangular blocky structure; very friable; common fine roots; slightly effervescent; mildly alkaline; abrupt smooth boundary.

C1—14 to 32 inches; dark grayish brown (2.5Y 4/2) loamy fine sand; single grain; loose; few fine roots in the upper part; strongly effervescent; mildly alkaline; clear smooth boundary.

C2—32 to 60 inches; grayish brown (2.5Y 5/2) loamy fine sand; single grain; loose; violently effervescent; mildly alkaline.

The A or Ap horizon has value of 3 or 4 and chroma of 2 or 3. It is typically loamy fine sand, but fine sandy loam and fine sand are within the range. The C horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4. It is loamy fine sand, loamy sand, or fine sand.

Sharpsburg Series

The Sharpsburg series consists of deep, moderately well drained soils on uplands. These soils formed in loess. Permeability is moderately slow. Slopes range from 2 to 14 percent.

These soils have a dark surface layer that is slightly thinner than is definitive for the Sharpsburg series. This difference, however, does not significantly affect the usefulness or behavior of the soils.

Sharpsburg soils are similar to Marshall soils and are commonly adjacent to Higginsville and Lamoni soils. Higginsville soils are grayer than the Sharpsburg soils and have less clay in the subsoil. They are in concave areas on the lower side slopes. Lamoni soils have more clay, sand, and pebbles in the subsoil than the Sharpsburg soils. They are on the lower side slopes. Marshall soils have less clay than the Sharpsburg soils and do not have an argillic horizon.

Typical pedon of Sharpsburg silt loam, 5 to 9 percent slopes, eroded, 2,600 feet north and 1,545 feet east of the southwest corner of sec. 32, T. 57 N., R. 33 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) silt loam, brown (10YR 5/3) dry; moderate fine granular structure; friable; thin continuous very dark gray (10YR 3/1) organic coatings on faces of peds; slightly acid; abrupt smooth boundary.

Bt1—7 to 13 inches; brown (10YR 4/3) silty clay loam; moderate medium subangular blocky structure; firm; few distinct dark brown (10YR 3/3) clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—13 to 19 inches; yellowish brown (10YR 5/4) silty clay loam; moderate medium subangular blocky structure; firm; few distinct brown (10YR 4/3) clay films on faces of peds; strongly acid; gradual smooth boundary.

Bt3—19 to 28 inches; yellowish brown (10YR 5/4) silty clay loam; few fine prominent grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; firm; few distinct brown (10YR 4/3) clay films on faces of peds; medium acid; gradual smooth boundary.

Bt4—28 to 35 inches; yellowish brown (10YR 5/4) silty clay loam; few fine prominent strong brown (7.5YR 5/6) and few medium prominent grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; firm; few distinct brown (10YR 4/3) clay films on faces of peds; common black (10YR 2/1) manganese accumulations; medium acid; clear smooth boundary.

BC—35 to 47 inches; yellowish brown (10YR 5/4) silty clay loam; few fine prominent strong brown (7.5YR 5/6) and common medium prominent grayish brown (2.5Y 5/2) mottles; moderate coarse subangular blocky structure; friable; common black (10YR 2/1) manganese accumulations; medium acid; clear smooth boundary.

C—47 to 60 inches; brown (10YR 4/3) silty clay loam; common medium prominent strong brown (7.5YR 5/6) and many medium prominent light brownish gray (2.5Y 6/2) mottles; massive; friable; few black (10YR 2/1) manganese accumulations; slightly acid.

The solum ranges from 45 to more than 60 inches in thickness. The dark surface layer is 7 to 12 inches thick. It has value of 2 or 3 and chroma of 1 to 3. The C horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 2 to 6. It is silty clay loam or silt loam.

Shelby Series

The Shelby series consists of deep, well drained soils on uplands. These soils formed in glacial till. Permeability is moderately slow. Slopes range from 9 to 14 percent.

These soils have a dark surface layer that is slightly thinner than is definitive for the Shelby series. This difference, however, does not significantly affect the usefulness or behavior of the soils.

Shelby soils are commonly adjacent to Colo, Lamoni, Olmitz, and Sharpsburg soils. Colo soils are poorly drained and are in narrow drainageways. Lamoni soils have more clay in the B horizon than the Shelby soils and are grayer in the upper part. They are on the higher parts of side slopes. Olmitz soils have a thick mollic epipedon. They are on foot slopes and alluvial fans below the Shelby soils. Sharpsburg soils formed in loess on ridgetops above the Shelby soils.

Typical pedon of Shelby loam, 9 to 14 percent slopes, eroded, 620 feet south and 675 feet east of the northwest corner of sec. 28, T. 57 N., R. 33 W.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; thin continuous black (10YR 2/1) organic coatings on faces of peds; neutral; abrupt smooth boundary.

BA—7 to 11 inches; brown (10YR 4/3) clay loam; weak fine subangular blocky structure parting to moderate fine granular; friable; thin discontinuous black (10YR 2/1) organic coatings on faces of peds; neutral; clear smooth boundary.

Bt1—11 to 16 inches; brown (10YR 4/3) clay loam; moderate fine and medium subangular blocky structure; friable; few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; slightly acid; clear smooth boundary.

Bt2—16 to 24 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine and medium subangular blocky structure; firm; few distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt3—24 to 30 inches; dark yellowish brown (10YR 4/4) clay loam; few fine prominent yellowish brown (10YR 5/6) and light brownish gray (2.5Y 6/2) mottles; moderate fine and medium subangular blocky structure; firm; few distinct clay films on faces of peds; few fine manganese accumulations; medium acid; clear smooth boundary.

Bt4—30 to 36 inches; brown (10YR 5/3) clay loam; common fine prominent yellowish brown (10YR 5/6 and 5/8) and light brownish gray (2.5Y 6/2) mottles; moderate medium subangular blocky structure; firm; few faint clay films along root channels; few fine manganese accumulations; slightly acid; clear smooth boundary.

C1—36 to 43 inches; yellowish brown (10YR 5/4) clay loam; common medium prominent strong brown (7.5YR 5/6) and light brownish gray (2.5Y 6/2) mottles; weak medium subangular blocky structure; firm; few fine manganese accumulations; strongly effervescent; moderately alkaline; gradual smooth boundary.

C2—43 to 60 inches; mottled light gray (10YR 6/1), brownish yellow (10YR 6/6), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6) clay loam; massive with vertical cleavage planes; firm; common fine accumulations of manganese and calcium carbonate; strongly effervescent; moderately alkaline.

The solum ranges from 35 to 50 inches in thickness. The depth to carbonates ranges from 36 to 44 inches. The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is typically loam, but clay loam is within the range. The Bt horizon has value of 4 or 5 and chroma of 3 or 4.

Sibley Series

The Sibley series consists of deep, well drained, moderately permeable soils on uplands. These soils formed in loess. Slopes range from 1 to 5 percent.

Sibley soils are similar to Judson, Marshall, and Wiota soils and are commonly adjacent to Colo, Higginsville, and Marshall soils. Colo soils are poorly drained and are on flood plains. Higginsville soils are somewhat poorly drained and are in concave areas on side slopes. Higginsville and Marshall soils have a mollic epipedon that is thinner than that of the Sibley soils. Judson and Marshall soils do not have an argillic horizon. Wiota soils have more sand in the lower part than the Sibley soils.

Typical pedon of Sibley silt loam, 1 to 5 percent slopes, 1,100 feet north and 1,500 feet east of the southwest corner of sec. 35, T. 55 N., R. 34 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.

A—8 to 28 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; slightly acid; clear smooth boundary.

Bt1—28 to 36 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium subangular blocky structure; friable; few distinct discontinuous very dark gray (10YR 3/1) clay films on faces of peds; slightly acid; abrupt smooth boundary.

Bt2—36 to 48 inches; brown (10YR 5/3) silty clay loam; few fine distinct light brownish gray (10YR 6/2) and few fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; few distinct discontinuous very dark gray (10YR 3/1) clay films on faces of peds; neutral; clear smooth boundary.

C—48 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; common medium distinct light brownish gray (10YR 6/2) and common medium prominent strong brown (7.5YR 5/6) mottles; massive; friable; neutral.

The solum ranges from 46 to more than 60 inches in thickness. The A horizon has value and chroma of 2 or 3. The Bt horizon has value of 3 to 5 and chroma of 3 or 4.

Wabash Series

The Wabash series consists of deep, very poorly drained, very slowly permeable soils on flood plains. These soils formed in clayey alluvium. Slopes are 0 to 1 percent.

Wabash soils are similar to Zook soils and are commonly adjacent to Colo and Zook soils. The adjacent soils are poorly drained and have less clay than the Wabash soils. Colo soils are in the slightly higher areas on the flood plains.

Typical pedon of Wabash silty clay, about 600 feet north and 275 feet east of the center of sec. 8, T. 57 N., R. 34 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; firm; slightly acid; clear smooth boundary.

A1—8 to 22 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

A2—22 to 40 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; few fine distinct dark yellowish brown (10YR 4/6) mottles; moderate fine subangular blocky structure; firm; neutral; gradual smooth boundary.

Bg1—40 to 50 inches; very dark grayish brown (2.5Y 3/2) silty clay, gray (10YR 5/1) dry; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; mildly alkaline; gradual smooth boundary.

Bg2—50 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark grayish brown (2.5Y 3/2) organic coatings on faces of peds; mildly alkaline.

The solum ranges from 38 to more than 60 inches in thickness. It has value of 3 or less to a depth of 38 to 50 inches.

The A horizon has hue of 10YR to 5Y, value of 2 or 3, and chroma of 2 or less. It is typically silty clay, but silty clay loam is within the range. The lower part of the Bg horizon and the Cg horizon have hue of 10YR to 5Y, value of 4 or 5, and chroma of 1 or 2.

Waldron Series

The Waldron series consists of deep, somewhat poorly drained, slowly permeable soils on flood plains along the Missouri River. These soils formed in calcareous alluvium. Slopes range from 0 to 2 percent.

Waldron soils are commonly adjacent to Haynie, Kenmoor, Modale, and Onawa soils. Haynie and Kenmoor soils are in the higher areas on the flood plains. They have a subsoil that is browner than that of the Waldron soils. Also, Haynie soils contain more sand and less clay in the solum, and Kenmoor soils have more sand and less clay in the upper part. Modale soils are silty in the upper part. They are in the slightly higher areas. Onawa soils have more sand in the lower part than the Waldron soils. They do not have a mollic epipedon. They are in landscape positions similar to those of the Waldron soils.

Typical pedon of Waldron silty clay loam, about 3,180 feet north and 200 feet west of the southeast corner of sec. 3, T. 57 N., R. 36 W.

Ap—0 to 7 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate fine subangular blocky structure; firm; very slightly effervescent; mildly alkaline; clear smooth boundary.

C1—7 to 12 inches; very dark grayish brown (10YR 3/2) silty clay, brown (10YR 5/3) dry; moderate fine angular blocky structure; firm; few thin strata of very fine sandy loam; slightly effervescent; mildly alkaline; clear wavy boundary.

C2—12 to 28 inches; dark grayish brown (2.5Y 4/2) silty clay; few fine prominent dark brown (7.5YR 4/4) mottles; moderate fine angular blocky structure; firm; many thin strata of silt loam and very fine sandy loam; slightly effervescent; mildly alkaline; clear wavy boundary.

