United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with
Missouri Agricultural
Experiment Station

Soil Survey of Putnam County, Missouri

How To Use This Soil Survey

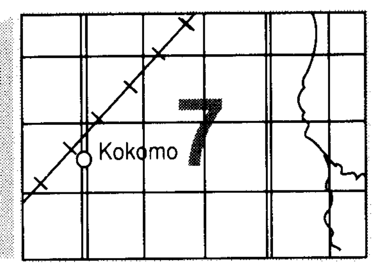
General Soil Map

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.

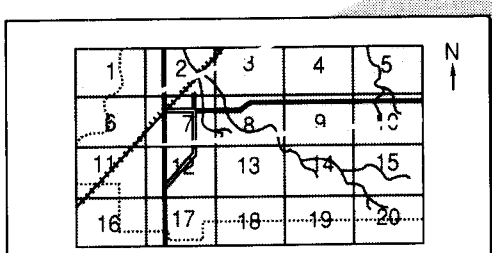
Detailed Soil Maps

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



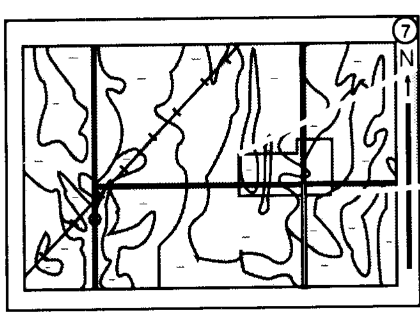
MAP SHEET

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.

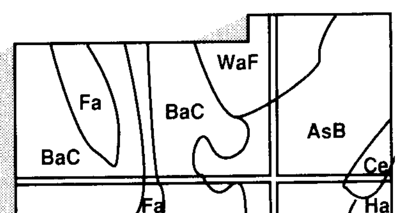


INDEX TO MAP SHEETS

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.

Major fieldwork for this soil survey was completed in 1988. Soil names and descriptions were approved in 1989. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1988. This survey was made cooperatively by the Soil Conservation Service and the Missouri Agricultural Experiment Station. The Putnam County Soil and Water Conservation District, through grant money from the Missouri Department of Natural Resources, provided a soil scientist to assist with the fieldwork. The Putnam County Commission provided office space for survey personnel. The survey is part of the technical assistance furnished to the Putnam 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.

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

Cover: Typical area of the Gara-Armstrong association.

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Issued September 1994

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Summary of Tables

Foreword

This soil survey contains information that can be used in land-planning programs in Putnam County. 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 over bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

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Soil Survey of Putnam County, Missouri

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Fieldwork by Buddy Festervand, Chad Remley, Clayton E. Lee, Leodis Williams, Soil Conservation Service, and Steven D. Peterson, Putnam County Soil and Water Conservation District

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

PUTNAM COUNTY is in the northeastern part of Missouri (fig. 1). It has a total area of 333,101 acres, or about 520 square miles. This acreage includes 1,065 acres of water areas more than 40 acres in size.

Putnam County is bordered on the north by Wayne and Appanoose Counties of Iowa and on the south by Adair and Sullivan Counties of Missouri. The western boundary is Mercer County, and the eastern boundary is the old Chariton River channel. The county generally is about 35 miles east to west and 14 miles north to south, except in the extreme eastern part of the county, where it is as much as 17 miles. Unionville, the county seat, is located in the center of the county.

This survey updates the soil survey of Putnam County published in 1908 *(6)*. It provides additional interpretative information and larger maps, which show the soils in greater detail.

The two major land resource areas in the county are the Iowa and Missouri Heavy Till Plain and the Iowa and Missouri Deep Loess Hills *(3)*. The major soils of the Iowa and Missouri Heavy Till Plain are Seymour and Pershing soils on ridges and Gara and Shelby on side slopes. Colo and Zook soils are on bottom land. The major soils of the Iowa and Missouri Deep Loess Hills are Gorin soils on narrow ridges and Keswick and Winnegan soils on side slopes. Nodaway soils are dominant on flood plains.

Farming is the main enterprise in the county. The principal crops are corn, soybeans, wheat, and grain sorghum. Beef and dairy cattle, hogs, and sheep are the commonly raised livestock. The county has some forested areas. These areas are mostly in the eastern part of the county on uplands along the flood plains of major creeks and rivers.

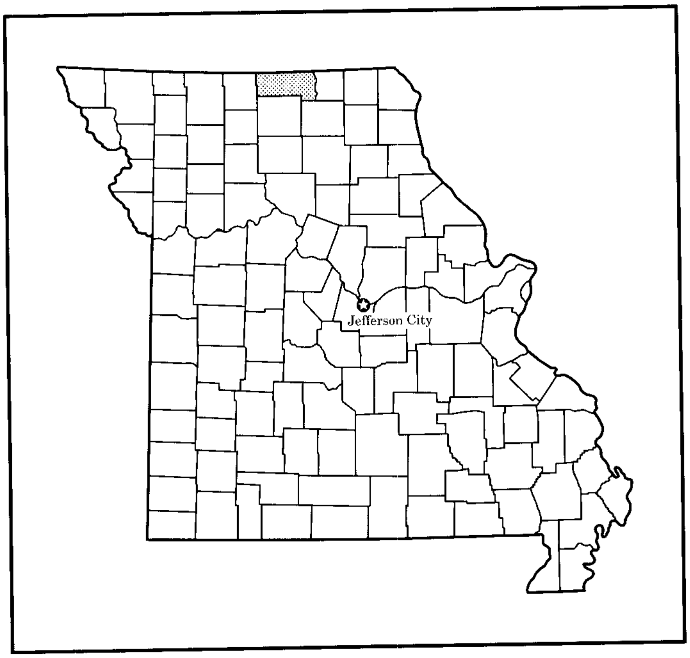

Figure 1.—Location of Putnam County in Missouri.

General Nature of the County

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

Climate

Table 1 gives data on temperature and precipitation for the survey area as recorded at Kirksville, Missouri, for the period 1951 to 1987. 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 27 degrees F and the average daily minimum temperature is 18 degrees. The lowest temperature on record, which occurred at Kirksville on January 10, 1982, is -23 degrees. In summer, the average temperature is 74 degrees and the average daily maximum temperature is 85 degrees. The highest recorded temperature, which occurred on July 14, 1954, is 109 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 37 inches. Of this, 24 inches, or about 65 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 8.07 inches at Kirksville on July 22, 1951. Thunderstorms occur on about 53 days each year.

The average seasonal snowfall is 25 inches. The greatest snow depth at any one time during the period of record was 27 inches. On the average, 17 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 55 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 13 miles per hour, in spring.

History and Development

The first settlers arrived in the area now known as Putnam County in 1836. They settled in the heavily wooded area directly west of the Chariton River. Putnam County was organized on February 28, 1845 *(5)*. The annexation of Dodge County in 1853 increased Putnam County to its present-day land area.

Most of the early settlements were in areas convenient to water and timber. The timbered ridgetops, predominantly areas of Keswick and Gorin soils, were cleared and planted. These soils were easier to cultivate than the prairie soils, such as Seymour, Clarinda, Lamoni, and Edina soils in the western part of the county.

The early settlers of Putnam County practiced only subsistence agriculture because they did not have a reasonable means of transporting surpluses to established markets. Maize, small grains, vegetables, hay, and livestock were the most important agricultural products.

In the 1870's, the county gained railway service and agriculture became more profitable. In the latter half of the 1800's, timber was exploited in the eastern part of the county as a valuable economic resource. Coal mining was and still is economically important to the county. Early mines provided a steady source of fuel for the local community. Currently, coal is strip mined and sold elsewhere. Recent laws passed by State and Federal legislatures require that strip-mined lands be reclaimed. Reclaimed areas in the county typically have been mapped as Schuline soils.

Agriculture has always been the dominant enterprise in Putnam County. In 1988, livestock production accounted for nearly 75 percent of the gross revenue generated in the county. The production of crops, such as soybeans, corn, and small grain, accounted for about 25 percent *(7)*.

In Putnam County the trends of population and farming are similar to those of other northern Missouri counties. In 1900, the population of the county peaked at approximately 16,000. In 1988, it had dropped to nearly 5,370. The number of farms in the county has decreased, and the number of acres per farm has increased.

Relief and Drainage

Relief in Putnam County ranges from 1,100 feet near Powersville, in the northwest, to 779 feet at the point where the Chariton River leaves the county, in the southeast.