C3—28 to 41 inches; grayish brown (2.5Y 5/2) silty clay; few fine prominent dark brown (7.5YR 4/4) mottles; moderate fine angular blocky structure; firm; many thin strata of silt loam and very fine sandy loam; slightly effervescent; mildly alkaline; clear wavy boundary.

C4—41 to 45 inches; dark grayish brown (2.5Y 4/2) very fine sandy loam; massive; friable; slightly effervescent; mildly alkaline; clear wavy boundary.
C5—45 to 60 inches; dark grayish brown (10YR 4/2) silty clay loam; massive; firm; slightly effervescent; mildly alkaline.

The Ap horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1 to 3. It is typically silty clay loam, but silty clay is within the range. The C horizon has hue of 10YR or 2.5Y, value of 3 to 5, and chroma of 2 to 4 and has mottles with higher chroma or redder hue. In most pedons it has strata of loamy material less than 4 inches thick.

Wiota Series

The Wiota series consists of deep, well drained, moderately permeable soils on stream terraces. These soils formed in silty alluvium. Slopes range from 1 to 3 percent.

Wiota soils are similar to Judson, Marshall, and Sibley soils and are commonly adjacent to Colo, Kennebec, and Zook soils. The adjacent soils have a mollic epipedon that is thicker than that of the Wiota soils. Colo and Zook soils are poorly drained and are on flood plains. Kennebec soils are on the narrower flood plains and on alluvial fans. Judson and Marshall soils do not have an argillic horizon. Sibley soils have less sand in the lower part than the Wiota soils.

Typical pedon of Wiota silt loam, 1 to 3 percent slopes, about 1,000 feet north and 2,000 feet west of the center of sec. 31, T. 56 N., R. 35 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.
A—8 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate medium angular and subangular blocky structure; friable; thin continuous very dark brown (10YR 2/2) organic coatings on faces of peds; slightly acid; clear smooth boundary.
BA—20 to 25 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; moderate medium and fine subangular blocky structure; friable; thin discontinuous very dark brown (10YR 2/2) organic coatings on faces of peds; slightly acid; abrupt smooth boundary.
Bt1—25 to 36 inches; brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; weak fine prismatic structure parting to moderate medium subangular blocky; friable; few distinct dark brown (10YR 3/3) clay films on faces of peds; slightly acid; gradual smooth boundary.
Bt2—36 to 46 inches; brown (10YR 4/3) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; few distinct dark brown (10YR 3/3) clay films on faces of peds; slightly acid; gradual smooth boundary.
C—46 to 60 inches; brown (10YR 4/3) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; neutral.

The solum ranges from 38 to 60 inches in thickness. The A horizon has value of 2 or 3 and chroma of 1 or 2. It is typically silt loam, but silty clay loam is within the range. The Bt and C horizons have value of 4 or 5 and chroma of 3 or 4. The C horizon is silt loam or silty clay loam.

Zook Series

The Zook series consists of deep, poorly drained, slowly permeable soils on flood plains. These soils formed in silty and clayey alluvium. Slopes range from 0 to 2 percent.

Zook soils are similar to Wabash soils and are commonly adjacent to Colo, Judson, and Nodaway soils. Colo soils have less clay than the Zook soils. They are in the slightly higher areas on the flood plains. Judson soils have a subsoil that is browner than that of the Zook soils. Also, they have less clay in the lower part. They are on foot slopes and alluvial fans adjacent to the uplands. Nodaway soils are stratified and have less clay throughout than the Zook soils. They are in the higher areas adjacent to streams. Wabash soils have more clay than the Zook soils.

Typical pedon of Zook silty clay loam, about 2,390 feet south and 2,850 feet east of the northwest corner of sec. 6, T. 57 N., R. 34 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; thin continuous black (10YR 2/1) organic coatings on faces of peds; neutral; clear smooth boundary.
A1—8 to 22 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; thin continuous black (N 2/0) organic coatings on faces of peds; neutral; gradual smooth boundary.
A2—22 to 36 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; few fine prominent brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; thin continuous black (N 2/0) organic coatings on faces of peds; slightly acid; gradual smooth boundary.
AB—36 to 44 inches; very dark gray (5Y 3/1) silty clay; few fine prominent brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; thin

discontinuous black (10YR 2/1) organic coatings on faces of peds; slightly acid; gradual smooth boundary.

Bg—44 to 60 inches; dark gray (5Y 4/1) silty clay; common fine prominent brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; thin discontinuous very dark gray (10YR 3/1) organic coatings on faces of peds; slightly acid.

The A horizon has hue of 10YR or is neutral in hue. It has value of 2 or 3 and chroma of 2 or less. It is typically silty clay loam, but silty clay and clay are within the range. The Bg horizon is silty clay loam or silty clay.

Factors of Soil Formation

Soil forms through processes that act on accumulated or deposited geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material has accumulated and existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time that the forces of soil formation have acted on the soil material. Human activities also affect soil formation.

Climate and plant and animal life are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of soil profile that forms and in extreme cases determines it almost entirely. Finally, time is needed for the transformation of the parent material into a soil that has distinct horizons. Some time is always required for the differentiation of soil horizons. Generally, a long time is required for the formation of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made about the effect of any one factor unless conditions are specified for the others.

Plants and Animals

Plants, burrowing animals, insects, bacteria, and fungi are important in the formation of soils. They affect the content of organic matter and plant nutrients, structure, and porosity of the soils.

Many of the soils in Buchanan County formed when the vegetation was mainly tall prairie grasses. These soils have a thick, dark surface layer that has a high content of organic matter because of abundant bacteria and decayed fine grass roots. Examples of soils that formed under this kind of plant cover are Higginsville, Lamoni, Marshall, Shelby, and Sibley soils. The dark surface layer in Gosport and other soils that formed under forest vegetation is thin.

Armster, Armstrong, and Knox soils have been affected by both grasses and trees. They have properties intermediate between those of soils that formed under grasses and those of soils that formed under trees.

Worms, insects, burrowing animals, and large animals affect the soils in various ways. The effects of bacteria and fungi, however, are greater than those of animals. Bacteria and fungi facilitate the decomposition of organic material, improve tilth, and fix nitrogen in the soils. The population of soil organisms is directly related to the rate at which organic material decomposes in the soils. The kinds of organisms in a given area and their activity are determined by in the kind of vegetation in that area.

Human activities have greatly affected the soils in the county. Because of intensive cultivation and poor grazing management, erosion has been severe on many of the soils. As much as 15 inches of topsoil has been lost from these soils. In many areas the soils are still eroding at an excessive rate. The rate is so excessive that productivity cannot be sustained for a long period.

Climate

Climate has been an important factor in the formation of the soils in Buchanan County. In the past 1 million years, variations in the climate have greatly affected soil formation.

Buchanan County has a subhumid, midcontinental climate that has changed little from 6,500 years ago to the present. This period has been drier than previous ones and has favored native prairie grasses. Most of the soils have a thick, dark surface layer, which indicates that they formed under prairie vegetation. Marshall and Sharpsburg soils are examples.

The period between 6,500 and 20,000 years ago was cool and moist. The climate favored forest vegetation. This vegetation remains only in some areas near streams and on the bluffs along the Missouri River.

Changes in climate caused the glacial periods. Thousands of years of cool temperatures resulted in the massive glaciers of the Nebraskan and Kansan ages. Warmer temperatures subsequently resulted in severe geologic erosion and the blowing of the loess that covered Buchanan County at one time. Extreme changes in climate occurred very slowly; therefore, there were long intermediate periods when different types of vegetation grew. Soils formed on the surface and were later covered by loess, truncated, and mixed by erosion or completely washed away. Some soils formed mainly in the old truncated or weathered areas. Examples are Armstrong and Lamoni soils.

The prevailing winds at the time the loess was deposited were from a westerly direction (*11*). Most of the loess, therefore, was blown in an easterly direction, probably from the flood plains along the Missouri River and other large streams. The distance that loess is carried by the wind depends on the size of the particles. The coarser particles remain closer to the source. Therefore, the soil particles tend to be coarser in the western part of Buchanan County than in the eastern part.

Local conditions can modify the influence of the general climate in a region. For example, south-facing slopes are warmer and drier than north-facing slopes, and low lying, poorly drained soils on bottom land stay wet and cool longer than the soils in the surrounding areas. These local conditions account for some of the differences among the soils in the county.

Parent Material

Parent material is the unconsolidated mass in which a soil forms. It determines the limits of the chemical and mineral composition of the soil. The soils in Buchanan County formed in loess, glacial till, alluvium, and residuum.

Loess is wind-deposited, silty and clayey material. It probably was blown in from large flood plains. It covers most of the ridgetops and upper side slopes in the county and is as much as 100 feet thick in some areas. Higginsville, Knox, Marshall, Sharpsburg, and Sibley soils formed in loess.

Prior to the deposition of loess, thick layers of glacial till were deposited over the bedrock. This till generally is yellowish brown. It is a heterogeneous mass of sand, silt, and clay that has rocks ranging in size from small pebbles to boulders. The till is a few feet to more than 100 feet thick. In some areas a soil formed in the till before the loess was deposited. Armstrong and Lamoni, for example, formed in a thin mantle of loess and in the underlying paleosol. In the steeper areas, the unweathered glacial material was exposed by geological erosion. Shelby soils formed in this material.

Alluvium is soil material that was transported by water and deposited on the nearly level flood plains along rivers and streams. Some soils formed in local alluvium, which has been transported only a short distance. Colo, Nodaway, and Zook soils are examples. Other soils, particularly those on the flood plains along the Missouri River, formed in alluvium that has been transported great distances. Haynie, Onawa, and Waldron soils are examples.

The residuum in Buchanan County is material that weathered from shale and limestone. The limestone layers generally are thinner than the shale layers and are above the shale. Gasconade and Gosport soils formed in residual material.

Relief

Relief influences soil formation mainly through its effect on drainage, runoff, and erosion. The amount of water entering and passing through the soil depends on the slope, the permeability of the soil material, and the amount and intensity of rainfall. Because runoff is rapid on steep soils, very little water passes through the soil material. As a result, these soils show little evidence of profile development. Runoff is slow on gently sloping and nearly level soils, and much of the water passes through the soil material. These soils have distinct horizons. Rapidly permeable soils form more slowly than slowly permeable soils in similar landscape positions.

Because they receive more direct sunrays, the soils on steep, south-facing slopes are more droughty than the soils that formed in similar material on north-facing slopes. Droughtiness influences soil formation through its effects on the amount and kind of vegetation, on erosion, and on freezing and thawing.

Time

The degree of profile development reflects the length of time that the parent material has been subject to weathering. Young soils show little evidence of profile development, or horizon differentiation. Old soils show the effects of the downward movement of clay and leaching and have distinct horizons.