Most streams in the county flow intermittently. The county, however, has three major perennial drainage systems. These drainage systems eventually flow south into the Missouri River. Much of the eastern part of the county has high, narrow ridges and steep-sided ravines. It is drained by Shoal and Blackbird Creeks and their tributaries. These water courses feed the Chariton River. The western part of the county is more gently sloping, and streams in this area have a more winding course. Medicine Creek enters the county directly west of Powersville. The headwaters of the Locust Creek system are in the west-central portion of the county, near the Iowa border.

How This Survey Was Made

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

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

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

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

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

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

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

Map Unit Composition

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

Most inclusions have properties and behavioral patterns similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are named and 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 with those of the soils identified on the maps of adjacent counties that were 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 conditions. In some areas combining small acreages of similar soils, which respond to use and management in much the same way, is more practical than mapping these areas separately.

Soil Descriptions

1. Seymour-Clarinda-Edina Association

Very deep, nearly level to moderately sloping, somewhat poorly drained and poorly drained soils that formed in loess and weathered glacial till; on uplands

This association consists of soils that formed in loess on high ridgetops and wide upland divides and of soils that formed in weathered glacial till on side slopes and in coves at the head of drainageways. Slopes range from 0 to 9 percent.

This association makes up about 10 percent of the county. It is about 54 percent Seymour and similar soils, 22 percent Clarinda soils, 11 percent Edina soils, and 13 percent soils of minor extent (fig. 2).

The somewhat poorly drained Seymour soils are on gently sloping, convex ridgetops and side slopes below nearly level upland divides. They formed in loess. Typically, the surface layer and the subsurface layer are very dark grayish brown silty clay loam. The subsoil is dark grayish brown, mottled silty clay in the upper part; grayish brown, mottled silty clay in the next part; and grayish brown, mottled silty clay loam in the lower part.

The poorly drained Clarinda soils are on moderately sloping side slopes and in concave areas at the head of drainageways. Typically, the surface layer is very dark gray silty clay loam. The subsoil is dark gray and gray, mottled silty clay in the upper part and gray and olive gray, mottled clay in the lower part.

The poorly drained Edina soils are on nearly level, wide upland divides and ridgetops. Typically, the surface layer is very dark gray silt loam. The subsurface layer is gray, mottled silt loam. The subsoil is mottled silty clay. It is very dark gray in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The substratum is gray, mottled silty clay loam.

Of minor extent in this association are Nodaway, Shelby, Vigar, and Zook soils. The moderately well drained Shelby soils are on side slopes. The moderately well drained Vigar soils are on gently sloping and moderately sloping foot slopes. The moderately well drained Nodaway and frequently flooded Zook soils are in narrow drainageways.

About 80 percent of this association is cultivated. The major crops are corn, soybeans, and wheat. About 20 percent of the association is used as pasture or hayland.

Growing cash crops is the main farm enterprise. Erosion is the main management concern in areas of the Seymour and Clarinda soils. Wetness is the main management concern in areas of the Edina soils. Overgrazing is the major concern in managing pasture

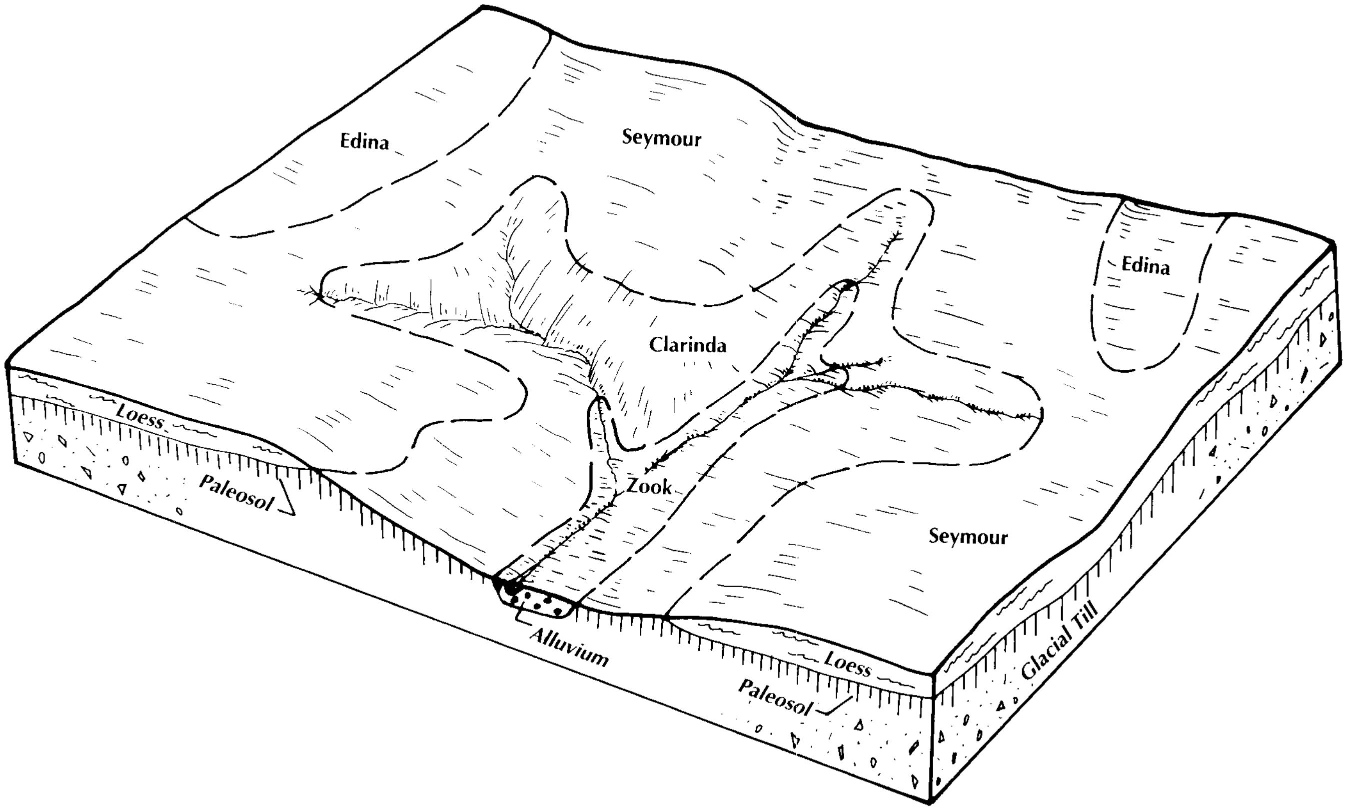

Figure 2.—Typical pattern of soils and parent material in the Seymour-Clarinda-Edina association.

because it causes rapid erosion and gullying in areas of the Seymour and Clarinda soils. It also causes surface compaction, excessive runoff, and poor tilth in areas of all the major soils.

This association is suited to onsite waste disposal if sewage lagoons are used. The slope is the main limitation in areas of the Seymour and Clarinda soils. Wetness and the shrink-swell potential are limitations on sites for dwellings. The wetness, low strength, frost action, and the shrink-swell potential are limitations on sites for local roads and streets.

2. Adair-Shelby Association

Very deep, gently sloping to moderately steep, moderately well drained and somewhat poorly drained soils that formed in pedisediments and weathered glacial till and in glacial till; on uplands

This association consists of soils on narrow and moderately wide, branching, convex ridgetops and dissected side slopes. Slopes range from 3 to 20 percent.

This association makes up about 14 percent of the county. It is about 58 percent Adair and similar soils, 32 percent Shelby soils, and 10 percent soils of minor extent (fig. 3).

The somewhat poorly drained Adair soils are on gently sloping and moderately sloping, convex ridges and side slopes. Typically, the surface layer is very dark grayish brown loam. The subsoil is brown, mottled clay loam and clay in the upper part and dark yellowish brown and brown, mottled clay loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled clay loam.

The moderately well drained Shelby soils are on strongly sloping and moderately steep, convex side slopes. Typically, the surface layer is very dark grayish brown loam. The subsoil is clay loam. It is dark yellowish brown in the upper part, yellowish brown in the next part, and yellowish brown and mottled in the lower part. The substratum is yellowish brown, mottled clay loam.

Of minor extent in this association are Clarinda, Nodaway, Vigar, and Zook soils. The poorly drained Clarinda soils are at the head of drainageways. The rarely flooded Vigar soils are on gently sloping and moderately sloping foot slopes. The frequently flooded Nodaway and Zook soils are in narrow drainageways.