The youngest soils in Buchanan County are those that formed in alluvium. Nodaway soils show no evidence of profile development because alluvial material is added to the surface nearly every year. Shelby soils formed on dissected slopes of the Late Wisconsin age, probably 11,000 to 14,000 years ago (*11*). Knox, Marshall, Sharpsburg, and Sibley soils formed in loess of the Early Wisconsin age, probably 14,000 to 16,000 years ago. The oldest soils in the county are Armstrong soils, which formed in weathered material of the Late Sangamon age, about 38,000 years ago, and Lamoni soils, which formed in material of the Yarmouth interglacial period, more than 150,000 years ago (*10*).

In some areas of the county, rocky residual material has been exposed by geologic erosion. This material is very old, but the soils in these areas show little evidence of profile development because they are steep and very steep and are shallow. The shallow Gasconade soils formed in this material.

References

(1) American Association of State Highway and Transportation Officials. 1982. Standard specifications for highway materials and methods of sampling and testing. Ed. 13, 2 vols., illus.

(2) American Society for Testing and Materials. 1985. Standard test method for classification of soils for engineering purposes. ASTM Stand. D 2487.

(3) Department of Regional and Community Affairs of the University of Missouri at Columbia. 1973. A-B-C-D regional profile. 82 pp., illus.

(4) Essex, Burton L. 1974. Forest area in Missouri counties, 1972. U.S. Dep. Agric., Forest Serv. Res. Note NC-182, 4 pp.

(5) Missouri Crop and Livestock Reporting Service. 1982. Missouri farm facts. Missouri Dep. Agric., 62 pp., illus.

(6) Missouri Department of Natural Resources, Division of Parks and Recreation. 1976. Missouri statewide comprehensive outdoor recreation plan.

(7) Missouri State Soil and Water Conservation Needs Inventory Committee. 1970. Missouri soil and water conservation needs inventory. 196 pp., illus.

(8) Nagel, Werner, ed. and comp. 1970. Conservation contrasts. Missouri Dep. of Conserv., 453 pp., illus.

(9) National Association of Conservation Districts. NACD nationwide outdoor recreation inventory—Missouri. Unpublished data assembled in 1974; available in field offices of the Soil Conservation Service.

(10) Ruhe, Robert V. 1969. Quaternary landscapes in Iowa. Iowa State Univ. Press, 255 pp., illus.

(11) Ruhe, Robert V., R.B. Daniels, and J.G. Cady. 1967. Landscape evolution and soil formation in southwestern Iowa. U.S. Dep. Agric. Tech. Bull. 1349, 242 pp., illus.

(12) St. Joseph Steam Printing Company. 1881. History of Buchanan County. 1,073 pp., illus. (Reprinted by Seward W. Lilly in 1973)

(13) State Interagency Council for Outdoor Recreation. 1980. Missouri statewide comprehensive outdoor recreation plan. 127 pp., illus.

(14) Tillman, B.W., and C.E. Deardorff. 1917. Soil survey of Buchanan County, Missouri. U.S. Dep. Agric., Bur of Soils, 46 pp., illus.

(15) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(16) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(17) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(18) United States Department of Commerce, Bureau of the Census. 1976. 1976 census of agriculture. AG 74-P-29-183, Vol. 1, Part 25, Book 2.

Glossary

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

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

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.

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

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—

	Inches
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 planes. Fine stratifications, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediments.

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

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.

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

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.

Chiseling. Tillage with an implement having one or more soil-penetrating points that shatter or loosen hard compacted layers to a depth below normal plow depth.

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.

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.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

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.

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 constructing terraces, diversions, and other water-control measures 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.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

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.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

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.

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.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically 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.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes 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.

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, and 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 drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

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.

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.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

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.

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.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

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 capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

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.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—

Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.

Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.

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

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

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 soil surface through pipes or nozzles from a pressure system.

Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.

Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

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.

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.

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

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

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

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

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

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

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Paleosol. A soil that formed on a landscape of the past and that has distinctive morphological features resulting from a soil-forming environment that no longer exists at the site.

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.

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

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

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

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.

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 degree of acidity or alkalinity is expressed as—

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

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

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.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

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.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts 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-size particles.

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.

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.

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.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Slow intake (in tables). The slow movement of water into the soil.

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 of separates recognized in the United States are as follows:

	Millimeters
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 underlying material. 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 sediment 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 wind 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 grain* (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 wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

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.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

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.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

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.

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

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

(Recorded in the period 1952-79 at St. Joseph, Missouri)

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	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	Units	In	In	In		In
January----	34.5	14.7	24.6	62	-14	0	0.98	0.25	1.55	3	5.9
February---	41.6	20.9	31.3	70	-7	16	.97	.29	1.50	3	4.2
March------	52.2	30.3	41.3	83	3	66	2.28	.77	3.52	5	4.9
April------	66.5	43.1	54.8	90	22	188	3.09	1.76	4.27	6	.6
May--------	76.3	53.7	65.0	92	33	470	4.64	2.55	6.47	7	.0
June-------	85.5	63.3	74.4	99	46	732	4.89	2.54	6.94	8	.0
July-------	89.4	67.3	78.4	102	50	880	3.83	1.16	5.98	6	.0
August-----	87.2	64.7	76.0	100	48	806	3.89	1.63	5.80	6	.0
September--	79.7	55.9	67.8	96	36	534	4.11	1.47	6.29	6	.0
October----	69.8	44.2	57.0	91	24	253	2.68	.53	4.38	5	.0
November---	53.1	31.7	42.4	78	10	23	1.66	.24	2.72	3	.6
December---	40.4	21.7	31.1	66	-6	0	1.04	.35	1.60	3	4.3
Yearly:											
Average--	64.7	42.6	53.7	---	---	---	---	---	---	---	---
Extreme--	---	---	---	102	-15	---	---	---	---	---	---
Total----	---	---	---	---	---	3,968	34.06	26.09	41.53	61	20.5

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50 degrees F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1952-79 at St. Joseph, Missouri)

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. 10	Apr. 21	May 4
2 years in 10 later than--	Apr. 5	Apr. 16	Apr. 29
5 years in 10 later than--	Mar. 25	Apr. 6	Apr. 19
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 23	Oct. 12	Sept. 30
2 years in 10 earlier than--	Oct. 28	Oct. 17	Oct. 5
5 years in 10 earlier than--	Nov. 6	Oct. 27	Oct. 16

TABLE 3.--GROWING SEASON

(Recorded in the period 1952-79 at St. Joseph, Missouri)

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	203	181	157
8 years in 10	211	189	165
5 years in 10	226	204	179
2 years in 10	242	219	193
1 year in 10	250	227	201

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

Map symbol	Soil name	Acres	Percent
1B	Marshall silt loam, 2 to 5 percent slopes	1,150	0.4
1B2	Marshall silt loam, 2 to 5 percent slopes, eroded	1,250	0.5
1C	Marshall silt loam, 5 to 9 percent slopes	1,850	0.7
1C2	Marshall silt loam, 5 to 9 percent slopes, eroded	18,350	7.0
1D2	Marshall silt loam, 9 to 14 percent slopes, eroded	21,000	8.0
2D	Contrary silt loam, 9 to 14 percent slopes	16,450	6.3
3C2	Higginsville silty clay loam, 5 to 9 percent slopes, eroded	800	0.3
3D2	Higginsville silty clay loam, 9 to 14 percent slopes, eroded	7,550	2.9
4C	Knox silt loam, 5 to 9 percent slopes	1,250	0.5
4C2	Knox silt loam, 5 to 9 percent slopes, eroded	7,700	2.9
4D2	Knox silt loam, 9 to 14 percent slopes, eroded	17,600	6.7
4D3	Knox silty clay loam, 9 to 14 percent slopes, severely eroded	3,550	1.4
4E3	Knox silty clay loam, 14 to 20 percent slopes, severely eroded	14,750	5.6
4F	Knox silt loam, 20 to 35 percent slopes	6,350	2.4
7B2	Sharpsburg silt loam, 2 to 5 percent slopes, eroded	310	0.1
7C2	Sharpsburg silt loam, 5 to 9 percent slopes, eroded	3,500	1.3
7D2	Sharpsburg silty clay loam, 9 to 14 percent slopes, eroded	1,200	0.5
11B	Sibley silt loam, 1 to 5 percent slopes	570	0.2
21B	Judson-Colo complex, 1 to 5 percent slopes	5,000	1.9
22A	Wiota silt loam, 1 to 3 percent slopes	1,350	0.5
25F	Gosport silty clay loam, 15 to 45 percent slopes	4,950	1.9
29F	Gasconade flaggy silty clay loam, 20 to 40 percent slopes	6,050	2.3
31D	Armster silt loam, 9 to 14 percent slopes	1,600	0.6
33D2	Armstrong loam, 9 to 14 percent slopes, eroded	1,900	0.7
42C2	Lamoni silty clay loam, 5 to 9 percent slopes, eroded	350	0.1
42D2	Lamoni silty clay loam, 9 to 14 percent slopes, eroded	12,250	4.6
44D2	Shelby loam, 9 to 14 percent slopes, eroded	2,600	1.0
52	Kennebec silt loam	4,150	1.6
53B	Judson silt loam, 1 to 4 percent slopes	2,300	0.9
54C	Olmitz loam, 3 to 9 percent slopes	820	0.3
55	Colo silty clay loam	26,550	10.1
56	Zook silty clay loam	4,800	1.8
57	Wabash silty clay	810	0.3
58	Waldron silty clay loam	4,500	1.7
60	Colo silt loam, overwash	2,500	1.0
61	Nodaway silt loam	5,400	2.1
64B	Sarpy loamy fine sand, 1 to 4 percent slopes	1,350	0.5
66	Haynie silt loam	11,350	4.3
70	Modale silt loam	2,750	1.1
74	Percival silty clay	1,750	0.7
77	Dockery silty clay loam	2,750	1.1
79	Onawa silty clay	8,850	3.4
81	Albaton silty clay	1,270	0.5
83	Levasy silty clay loam	700	0.3
93	Grable very fine sandy loam	1,150	0.4
98	Udifluvents-Water complex	350	0.1
99	Pits, quarries	182	0.1
101	Kenmoor loamy fine sand	450	0.2
102	Haynie-Onawa complex	1,250	0.5
104E	Knox-Urban land complex, 9 to 20 percent slopes	500	0.2
104F	Knox-Urban land complex, 20 to 30 percent slopes	2,300	0.9
105C	Marshall-Urban land complex, 4 to 9 percent slopes	1,050	0.4
105E	Marshall-Urban land complex, 9 to 20 percent slopes	2,350	0.9
106A	Urban land, bottom land, 0 to 3 percent slopes	3,650	1.4
229F	Gosport-Gasconade complex, 20 to 45 percent slopes	3,300	1.3
	Water areas less than 40 acres in size	1,500	0.6
	Total land area	261,862	100.0
	Water areas more than 40 acres in size	3,392	
	Total area	265,254	