About 60 percent of this association is used as pasture or hayland. The moderately sloping soils are more intensely cropped. The major crops are corn, soybeans, and small grain. Erosion is the main management concern. Tall fescue, smooth bromegrass, orchardgrass, alfalfa, and red clover are the main pasture plants and hay crops. Overgrazing is the major concern in managing pasture because it causes rapid erosion and gullying.

This association is suited to onsite waste disposal if sewage lagoons are used. The slope is the main limitation. Wetness and the shrink-swell potential are limitations on sites for dwellings. The slope, low strength, frost action, and the shrink-swell potential are limitations on sites for local roads and streets.

3. Gara-Armstrong Association

Very deep, moderately sloping to steep, moderately well drained and somewhat poorly drained soils that formed in glacial till and in loess or sediments and weathered glacial till; on uplands

This association consists of soils on narrow, branching, convex ridgetops and highly dissected side slopes that commonly are adjacent to stream valleys. Slopes range from 5 to 30 percent.

This association makes up about 33 percent of the county. It is about 60 percent Gara soils, 34 percent Armstrong and the similar Pershing soils, and 6 percent soils of minor extent and areas of water more than 40 acres in size (fig. 3).

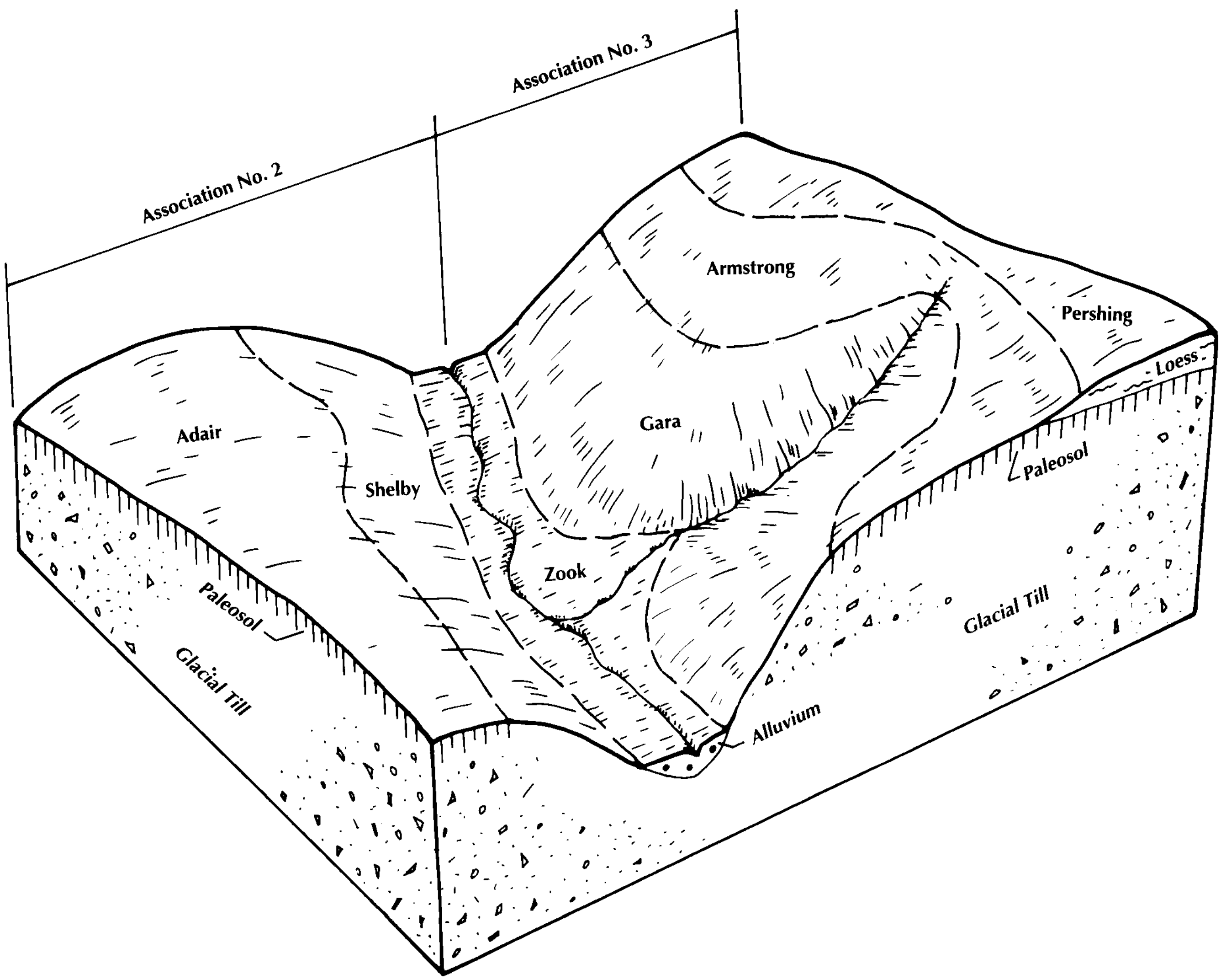

Figure 3.—Typical pattern of soils and parent material in the Adair-Shelby and Gara-Armstrong associations.

The moderately well drained Gara soils are on moderately steep and steep dissected side slopes. They commonly are adjacent to stream valleys. Typically, the surface layer is very dark grayish brown loam. The subsoil is clay loam. It is dark yellowish brown and yellowish brown in the upper part and yellowish brown and mottled in the lower part. The substratum is yellowish brown, mottled clay loam.

The somewhat poorly drained Armstrong soils are on moderately sloping and strongly sloping, narrow convex ridgetops and side slopes. Typically, the surface layer is very dark grayish brown clay loam. The subsoil is brown, mottled clay loam in the upper part; brown, strong brown, and yellowish brown, mottled clay in the next part; and yellowish brown, mottled clay loam in the lower part.

Of minor extent in this association are Nodaway, Rinda, Vigar, and Zook soils and areas of water more than 40 acres in size. The frequently flooded Nodaway and poorly drained Zook soils are in narrow drainageways. Rinda soils are poorly drained. They are at the head of drainageways and on side slopes in areas above the Gara and Armstrong soils. The rarely flooded Vigar soils are on foot slopes. The areas of water are Lake Thunderhead and Unionville City Lake.