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
1B	Marshall silt loam, 2 to 5 percent slopes
1B2	Marshall silt loam, 2 to 5 percent slopes, eroded
7B2	Sharpsburg silt loam, 2 to 5 percent slopes, eroded
11B	Sibley silt loam, 1 to 5 percent slopes
21B	Judson-Colo complex, 1 to 5 percent slopes (where drained)
22A	Wiota silt loam, 1 to 3 percent slopes
52	Kennebec silt loam
53B	Judson silt loam, 1 to 4 percent slopes
55	Colo silty clay loam (where drained)
56	Zook silty clay loam (where drained and either protected from flooding or not frequently flooded during the growing season)
57	Wabash silty clay (where drained and either protected from flooding or not frequently flooded during the growing season)
58	Waldron silty clay loam (where drained)
60	Colo silt loam, overwash (where drained)
61	Nodaway silt loam (where protected from flooding or not frequently flooded during the growing season)
66	Haynie silt loam
70	Modale silt loam
74	Percival silty clay
77	Dockery silty clay loam
79	Onawa silty clay (where drained)
81	Albaton silty clay (where drained)
83	Levasy silty clay loam (where drained)
93	Grable very fine sandy loam
101	Kenmoor loamy fine sand
102	Haynie-Onawa complex (where the Onawa soil is drained)

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE

(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	Corn	Soybeans	Grain sorghum	Winter wheat	Orchard-grass-alfalfa hay	Smooth bromegrass	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
1B-------------- Marshall	IIe	130	45	115	50	6.3	9.3	3.8
1B2------------- Marshall	IIe	125	44	110	50	6.1	9.0	3.6
1C-------------- Marshall	IIIe	125	44	110	48	6.1	8.8	3.5
1C2------------- Marshall	IIIe	120	42	105	45	6.0	8.6	3.3
1D2------------- Marshall	IIIe	102	35	90	40	5.5	8.0	3.0
2D-------------- Contrary	IIIe	92	35	80	32	3.8	7.5	3.0
3C2------------- Higginsville	IIIe	103	39	89	43	4.6	9.0	3.8
3D2------------- Higginsville	IIIe	92	35	80	39	4.2	8.6	3.5
4C-------------- Knox	IIIe	103	39	75	36	4.0	8.0	3.3
4C2------------- Knox	IIIe	92	35	72	34	3.7	7.4	3.0
4D2------------- Knox	IIIe	80	30	60	30	3.2	6.4	3.0
4D3------------- Knox	IVe	75	22	50	30	2.8	6.0	2.8
4E3------------- Knox	VIe	---	---	---	---	2.6	5.4	2.5
4F-------------- Knox	VIe	---	---	---	---	---	6.0	2.8
7B2------------- Sharpsburg	IIe	120	40	110	50	6.3	9.0	4.1
7C2------------- Sharpsburg	IIIe	110	38	105	45	6.1	8.2	4.0
7D2------------- Sharpsburg	IIIe	95	35	89	40	5.7	8.0	3.8
11B------------- Sibley	IIe	130	45	115	50	4.8	9.6	3.6
21B------------- Judson-Colo	IIw	120	40	100	45	5.8	9.6	4.2

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchard-grass-alfalfa hay	Smooth bromegrass	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
22A------------- Wiota	I	130	45	115	50	6.8	9.7	4.2
25F------------- Gosport	VIIe	---	---	---	---	1.3	1.0	1.0
29F------------- Gasconade	VIIs	---	---	---	---	---	---	---
31D------------- Armster	IVe	65	21	55	28	2.7	5.4	1.7
33D2------------ Armstrong	IVe	60	22	50	25	2.7	5.0	1.7
42C2------------ Lamoni	IIIe	82	31	72	35	3.7	7.4	2.7
42D2------------ Lamoni	IVe	70	25	55	28	3.0	6.0	2.1
44D2------------ Shelby	IVe	95	35	85	40	4.8	7.2	3.3
52-------------- Kennebec	I	130	47	115	50	6.5	10.0	4.2
53B------------- Judson	IIe	125	45	112	50	6.7	10.0	4.2
54C------------- Olmitz	IIIe	110	40	90	45	5.5	9.2	3.7
55-------------- Colo	IIw	100	35	85	35	4.2	7.8	4.5
56-------------- Zook	IIIw	90	26	70	32	3.8	6.6	4.0
57-------------- Wabash	IIIw	65	32	65	30	2.0	5.5	2.5
58-------------- Waldron	IIw	92	35	80	38	3.8	7.6	4.0
60-------------- Colo	IIw	103	38	85	35	4.5	5.8	4.2
61-------------- Nodaway	IIIw	73	27	60	30	4.2	5.5	4.0
64B------------- Sarpy	IVs	---	20	39	20	2.3	4.0	---
66-------------- Haynie	I	126	42	95	46	5.3	9.8	3.7
70-------------- Modale	I	126	42	95	46	5.0	9.8	3.7

See footnotes at end of table.

TABLE 6.--LAND CAPABILITY CLASSES AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Grain sorghum	Winter wheat	Orchard-grass-alfalfa hay	Smooth bromegrass	Kentucky bluegrass
		Bu	Bu	Bu	Bu	Tons	AUM*	AUM*
74-------------- Percival	IIw	90	30	70	35	4.0	6.0	2.3
77-------------- Dockery	IIw	95	27	85	42	4.4	9.0	3.7
79-------------- Onawa	IIw	100	40	80	40	4.3	8.8	3.7
81-------------- Albaton	IIIw	80	30	65	30	3.3	6.6	3.3
83-------------- Levasy	IIIw	85	30	70	35	3.7	7.2	---
93-------------- Grable	IIs	103	35	90	40	4.3	6.7	2.7
98**. Udifluvents-Water								
99**. Pits								
101------------- Kenmoor	IIIs	75	30	65	30	3.0	6.0	---
102------------- Haynie-Onawa	IIw	110	40	105	42	4.8	5.6	3.7
104E**. Knox-Urban land								
104F**. Knox-Urban land								
105C**. Marshall-Urban land								
105E**. Marshall-Urban land								
106A**. Urban land								
229F------------ Gosport-Gasconade	VIIe	---	---	---	---	---	---	---

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.

** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--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	Equipment limitation	Seedling mortality	Windthrow hazard	Potential productivity: Common trees	Site index	Volume*	Trees to plant
4C, 4C2, 4D2, 4D3: Knox	3A	Slight	Slight	Slight	Slight	White oak	65	48	Eastern white pine, green ash, black walnut, yellow-poplar.
4E3, 4F: Knox	3R	Moderate	Moderate	Moderate	Slight	White oak	65	48	Eastern white pine, green ash, black walnut, yellow-poplar.
25F: Gosport	2R	Moderate	Moderate	Severe	Severe	White oak	45	30	Eastern white pine, Scotch pine, cottonwood.
29F: Gasconade	2R	Slight	Severe	Moderate	Moderate	Chinkapin oak	40	26	Eastern redcedar.
						Eastern redcedar	30	---	
						White ash	---	---	
						Sugar maple	---	---	
						Mockernut hickory	---	---	
						Post oak	---	---	
						Blackjack oak	---	---	
31D: Armster	4A	Slight	Slight	Slight	Slight	White oak	60	43	Pin oak, green ash, northern red oak, white oak, black oak.
						Northern red oak	---	---	
						Black oak	---	---	
33D2: Armstrong	3C	Slight	Slight	Severe	Severe	White oak	55	38	Pin oak, green ash, northern red oak, white oak, black oak.
						Northern red oak	55	38	
						Black oak	---	---	
57: Wabash	4W	Slight	Severe	Severe	Moderate	Pin oak	75	57	Pin oak, pecan, eastern cottonwood.
58: Waldron	4C	Slight	Moderate	Severe	Slight	Pin oak	80	62	Pin oak, pecan, eastern cottonwood, green ash, silver maple.
						Eastern cottonwood	110	---	

See footnotes at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity			Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Windthrow hazard	Common trees	Site index	Volume*	
61---------- Nodaway	4A	Slight	Slight	Slight	Slight	White oak----------	76	58	Eastern white pine, black walnut.
64B---------- Sarpy	8S	Slight	Slight	Severe	Slight	Eastern cottonwood-- Silver maple--------	95 90	116 41	Eastern cottonwood, American sycamore.
66---------- Haynie	11A	Slight	Slight	Slight	Slight	Eastern cottonwood-- American sycamore--- Black walnut-------- Green ash----------	110 110 --- ---	156 --- --- ---	Black walnut, eastern cottonwood.
77---------- Dockery	4A	Slight	Slight	Slight	Slight	Pin oak------------	76	58	Pin oak, pecan, eastern cottonwood.
83---------- Levasy	7W	Slight	Severe	Moderate	Moderate	Eastern cottonwood-- Silver maple-------- Black willow--------	90 85 ---	103 38 ---	Eastern cottonwood, pecan.
101---------- Kenmoor	4S	Slight	Slight	Moderate	Slight	Pin oak------------ Eastern cottonwood-- Green ash----------	75 85 60	57 --- 51	Eastern cottonwood, pin oak, green ash.
102**: Haynie---------	11A	Slight	Slight	Slight	Slight	Eastern cottonwood-- American sycamore--- Black walnut-------- Green ash----------	110 110 --- ---	156 --- --- ---	Black walnut, eastern cottonwood.
Onawa.									
229F**: Gosport--------	2R	Moderate	Moderate	Severe	Severe	White oak----------	45	30	Eastern white pine, white oak, northern red oak, black oak.
Gasconade------	2R	Slight	Severe	Moderate	Moderate	Chinkapin oak------- Eastern redcedar---- White ash---------- Sugar maple--------- Mockernut hickory--- Post oak----------- Blackjack oak-------	40 30 --- --- --- --- ---	26 --- --- --- --- --- ---	Eastern redcedar.

* Volume is the yield in cubic feet per acre 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 8.--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
1B, 1B2, 1C, 1C2, 1D2 Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
2D Contrary	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Eastern redcedar, bur oak, hackberry, green ash, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
3C2, 3D2 Higginsville	---	Amur honeysuckle, lilac, autumn-olive, Amur maple.	Eastern redcedar	Austrian pine, eastern white pine, honeylocust, hackberry, green ash, pin oak.	Eastern cottonwood.
4C, 4C2, 4D2, 4D3, 4E3, 4F Knox	---	Amur honeysuckle, autumn-olive, lilac, Amur maple.	Hackberry, eastern redcedar, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
7B2, 7C2, 7D2 Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, bur oak, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
11B Sibley	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, eastern redcedar, hackberry, bur oak, Russian-olive.	Eastern white pine, honeylocust, Austrian pine.	---
21B*:					
Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, bur oak, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
22A Wiota	---	Lilac, Amur honeysuckle, autumn-olive, Amur maple.	Eastern redcedar, hackberry, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---

See footnote at end of table.

TABLE 8.--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
25F: Gosport	Lilac	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn-olive.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian-olive.	Honeylocust	---
29F. Gasconade					
31D: Armster	---	Lilac, autumn-olive, Amur honeysuckle, Amur maple.	Eastern redcedar, hackberry, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
33D2: Armstrong	Lilac	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn-olive.	Austrian pine, eastern redcedar, green ash, jack pine, Russian-olive, hackberry.	Honeylocust	---
42C2, 42D2: Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
44D2: Shelby	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
52: Kennebec	---	Amur maple, autumn-olive, Amur honeysuckle, lilac.	Eastern redcedar	Eastern white pine, honeylocust, Austrian pine, pin oak, hackberry, green ash.	Eastern cottonwood.
53B: Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, bur oak, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
54C: Olmitz	---	Amur maple, lilac, autumn-olive, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---

See footnote at end of table.

TABLE 8.--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
55---------------- Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
56---------------- Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
57---------------- Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
58---------------- Waldron	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, Russian-olive, osageorange, Washington hawthorn.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.
60---------------- Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
61---------------- Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
64B--------------- Sarpy	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub, Washington hawthorn.	Eastern redcedar, Russian-olive, osageorange.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.
66---------------- Haynie	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--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
70---------------- Modale	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Osageorange, Russian-olive, eastern redcedar, Washington hawthorn.	Honeylocust, bur oak, green ash, hackberry.	Eastern cottonwood.
74---------------- Percival	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Honeylocust, green ash, bur oak, hackberry.	Eastern cottonwood.
77---------------- Dockery	---	Amur honeysuckle, lilac, autumn-olive, Amur maple.	Eastern redcedar, pin oak.	Austrian pine, eastern white pine, honeylocust, hackberry, green ash.	Eastern cottonwood.
79---------------- Onawa	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Osageorange, eastern redcedar, Russian-olive, Washington hawthorn.	Hackberry, bur oak, green ash, honeylocust.	Eastern cottonwood.
81---------------- Albaton	Blackhaw----------	Siberian peashrub, Tatarian honeysuckle.	Osageorange, Russian-olive, eastern redcedar, Washington hawthorn.	Hackberry, bur oak, honeylocust.	Eastern cottonwood, green ash.
83---------------- Levasy	---	American plum, common chokecherry.	White spruce, Manchurian crabapple, hackberry, eastern redcedar.	Russian mulberry, Austrian pine, green ash, golden willow, honeylocust.	Eastern cottonwood.
93---------------- Grable	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, Washington hawthorn, eastern redcedar.	Honeylocust, bur oak, green ash, hackberry.	Eastern cottonwood.
98*: Udifluvents.					
Water.					
99*. Pits					
101--------------- Kenmoor	Blackhaw----------	Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, osageorange, Russian-olive, Washington hawthorn.	Honeylocust, hackberry, green ash, bur oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 8.--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
102*:					
Haynie	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Russian-olive, osageorange, eastern redcedar, Washington hawthorn.	Green ash, hackberry, honeylocust, bur oak.	Eastern cottonwood.
Onawa	Blackhaw	Tatarian honeysuckle, Siberian peashrub.	Osageorange, eastern redcedar, Russian-olive, Washington hawthorn.	Hackberry, bur oak, green ash, honeylocust.	Eastern cottonwood.
104E*, 104F*:					
Knox	---	Amur honeysuckle, autumn-olive, lilac, Amur maple.	Hackberry, eastern redcedar, green ash, bur oak, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
Urban land.					
105C*, 105E*:					
Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, bur oak, green ash.	Austrian pine, eastern white pine, honeylocust.	---
Urban land.					
106A*. Urban land					
229F*:					
Gosport	Lilac	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn-olive.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian-olive.	Honeylocust	---
Gasconade.					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--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	Golf fairways
1B, 1B2-------------- Marshall	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
1C, 1C2-------------- Marshall	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
1D2------------------ Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
2D------------------- Contrary	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
3C2------------------ Higginsville	Moderate: wetness.	Moderate: wetness.	Severe: slope.	Moderate: wetness.	Moderate: wetness.
3D2------------------ Higginsville	Moderate: slope, wetness.	Moderate: slope, wetness.	Severe: slope.	Severe: erodes easily.	Moderate: wetness, slope.
4C, 4C2-------------- Knox	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
4D2, 4D3------------- Knox	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
4E3------------------ Knox	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
4F------------------- Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
7B2------------------ Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight----------	Slight.
7C2------------------ Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight----------	Slight.
7D2------------------ Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight----------	Moderate: slope.
11B------------------ Sibley	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
21B*:					
Judson---------------	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
Colo-----------------	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
22A------------------ Wiota	Severe: flooding.	Slight----------	Slight----------	Slight----------	Slight.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
25F Gosport	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, erodes easily.	Severe: slope.
29F Gasconade	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: large stones, slope, small stones.	Severe: slope.	Severe: large stones, slope, depth to rock.
31D Armster	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
33D2 Armstrong	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
42C2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
42D2 Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
44D2 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
52 Kennebec	Severe: flooding.	Slight	Slight	Slight	Slight.
53B Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
54C Olmitz	Slight	Slight	Severe: slope.	Slight	Slight.
55 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
56 Zook	Severe: wetness, flooding.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
57 Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness, flooding.	Severe: wetness, too clayey.	Severe: wetness, flooding, too clayey.
58 Waldron	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
60 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
61------------------- Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
64B------------------ Sarpy	Severe: flooding.	Slight----------	Moderate: slope.	Slight----------	Moderate: droughty.
66------------------- Haynie	Severe: flooding.	Slight----------	Slight----------	Slight----------	Slight.
70------------------- Modale	Severe: flooding, percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Moderate: wetness.	Moderate: wetness.
74------------------- Percival	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
77------------------- Dockery	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight----------	Moderate: flooding.
79------------------- Onawa	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too sandy.	Severe: too clayey.
81------------------- Albaton	Severe: flooding, wetness.	Severe: too clayey.	Severe: too clayey, wetness.	Severe: too clayey.	Severe: too clayey.
83------------------- Levasy	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
93------------------- Grable	Severe: flooding.	Slight----------	Slight----------	Slight----------	Slight.
98*:					
Udifluvents.					
Water.					
99*. Pits					
101------------------ Kenmoor	Severe: flooding.	Moderate: percs slowly.	Moderate: percs slowly.	Slight----------	Moderate: droughty.
102*:					
Haynie---------------	Severe: flooding.	Slight----------	Slight----------	Slight----------	Slight.
Onawa----------------	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too sandy.	Severe: too clayey.
104E*:					
Knox-----------------	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
Urban land.					

See footnote at end of table.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
104F*:					
Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Urban land.					
105C*:					
Marshall	Slight	Slight	Severe: slope.	Slight	Slight.
Urban land.					
105E*:					
Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Urban land.					
106A*. Urban land					
229F*:					
Gosport	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, erodes easily.	Severe: slope.
Gasconade	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: large stones, slope, small stones.	Severe: slope.	Severe: large stones, slope, depth to rock.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--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: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
1B, 1B2 Marshall	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
1C, 1C2, 1D2 Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
2D Contrary	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
3C2 Higginsville	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
3D2 Higginsville	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
4C, 4C2, 4D2, 4D3 Knox	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
4E3 Knox	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
4F Knox	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
7B2 Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
7C2, 7D2 Sharpsburg	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
11B Sibley	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
21B*:										
Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
22A Wiota	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
25F Gosport	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
29F Gasconade	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
31D Armster	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
33D2 Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Poor	Fair	Good	Very poor.
42C2, 42D2 Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.

See footnote at end of table.

TABLE 10.--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	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
44D2: Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
52: Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
53B: Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
54C: Olmitz	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
55: Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
56: Zook	Poor	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
57: Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Poor	Poor	Fair.
58: Waldron	Fair	Fair	Fair	Good	Good	Poor	Fair	Fair	Fair	Poor.
60: Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
61: Nodaway	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
64B: Sarpy	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
66: Haynie	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
70: Modale	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
74: Percival	Fair	Fair	Fair	Fair	Poor	Fair	Fair	Fair	Fair	Fair.
77: Dockery	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
79: Onawa	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
81: Albaton	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
83: Levasy	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
93: Grable	Good	Good	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.
98*: Udifluvents.										

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
98*: Water.										
99*. Pits										
101------ Kenmoor	Poor	Fair	Good	Good	Good	Poor	Fair	Fair	Good	Poor.
102*: Haynie------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Onawa------	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
104E*: Knox------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Urban land.										
104F*: Knox------	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Urban land.										
105C*, 105E*: Marshall------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Urban land.										
106A*. Urban land										
229F*: Gosport------	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Gasconade------	Very poor.	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--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	Lawns and landscaping
1B, 1B2----------- Marshall	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
1C, 1C2----------- Marshall	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
1D2--------------- Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
2D---------------- Contrary	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
3C2--------------- Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.	Moderate: wetness.
3D2--------------- Higginsville	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Severe: wetness.	Severe: slope.	Severe: low strength, frost action.	Moderate: wetness, slope.
4C, 4C2----------- Knox	Slight---------	Moderate: shrink-swell.	Slight---------	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
4D2, 4D3---------- Knox	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
4E3, 4F----------- Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
7B2--------------- Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
7C2--------------- Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
7D2--------------- Sharpsburg	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
11B--------------- Sibley	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
21B*:						
Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
22A Wiota	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
25F Gosport	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
29F Gasconade	Severe: depth to rock, large stones, slope.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: large stones, slope, depth to rock.
31D Armster	Moderate: too clayey, wetness, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: slope.
33D2 Armstrong	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, wetness, slope.	Severe: low strength, shrink-swell.	Moderate: slope, wetness.
42C2 Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, low strength.	Moderate: wetness.
42D2 Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
44D2 Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
52 Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
53B Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
54C Olmitz	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
55----------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
56----------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Severe: flooding.
57----------------- Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding, too clayey.
58----------------- Waldron	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
60----------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
61----------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Severe: flooding.
64B---------------- Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Moderate: droughty.
66----------------- Haynie	Slight-----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
70----------------- Modale	Severe: wetness.	Severe: flooding, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
74----------------- Percival	Severe: cutbanks cave, wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Moderate: wetness, flooding, frost action.	Severe: too clayey.
77----------------- Dockery	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
79----------------- Onawa	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Severe: too clayey.
81----------------- Albaton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, shrink-swell.	Severe: too clayey.

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
83----------------- Levasy	Severe: ponding.	Severe: flooding, ponding, shrink-swell.	Severe: flooding, ponding.	Severe: flooding, ponding, shrink-swell.	Severe: low strength, ponding.	Severe: ponding.
93----------------- Grable	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.	Slight.
98*: Udifluvents.						
Water.						
99*. Pits						
101---------------- Kenmoor	Moderate: too clayey, wetness.	Severe: flooding.	Severe: flooding, shrink-swell.	Severe: flooding.	Moderate: flooding, frost action.	Moderate: droughty.
102*: Haynie-----------	Slight----------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
Onawa------------	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Severe: too clayey.
104E*: Knox-------------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Urban land.						
104F*: Knox-------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
Urban land.						
105C*: Marshall---------	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
Urban land.						
105E*: Marshall---------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Urban land.						
106A*. Urban land						

See footnote at end of table.

TABLE 11.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
229F*:						
Gosport	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, shrink-swell.	Severe: slope.
Gasconade	Severe: depth to rock, large stones, slope.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: slope, depth to rock, large stones.	Severe: depth to rock, slope, large stones.	Severe: large stones, slope, depth to rock.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--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
1B, 1B2 Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
1C, 1C2 Marshall	Slight	Severe: slope.	Slight	Slight	Good.
1D2 Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
2D Contrary	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
3C2 Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness.	Fair: too clayey, wetness.
3D2 Higginsville	Severe: wetness.	Severe: slope, wetness.	Severe: wetness.	Moderate: wetness, slope.	Fair: too clayey, slope, wetness.
4C, 4C2 Knox	Slight	Severe: slope.	Slight	Slight	Good.
4D2, 4D3 Knox	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
4E3, 4F Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
7B2 Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
7C2 Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
7D2 Sharpsburg	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
11B Sibley	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Poor: hard to pack.
21B*:					
Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.