Most of this association is used as pasture or hayland. The moderately sloping soils are more intensely cropped. The major crops are corn, soybeans, and small grain. Erosion is the main management concern. Tall fescue, smooth bromegrass, orchardgrass, alfalfa, red clover, and birdsfoot trefoil are the main pasture plants and hay crops. Overgrazing is the major concern in managing pasture because it causes rapid erosion and gullying.

This association is suited to onsite waste disposal if sewage lagoons are used. The slope is the main limitation. Wetness and the shrink-swell potential are limitations on sites for dwellings. The slope, low strength, frost action, and the shrink-swell potential are limitations on sites for local roads and streets.

4. Winnegan-Keswick Association

Very deep, moderately sloping to very steep, moderately well drained soils that formed in glacial till and in loess or sediments and weathered glacial till; on uplands

This association consists of soils on highly dissected side slopes and secondary ridges adjacent to flood plains. Slopes range from 5 to 35 percent.

This association makes up about 30 percent of the county. It is about 52 percent Winnegan soils, 27 percent Keswick soils, and 21 percent soils of minor extent (fig. 4).

The moderately well drained Winnegan soils are on moderately steep to very steep, dissected side slopes. Typically, the surface layer is dark grayish brown loam and the subsurface layer is brown loam. The subsoil is clay loam. It is yellowish brown in the upper part and is dark yellowish brown and yellowish brown and mottled in the lower part. The substratum is mottled dark yellowish brown and light brownish gray clay loam.

The moderately well drained Keswick soils are on moderately sloping and strongly sloping side slopes and narrow secondary ridges. Typically, the surface layer is dark grayish brown loam. The subsoil is reddish brown, mottled clay loam in the upper part; brown and strong brown, mottled clay in the next part; and yellowish brown, mottled clay loam in the lower part.

Of minor extent in this association are Gorin, Nodaway, Putco, Schuline, Vanmeter, Vigar, and Zook soils. The somewhat poorly drained Gorin soils are on gently sloping and moderately sloping, narrow convex ridgetops and side slopes adjacent to the flood plains. The frequently flooded Nodaway soils and poorly drained Zook soils are in narrow drainageways. Putco soils are in areas that were mined for coal and have not been reclaimed. Schuline soils are in areas that were mined for coal and have been reclaimed. Vanmeter soils are moderately deep to soft, weathered, calcareous shale. They commonly are on the lower side slopes directly adjacent to the flood plains. The rarely flooded Vigar soils are on gently sloping and moderately sloping foot slopes.