See footnote at end of table.

TABLE 12.--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
22A: Wiota	Moderate: flooding, percs slowly.	Moderate: seepage.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
25F: Gosport	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, hard to pack, slope.
29F: Gasconade	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: depth to rock, too clayey, large stones.
31D: Armster	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: too clayey.	Moderate: slope.	Poor: too clayey, hard to pack.
33D2: Armstrong	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
42C2, 42D2: Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
44D2: Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
52: Kennebec	Moderate: flooding, wetness, percs slowly.	Moderate: seepage.	Severe: wetness.	Moderate: flooding, wetness.	Good.
53B: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
54C: Olmitz	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
55: Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
56: Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
57: Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
58: Waldron	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.

See footnote at end of table.

TABLE 12.--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
60 Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
61 Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
64B Sarpy	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
66 Haynie	Moderate: flooding.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.
70 Modale	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
74 Percival	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness.	Severe: seepage, wetness.	Poor: seepage, too sandy.
77 Dockery	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
79 Onawa	Severe: wetness.	Severe: wetness, seepage.	Severe: seepage, wetness.	Severe: seepage, wetness.	Fair: wetness.
81 Albaton	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
83 Levasy	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.
93 Grable	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
98*:					
Udifluvents.					
Water.					
99*. Pits					
101 Kenmoor	Severe: wetness, percs slowly.	Severe: wetness, seepage.	Severe: too clayey.	Severe: seepage.	Poor: too clayey, hard to pack.
102*:					
Haynie	Moderate: flooding.	Moderate: seepage.	Moderate: flooding.	Moderate: flooding.	Good.

See footnote at end of table.

TABLE 12.--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
102*:					
Onawa	Severe: wetness.	Severe: wetness, seepage.	Severe: seepage, wetness.	Severe: seepage, wetness.	Fair: wetness.
104E*:					
Knox	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Urban land.					
104F*:					
Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Urban land.					
105C*:					
Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Urban land.					
105E*:					
Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Urban land.					
106A*. Urban land					
229F*:					
Gosport	Severe: depth to rock, percs slowly, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: depth to rock, hard to pack, slope.
Gasconade	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, large stones.	Severe: depth to rock, slope, too clayey.	Severe: depth to rock, slope.	Poor: depth to rock, too clayey, large stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--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
1B, 1B2, 1C, 1C2------ Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
1D2------------------ Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
2D------------------- Contrary	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
3C2------------------ Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
3D2------------------ Higginsville	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
4C, 4C2-------------- Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
4D2------------------ Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
4D3------------------ Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
4E3------------------ Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
4F------------------- Knox	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
7B2, 7C2, 7D2--------- Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
11B------------------ Sibley	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
21B*:				
Judson---------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Colo-----------------	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
22A------------------ Wiota	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
25F------------------ Gosport	Poor: depth to rock, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
29F: Gasconade	Poor: depth to rock, large stones, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: depth to rock, large stones.
31D: Armster	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
33D2: Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
42C2, 42D2: Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
44D2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer, slope.
52: Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
53B: Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
54C: Olmitz	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
55: Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
56: Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
57: Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
58: Waldron	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
60: Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
61: Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
64B: Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
66: Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
70: Modale	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: thin layer.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
74 Percival	Fair: wetness.	Probable	Improbable: too sandy.	Poor: too clayey.
77 Dockery	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
79 Onawa	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
81 Albaton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
83 Levasy	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
93 Grable	Good	Probable	Improbable: too sandy.	Fair: thin layer.
98*: Udifluvents.				
Water.				
99*. Pits				
101 Kenmoor	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
102*: Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Onawa	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
104E*: Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Urban land.				
104F*: Knox	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Urban land.				
105C*: Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Urban land.				
105E*: Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Urban land.				

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
106A*. Urban land				
229F*:				
Gosport	Poor: depth to rock, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
Gasconade	Poor: depth to rock, large stones, slope.	Improbable: excess fines, large stones.	Improbable: excess fines, large stones.	Poor: depth to rock, large stones.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

(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 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
1B, 1B2, 1C, 1C2-- Marshall	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
1D2--------------- Marshall	Severe: slope.	Slight---------	Deep to water	Slope----------	Erodes easily, slope.	Slope, erodes easily.
2D---------------- Contrary	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
3C2--------------- Higginsville	Moderate: seepage, slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Erodes easily, wetness.	Erodes easily.
3D2--------------- Higginsville	Severe: slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope, erodes easily.	Slope, erodes easily, wetness.	Slope, erodes easily.
4C, 4C2----------- Knox	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
4D2, 4D3, 4E3, 4F- Knox	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
7B2, 7C2---------- Sharpsburg	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
7D2--------------- Sharpsburg	Severe: slope.	Slight---------	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
11B--------------- Sibley	Moderate: seepage, slope.	Severe: hard to pack.	Deep to water	Slope----------	Favorable------	Favorable.
21B*:						
Judson-----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Colo-------------	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness--------	Wetness.
22A--------------- Wiota	Moderate: seepage.	Slight---------	Deep to water	Favorable------	Erodes easily	Erodes easily.
25F--------------- Gosport	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock, rooting depth.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
29F--------------- Gasconade	Severe: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, droughty.	Slope, large stones, depth to rock.	Large stones, slope, droughty.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
31D: Armster	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
33D2: Armstrong	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, percs slowly, wetness.	Percs slowly, slope, wetness.
42C2: Lamoni	Moderate: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Percs slowly, wetness.	Percs slowly, wetness.
42D2: Lamoni	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.
44D2: Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
52: Kennebec	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable	Favorable	Favorable.
53B: Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
54C: Olmitz	Moderate: seepage, slope.	Slight	Deep to water	Slope	Favorable	Favorable.
55: Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
56: Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed	Not needed.
57: Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
58: Waldron	Slight	Severe: hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
60: Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
61: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
64B: Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
66: Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
70: Modale	Moderate: seepage.	Severe: hard to pack, wetness.	Percs slowly, frost action.	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Erodes easily, percs slowly.

See footnote at end of table.

TABLE 14.--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
74----------------- Percival	Severe: seepage.	Severe: seepage, piping.	Percs slowly, cutbanks cave.	Wetness, droughty, slow intake.	Wetness, too sandy.	Droughty, percs slowly.
77----------------- Dockery	Moderate: seepage.	Moderate: piping, wetness.	Flooding, frost action.	Wetness, erodes easily, flooding.	Erodes easily, wetness.	Erodes easily.
79----------------- Onawa	Severe: seepage.	Severe: piping.	Frost action, percs slowly.	Wetness, slow intake, percs slowly.	Not needed-----	Not needed.
81----------------- Albaton	Slight---------	Severe: hard to pack, wetness.	Percs slowly---	Wetness, slow intake, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
83----------------- Levasy	Moderate: seepage.	Severe: piping, ponding.	Ponding, percs slowly.	Ponding, percs slowly.	Erodes easily, ponding.	Wetness, erodes easily, percs slowly.
93----------------- Grable	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable------	Erodes easily, too sandy.	Erodes easily.
98*: Udifluvents.						
Water.						
99*. Pits						
101---------------- Kenmoor	Severe: seepage.	Severe: hard to pack.	Percs slowly---	Wetness, fast intake, droughty.	Wetness, soil blowing, percs slowly.	Percs slowly, droughty.
102*: Haynie-----------	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily	Erodes easily	Erodes easily.
Onawa------------	Severe: seepage.	Severe: piping.	Frost action, percs slowly.	Wetness, slow intake, percs slowly.	Not needed-----	Not needed.
104E*, 104F*: Knox-------------	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
Urban land.						
105C*: Marshall---------	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
Urban land.						
105E*: Marshall---------	Severe: slope.	Slight---------	Deep to water	Slope----------	Erodes easily, slope.	Slope, erodes easily.

See footnote at end of table.

TABLE 14.--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
105E*: Urban land.						
106A*. Urban land						
229F*: Gosport	Severe: slope.	Severe: hard to pack.	Deep to water	Percs slowly, depth to rock, rooting depth.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
Gasconade	Severe: depth to rock, slope.	Severe: large stones.	Deep to water	Large stones, droughty.	Slope, large stones, depth to rock.	Large stones, slope, droughty.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--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: Unified	Classification: AASHTO	Frag-ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
1B, 1B2, 1C, 1C2, 1D2------------- Marshall	0-12	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-40	5-15
	12-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
2D--------------- Contrary	0-8	Silt loam--------	CL	A-6	0	100	100	90-100	85-90	30-40	11-18
	8-37	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	85-95	30-45	11-20
	37-60	Silt loam--------	CL, ML	A-6, A-4	0	100	100	90-100	85-90	30-40	5-15
3C2, 3D2--------- Higginsville	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	95-100	35-45	15-20
	9-35	Silty clay loam	CL	A-7	0	100	100	95-100	90-100	40-50	15-25
	35-60	Silty clay loam, silt loam.	CL, ML	A-6, A-7	0	100	100	95-100	90-100	35-45	10-20
4C, 4C2, 4D2----- Knox	0-8	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	90-100	20-35	2-15
	8-48	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	48-60	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
4D3, 4E3--------- Knox	0-8	Silty clay loam	CL	A-6	0	100	100	95-100	95-100	30-35	10-15
	8-32	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	32-60	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
4F--------------- Knox	0-12	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	90-100	20-35	2-15
	12-50	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	50-60	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
7B2, 7C2--------- Sharpsburg	0-7	Silt loam--------	CL	A-6	0	100	100	100	95-100	25-40	10-20
	7-35	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	35-47	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	47-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
7D2-------------- Sharpsburg	0-9	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	9-35	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	35-51	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	51-60	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
11B-------------- Sibley	0-28	Silt loam--------	CL	A-6	0	100	100	95-100	90-100	30-40	10-20
	28-48	Silty clay loam	CL, CH, MH	A-7	0	100	100	95-100	90-100	40-55	20-35
	48-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	90-100	35-45	15-25
21B*:											
Judson----------	0-32	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	32-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
21B*:											
Colo------------	0-32	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	32-54	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	54-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
22A-------------- Wiota	0-20	Silt loam, silty clay loam.	CL	A-6	0	100	100	100	90-95	30-40	10-20
	20-46	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	15-25
	46-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
25F-------------- Gosport	0-3	Silty clay loam	ML, MH	A-7	0	100	100	95-100	85-100	41-55	11-20
	3-32	Clay, silty clay	CH	A-7	0	100	100	95-100	85-100	50-65	35-50
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
29F-------------- Gasconade	0-9	Flaggy silty clay loam.	CL	A-6	20-50	75-90	70-85	60-75	55-65	30-40	15-25
	9-17	Flaggy silty clay, flaggy silty clay loam, very flaggy silty clay loam.	GC	A-2-7	20-70	45-55	40-50	30-40	20-35	55-65	35-45
	17	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
31D-------------- Armster	0-10	Silt loam--------	CL	A-6	0	95-100	80-95	75-90	55-80	25-40	11-20
	10-38	Clay loam, clay	CL, CH	A-7	0	95-100	80-95	70-90	55-80	45-60	25-35
	38-60	Silty clay loam, clay loam, loam.	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	30-45	15-25
33D2------------ Armstrong	0-7	Loam-------------	CL, CL-ML	A-6, A-4	0-5	90-100	80-95	75-90	55-80	20-30	5-15
	7-35	Clay loam, clay, silty clay loam.	CL, CH	A-7	0-5	90-100	80-95	70-90	55-80	45-60	20-30
	35-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
42C2, 42D2------- Lamoni	0-9	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	9-33	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	33-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
44D2------------ Shelby	0-7	Loam-------------	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
	7-36	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	36-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
52--------------- Kennebec	0-44	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	44-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	90-100	25-40	5-15
53B-------------- Judson	0-32	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	32-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
54C-------------- Olmitz	0-35	Loam, clay loam	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	35-60	Clay loam--------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
55--------------- Colo	0-32	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	32-54	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	54-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30

See footnote at end of table.

TABLE 15.--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	
56------------ Zook	0-22	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	22-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
57------------ Wabash	0-8	Silty clay-------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	8-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
58------------ Waldron	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	15-25
	7-60	Stratified silty clay to very fine sandy loam.	CL, CH	A-7	0	100	100	95-100	90-100	40-65	20-45
60------------ Colo	0-12	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
	12-60	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
61------------ Nodaway	0-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
64B----------- Sarpy	0-14	Loamy fine sand	SM	A-2-4	0	100	100	60-80	15-35	---	NP
	14-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
66------------ Haynie	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	9-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
70------------ Modale	0-30	Silt loam, very fine sandy loam.	CL	A-4, A-6	0	100	100	95-100	70-90	25-40	8-18
	30-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	65-85	40-60
74------------ Percival	0-9	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	35-60
	9-24	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	35-60
	24-60	Stratified fine sand to loamy fine sand.	SM, SM-SC, SP-SM	A-2	0	100	100	80-95	12-30	<20	NP-5
77------------ Dockery	0-9	Silty clay loam	CL	A-6	0	100	100	90-100	85-100	35-40	15-20
	9-60	Stratified silt loam to silty clay loam.	CL	A-4, A-6	0	100	100	90-100	85-95	25-40	8-20
79------------ Onawa	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	8-24	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	24-60	Silt loam, very fine sandy loam, loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
81------------ Albaton	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	8-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
83------------ Levasy	0-23	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	85-95	40-60	20-40
	23-60	Very fine sandy loam, silt loam, fine sandy loam.	CL, SC, CL-ML, SM-SC	A-6, A-4	0	100	100	70-95	40-75	20-40	4-15
93------------ Grable	0-9	Very fine sandy loam.	CL	A-4, A-6	0	100	100	80-95	50-75	25-40	8-20
	9-16	Silt loam, very fine sandy loam.	CL	A-4, A-6	0	100	100	80-95	50-75	25-40	8-20
	16-60	Fine sand, loamy sand, sand.	SM, SM-SC, SP-SM	A-2, A-3	0	100	100	65-80	5-35	<20	NP-5

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
98*: Udifluvents.											
Water.											
99*. Pits											
101-------------- Kenmoor	0-10	Loamy fine sand	SM	A-2, A-4	0	100	100	75-95	15-45	---	NP
	10-25	Sand, loamy fine sand, fine sand.	SM	A-2, A-4	0	100	100	65-80	15-40	---	NP
	25-60	Silty clay loam, silty clay, clay.	CH, CL	A-7	0	100	100	95-100	75-95	40-70	25-45
102*: Haynie----------	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	9-60	Silt loam, very fine sandy loam.	CL-ML, CL	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
Onawa-----------	0-8	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	8-24	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	24-60	Silt loam, very fine sandy loam, loam.	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
104E*: Knox------------	0-7	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	90-100	20-35	2-15
	7-48	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	48-60	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
Urban land.											
104F*: Knox------------	0-6	Silty clay loam	CL	A-6	0	100	100	95-100	95-100	30-35	10-15
	6-39	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	39-60	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	10-25
Urban land.											
105C*, 105E*: Marshall--------	0-8	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-40	5-15
	8-53	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	53-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
Urban land.											
106A*. Urban land											
229F*: Gosport---------	0-3	Silty clay loam	ML, MH	A-7	0	100	100	95-100	85-100	41-55	11-20
	3-32	Clay, silty clay	CH	A-7	0	100	100	95-100	85-100	50-65	35-50
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
229F*:											
Gasconade	0-9	Flaggy silty clay loam.	CL	A-6	20-50	75-90	70-85	60-75	55-65	30-40	15-25
	9-17	Flaggy silty clay, flaggy clay, very flaggy silty clay.	GC	A-2-7	20-70	45-55	40-50	30-40	20-35	55-65	35-45
	17	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--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	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
1B, 1B2, 1C, 1C2, 1D2	0-12	25-27	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Low	0.32	5	6	3-4
Marshall	12-60	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43			
2D	0-8	20-27	1.25-1.35	0.6-2.0	0.22-0.24	5.6-6.5	Low	0.32	5	6	2-4
Contrary	8-37	20-30	1.30-1.40	0.6-2.0	0.20-0.22	5.6-7.3	Low	0.43			
	37-60	16-25	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.43			
3C2, 3D2	0-9	27-30	1.30-1.40	0.6-2.0	0.20-0.23	5.6-7.3	Moderate	0.37	4	6	1-3
Higginsville	9-35	27-35	1.40-1.50	0.6-2.0	0.18-0.20	5.1-7.3	Moderate	0.37			
	35-60	25-30	1.50-1.60	0.6-2.0	0.18-0.22	5.1-7.3	Moderate	0.37			
4C, 4C2, 4D2	0-8	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5	6	1-3
Knox	8-48	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43			
	48-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.43			
4D3, 4E3	0-8	27-30	1.20-1.30	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.32	5	6	1-3
Knox	8-32	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43			
	32-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.43			
4F	0-12	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5	6	1-3
Knox	12-50	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43			
	50-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.43			
7B2, 7C2	0-7	25-27	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate	0.32	5	6	3-4
Sharpsburg	7-35	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	Moderate	0.43			
	35-47	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.43			
	47-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate	0.43			
7D2	0-9	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate	0.32	5	7	3-4
Sharpsburg	9-35	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.5	Moderate	0.43			
	35-51	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.43			
	51-60	25-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate	0.43			
11B	0-28	20-30	1.20-1.50	0.6-2.0	0.19-0.21	5.6-7.8	Moderate	0.28	5	6	3-4
Sibley	28-48	28-38	1.30-1.50	0.6-2.0	0.19-0.21	5.6-7.3	Moderate	0.28			
	48-60	20-30	1.20-1.50	0.6-2.0	0.19-0.21	5.6-7.3	Moderate	0.43			
21B*:											
Judson	0-32	25-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.28	5	7	3-4
	32-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate	0.43			
Colo	0-32	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High	0.28	5	7	5-7
	32-54	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	High	0.28			
	54-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	High	0.28			
22A	0-20	24-32	1.30-1.35	0.6-2.0	0.21-0.23	5.1-7.3	Moderate	0.32	5	6	3-4
Wiota	20-46	30-36	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate	0.43			
	46-60	28-34	1.40-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate	0.43			
25F	0-3	27-34	1.30-1.40	0.2-0.6	0.14-0.16	5.1-7.3	Moderate	0.43	2	4	1-2
Gosport	3-32	40-60	1.50-1.60	<0.06	0.12-0.14	3.6-6.0	High	0.32			
	32	40-75	1.70-1.90	<0.06	0.08-0.10	3.6-6.5	High	----			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
29F-------------- Gasconade	0-9	35-50	1.35-1.50	0.6-2.0	0.10-0.12	6.1-7.8	Moderate-----	0.20	2	8	2-4
	9-17	35-60	1.45-1.70	0.2-0.6	0.05-0.07	6.1-7.8	Moderate-----	0.20			
	17	---	---	---	---	---	-------------	----			
31D-------------- Armster	0-10	15-27	1.35-1.50	0.6-2.0	0.17-0.20	4.5-7.3	Moderate-----	0.37	5	6	1-2
	10-38	35-48	1.35-1.45	0.2-0.6	0.10-0.18	4.5-7.3	High---------	0.37			
	38-60	25-40	1.30-1.40	0.2-0.6	0.10-0.15	6.6-7.8	Moderate-----	0.37			
33D2------------- Armstrong	0-7	22-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	3	6	1-2
	7-35	36-48	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	35-60	30-36	1.55-1.75	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.32			
42C2, 42D2------- Lamoni	0-9	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.32	2	7	2-3
	9-33	38-50	1.55-1.75	<0.2	0.13-0.17	5.1-7.3	High---------	0.32			
	33-60	32-40	1.75-1.85	0.06-0.2	0.14-0.18	5.6-8.4	High---------	0.32			
44D2------------- Shelby	0-7	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.28	5	6	3-4
	7-36	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	36-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
52--------------- Kennebec	0-44	26-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	6	5-6
	44-60	24-40	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
53B-------------- Judson	0-32	25-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	3-4
	32-60	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43			
54C-------------- Olmitz	0-35	24-30	1.40-1.45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	3-4
	35-60	28-34	1.45-1.55	0.6-2.0	0.15-0.17	5.1-6.5	Moderate-----	0.28			
55--------------- Colo	0-32	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	32-54	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	High---------	0.28			
	54-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
56--------------- Zook	0-22	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	22-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
57--------------- Wabash	0-8	40-46	1.25-1.45	<0.06	0.12-0.14	5.6-7.3	Very high----	0.28	5	4	2-4
	8-60	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	Very high----	0.28			
58--------------- Waldron	0-7	30-35	1.35-1.50	0.2-0.6	0.21-0.23	6.6-7.8	Moderate-----	0.32	5	7	2-4
	7-60	35-50	1.45-1.60	0.06-0.2	0.10-0.18	7.4-8.4	High---------	0.32			
60--------------- Colo	0-12	20-26	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.28	5	6	3-5
	12-60	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	High---------	0.28			
61--------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	2-3
64B-------------- Sarpy	0-14	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	Low----------	0.15	5	2	<1
	14-60	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	Low----------	0.15			
66--------------- Haynie	0-9	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	Low----------	0.37	5	4L	1-3
	9-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	Low----------	0.37			
70--------------- Modale	0-30	10-18	1.20-1.30	0.6-2.0	0.21-0.23	7.4-8.4	Moderate-----	0.37	5	4L	1-3
	30-60	50-60	1.35-1.45	<0.2	0.11-0.13	7.4-8.4	High---------	0.28			
74--------------- Percival	0-9	40-60	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	High---------	0.28	4	4	1-3
	9-24	40-60	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	High---------	0.28			
	24-60	2-12	1.30-1.50	6.0-20	0.06-0.08	7.4-8.4	Low----------	0.15			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodi-bility group	Organic matter
								K	T		
	In	Pct	g/cc	In/hr	In/in	pH					Pct
77--------------- Dockery	0-9	27-32	1.35-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.37	5	7	2-4
	9-60	18-30	1.35-1.45	0.6-2.0	0.20-0.24	5.6-7.3	Moderate-----	0.37			
79--------------- Onawa	0-8	38-55	1.30-1.35	0.2-0.6	0.12-0.14	7.4-8.4	High---------	0.32	5	4	2-3
	8-24	50-60	1.30-1.40	0.06-0.2	0.12-0.14	7.4-8.4	High---------	0.32			
	24-60	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	Low----------	0.43			
81--------------- Albaton	0-8	40-60	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	High---------	0.28	5	4	2-3
	8-60	40-60	1.35-1.45	0.06-0.2	0.11-0.13	7.4-8.4	High---------	0.28			
83--------------- Levasy	0-23	35-60	1.25-1.40	0.06-0.2	0.12-0.20	7.4-8.4	High---------	0.28	5	8	2-4
	23-60	12-27	1.35-1.50	0.6-2.0	0.10-0.18	7.4-8.4	Low----------	0.43			
93--------------- Grable	0-9	18-27	1.20-1.25	0.6-2.0	0.22-0.24	7.4-8.4	Low----------	0.32	4	4L	1-3
	9-16	12-16	1.25-1.50	0.6-2.0	0.20-0.22	7.4-8.4	Low----------	0.43			
	16-60	2-10	1.20-1.50	6.0-20	0.02-0.07	7.4-8.4	Low----------	0.15			
98*: Udifluvents.											
Water.											
99*. Pits											
101-------------- Kenmoor	0-10	5-10	1.50-1.60	>6.0	0.10-0.12	6.6-8.4	Low----------	0.17	4	2	<1
	10-25	5-10	1.50-1.60	>6.0	0.05-0.12	6.6-8.4	Low----------	0.17			
	25-60	35-60	1.30-1.50	0.06-0.2	0.12-0.19	6.6-8.4	High---------	0.32			
102*: Haynie----------	0-9	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	Low----------	0.37	5	4L	1-3
	9-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	Low----------	0.37			
Onawa-----------	0-8	38-55	1.30-1.35	0.2-0.6	0.12-0.14	7.4-8.4	High---------	0.32	5	4	2-3
	8-24	50-60	1.30-1.40	0.06-0.2	0.12-0.14	7.4-8.4	High---------	0.32			
	24-60	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	Low----------	0.43			
104E*: Knox------------	0-7	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	1-3
	7-48	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	48-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
Urban land.											
104F*: Knox------------	0-6	27-30	1.20-1.30	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.32	5	6	1-3
	6-39	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	39-60	18-27	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
Urban land.											
105C*, 105E*: Marshall--------	0-8	25-27	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Low----------	0.32	5	6	3-4
	8-53	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	53-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
Urban land.											
106A*. Urban land											