Most of this association is used as pasture, hayland, or woodland. The association also has many areas that have been strip mined for coal. Many of the moderately steep to very steep areas are used for trees. The equipment limitation and erosion hazard are the main management concerns.

The moderately sloping and strongly sloping Keswick soils are mostly used for pasture or hayland. Tall fescue, smooth bromegrass, orchardgrass, alfalfa, red clover, and birdsfoot trefoil are the main pasture plants and hay crops. Overgrazing is the major concern in managing pasture because it causes rapid erosion and gullying.

This association is suited to onsite waste disposal if sewage lagoons are used. The slope is the main limitation. Wetness and the shrink-swell potential are the main limitations on sites for dwellings in areas of the Keswick soils. The slope, low strength, the shrink-swell potential, and frost action are limitations on sites for local roads and streets.

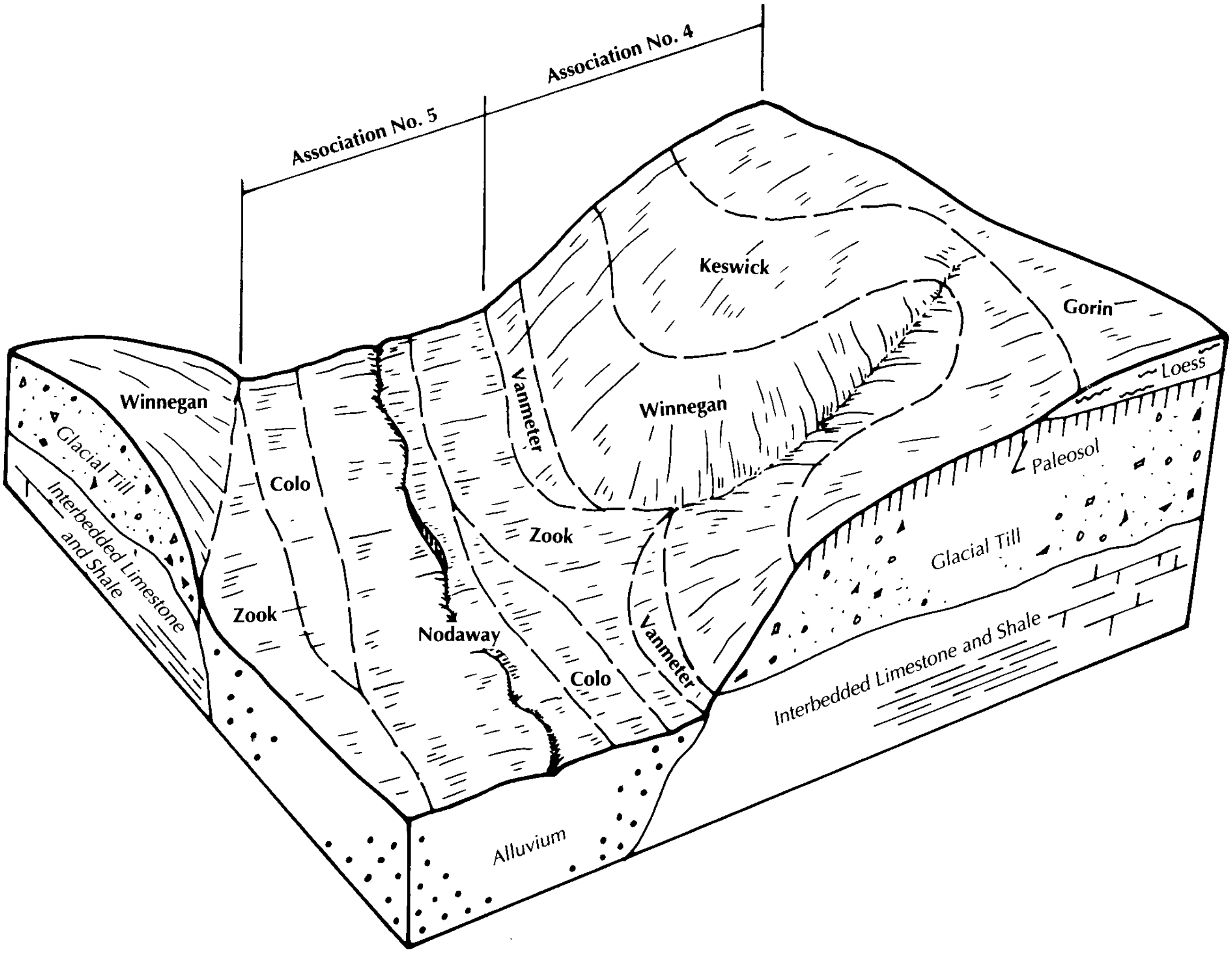

Figure 4.—Typical pattern of soils and parent material in the Winnegan-Keswick and Nodaway-Zook-Colo associations.

5. Nodaway-Zook-Colo Association

Very deep, nearly level, moderately well drained and poorly drained soils that formed in silty and clayey alluvium; on flood plains

This association consists of soils on narrow and intermediate-sized flood plains. Old abandoned channels are in many areas where the course of a stream has been straightened. Slopes range from 0 to 2 percent.

This association makes up about 13 percent of the county. It is about 38 percent Nodaway soils, 29 percent Zook soils, 12 percent Colo soils, and 21 percent soils of minor extent (fig. 4).

The moderately well drained Nodaway soils commonly are adjacent to river or stream channels. Typically, the surface layer is very dark gray silt loam. The substratum is stratified very dark gray, grayish brown, very dark grayish brown, dark grayish brown, and brown silt loam.

The poorly drained Zook soils commonly are in slack-water areas adjacent to the uplands. Typically, the surface layer is black silty clay loam. The subsurface layer is black silty clay loam and silty clay. The subsoil is very dark gray silty clay. The substratum is dark gray, mottled silty clay.

The poorly drained Colo soils typically are in areas between the Nodaway and Zook soils. Typically, the surface layer is very dark gray silt loam. The subsurface layer is black silt loam in the upper part and black silty clay loam in the lower part. The subsoil is very dark gray, mottled silty clay loam.

Of minor extent in this association are the somewhat poorly drained Amana, poorly drained Belinda and