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
229F*:											
Gosport---------	0-3	27-34	1.30-1.40	0.2-0.6	0.14-0.16	5.1-7.3	Moderate-----	0.43	2	4	1-2
	3-32	40-60	1.50-1.60	<0.06	0.12-0.14	3.6-5.5	High---------	0.32			
	32	---	---	---	---	---	-------------	----			
Gasconade-------	0-9	35-50	1.35-1.50	0.6-2.0	0.10-0.12	6.1-7.8	Moderate-----	0.20	2	8	2-4
	9-17	35-60	1.45-1.70	0.2-0.6	0.05-0.07	6.1-7.8	Moderate-----	0.20			
	17	---	---	---	---	---	-------------	----			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--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				
1B, 1B2, 1C, 1C2, 1D2: Marshall	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
2D: Contrary	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
3C2, 3D2: Higginsville	C	None	---	---	1.5-3.0	Perched	Nov-Apr	>60	---	High	Moderate	Moderate.
4C, 4C2, 4D2, 4D3, 4E3, 4F: Knox	B	None	---	---	>6.0	---	---	>60	---	High	Low	Low.
7B2, 7C2, 7D2: Sharpsburg	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
11B: Sibley	B	None	---	---	>6.0	---	---	>60	---	High	Low	Moderate.
21B*:												
Judson	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
Colo	B/D	Occasional	Very brief to long.	Nov-Jun	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
22A: Wiota	B	Rare	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
25F: Gosport	C	None	---	---	>6.0	---	---	20-40	Soft	Moderate	High	High.
29F: Gasconade	D	None	---	---	>6.0	---	---	4-20	Hard	Moderate	High	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic 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				
31D---------------- Armster	C	None---------	---	---	3.0-5.0	Perched	Nov-Mar	>60	---	Moderate	High-----	Moderate.
33D2--------------- Armstrong	C	None---------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	High-----	High-----	Moderate.
42C2, 42D2--------- Lamoni	C	None---------	---	---	1.0-3.0	Perched	Nov-Jul	>60	---	Moderate	High-----	Moderate.
44D2--------------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
52----------------- Kennebec	B	Rare---------	---	---	4.0-6.0	Apparent	Nov-Jul	>60	---	High-----	Moderate	Low.
53B---------------- Judson	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Low.
54C---------------- Olmitz	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
55----------------- Colo	B/D	Occasional	Very brief to long.	Nov-Jun	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
56----------------- Zook	C/D	Frequent----	Brief to long.	Nov-Jun	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
57----------------- Wabash	D	Frequent----	Brief to long.	Nov-May	0-1.0	Apparent	Nov-May	>60	---	Moderate	High-----	Moderate.
58----------------- Waldron	D	Rare---------	---	---	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
60----------------- Colo	B/D	Occasional	Very brief to long.	Nov-Jun	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
61----------------- Nodaway	B	Frequent----	Very brief to brief.	Nov-Jun	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic 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				
64B----------------- Sarpy	A	Rare----------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
66----------------- Haynie	B	Rare----------	---	---	>6.0	---	---	>60	---	High------	Low-------	Low.
70----------------- Modale	C	Rare----------	---	---	1.5-3.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
74----------------- Percival	C	Rare----------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Low.
77----------------- Dockery	C	Occasional	Brief------	Nov-Jun	2.0-3.0	Apparent	Nov-Apr	>60	---	High------	Moderate	Low.
79----------------- Onawa	D	Rare----------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
81----------------- Albaton	D	Rare----------	---	---	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Low.
83----------------- Levasy	C	Rare----------	---	---	+1-1.5	Apparent	Nov-Jun	>60	---	High------	High------	Low.
93----------------- Grable	B	Rare----------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
98*: Udifluvents.												
Water.												
99*. Pits												
101---------------- Kenmoor	B	Rare----------	---	---	2.5-3.0	Perched	Nov-Jun	>60	---	Moderate	High------	Low.

See footnote at end of table.

TABLE 17.--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				
102*:												
Haynie----------	B	Rare--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Onawa-----------	D	Rare--------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
104E*, 104F*:												
Knox------------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Urban land.												
105C*, 105E*:												
Marshall--------	B	None--------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
Urban land.												
106A*. Urban land												
229F*:												
Gosport---------	C	None--------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	High.
Gasconade-------	D	None--------	---	---	>6.0	---	---	4-20	Hard	Moderate	High-----	Low.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 18.--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
Albaton	Fine, montmorillonitic (calcareous), mesic Vertic Fluvaquents
Armster	Fine, montmorillonitic, mesic Mollic Hapludalfs
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Contrary	Fine-silty, mixed, mesic Dystric Eutrochrepts
Dockery	Fine-silty, mixed, nonacid, mesic Aquic Udifluvents
Gasconade	Clayey-skeletal, mixed, mesic Lithic Hapludolls
Gosport	Fine, illitic, mesic Typic Dystrochrepts
Grable	Coarse-silty over sandy or sandy-skeletal, mixed (calcareous), mesic Mollic Udifluvents
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
*Higginsville	Fine-silty, mixed, mesic Aquic Argiudolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kenmoor	Sandy over clayey, mixed (calcareous), mesic Aquic Udifluvents
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Knox	Fine-silty, mixed, mesic Mollic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Levasy	Clayey over loamy, montmorillonitic (calcareous), mesic Fluvaquentic Haplaquolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
Modale	Coarse-silty over clayey, mixed (calcareous), mesic Aquic Udifluvents
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Onawa	Clayey over loamy, montmorillonitic (calcareous), mesic Aquic Udifluvents
Percival	Clayey over sandy or sandy-skeletal, montmorillonitic (calcareous), mesic Aquic Udifluvents
Sarpy	Mixed, mesic Typic Udipsamments
*Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
*Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Sibley	Fine-silty, mixed, mesic Typic Argiudolls
Udifluvents	Loamy or clayey, mixed, mesic Udifluvents
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Waldron	Fine, montmorillonitic (calcareous), mesic Aeric Fluvaquents
Wiota	Fine-silty, mixed, mesic Typic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

☆ U.S. GOVERNMENT PRINTING OFFICE : 1989 O - 205-526 : QL 3

Accessibility Statement

This document is not accessible by screen-reader software. The Natural Resources Conservation Service (NRCS) is committed to making its information accessible to all of its customers and employees. If you are experiencing accessibility issues and need assistance, please contact our Helpdesk by phone at (800) 457-3642 or by e-mail at ServiceDesk-FTC@ftc.usda.gov. For assistance with publications that include maps, graphs, or similar forms of information, you may also wish to contact our State or local office. You can locate the correct office and phone number at http://offices.sc.egov.usda.gov/locator/app.

Nondiscrimination Statement

Nondiscrimination Policy

The U.S. Department of Agriculture (USDA) prohibits discrimination against its customers, employees, and applicants for employment on the basis of race, color, national origin, age, disability, sex, gender identity, religion, reprisal, and where applicable, political beliefs, marital status, familial or parental status, sexual orientation, whether all or part of an individual's income is derived from any public assistance program, or protected genetic information. The Department prohibits discrimination in employment or in any program or activity conducted or funded by the Department. (Not all prohibited bases apply to all programs and/or employment activities.)

To File an Employment Complaint

If you wish to file an employment complaint, you must contact your agency's EEO Counselor (http://directives.sc.egov.usda.gov/33081.wba) within 45 days of the date of the alleged discriminatory act, event, or personnel action. Additional information can be found online at http://www.ascr.usda.gov/complaint_filing_file.html.

To File a Program Complaint

If you wish to file a Civil Rights program complaint of discrimination, complete the USDA Program Discrimination Complaint Form, found online at http://www.ascr.usda.gov/complaint_filing_cust.html or at any USDA office, or call (866) 632-9992 to request the form. You may also write a letter containing all of the information requested in the form. Send your completed complaint form or letter by mail to U.S. Department of Agriculture; Director, Office of Adjudication; 1400 Independence Avenue, S.W.; Washington, D.C. 20250-9419; by fax to (202) 690-7442; or by email to program.intake@usda.gov.

Persons with Disabilities

If you are deaf, are hard of hearing, or have speech disabilities and you wish to file either an EEO or program complaint, please contact USDA through the Federal Relay Service at (800) 877-8339 or (800) 845-6136 (in Spanish).

If you have other disabilities and wish to file a program complaint, please see the contact information above. If you require alternative means of communication for program information (e.g., Braille, large print, audiotape, etc.), please contact USDA's TARGET Center at (202) 720-2600 (voice and TDD).

Supplemental Nutrition Assistance Program

For additional information dealing with Supplemental Nutrition Assistance Program (SNAP) issues, call either the USDA SNAP Hotline Number at (800) 221-5689, which is also in Spanish, or the State Information/Hotline Numbers (http://directives.sc.egov.usda.gov/33085.wba).

All Other Inquiries

For information not pertaining to civil rights, please refer to the listing of the USDA Agencies and Offices (http://directives.sc.egov.usda.gov/33086.wba).