Humeston, and moderately well drained Vigar soils. Amana soils have a surface layer that is thinner than that of the major soils. They are on flood plains. Belinda soils are not subject to flooding and are on nearly level stream terraces. Humeston soils have a surface layer and subsurface layer that are thinner than those of the Zook and Colo soils. They commonly are on low, concave terraces and concave foot slopes. Vigar soils are on gently sloping and moderately sloping foot slopes adjacent to and slightly higher than the flood plains.

Most areas of this association are cultivated. The major crops are corn and soybeans. Flooding and wetness are the main management concerns.

Many areas of this association are used as pasture or hayland. Wetness-tolerant plants, such as reed canarygrass, grow best. Flooding and wetness are the main management concerns.

A small percentage of this association is used as woodland. Most of the wooded areas are adjacent to river or stream channels and are in old meander scars. These areas are subject to flooding.

This association is unsuitable for sanitary facilities and building site development because of the flooding and wetness.

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 the heading "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, Gara loam, 14 to 20 percent slopes, eroded, is a phase of the Gara 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. Vigar-Zook-Nodaway complex, 1 to 5 percent slopes, is an example.

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

The descriptions, names, and delineations of soils identified on the detailed soil maps of this county do not fully agree with those of the soils identified on the maps of adjacent counties that were published at a different date. Differences are the result of additional data, variations in the intensity of mapping, and correlation decisions that reflect local conditions. In some areas combining small acreages of similar soils, which 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

10C2—Rinda silty clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, poorly drained soil is on concave slopes at the head of drainageways and on the sides of ridges in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 4 inches thick. The subsoil is dark grayish brown and gray, mottled silty clay about 56 inches thick.

Included with this soil in mapping are areas of the somewhat poorly drained Armstrong soils. These soils have more glacial sand and pebbles than the Rinda soil and are on the more dissected parts of the landscape.

Figure 5.—Grass-legume hay in an area of Rinda silty clay loam, 5 to 9 percent slopes, eroded.

Also included are a few areas of severely eroded soils that have a surface layer of grayish brown silty clay. Included soils make up about 10 percent of this unit.

Permeability is very slow in the Rinda soil. Surface runoff is medium in cultivated areas. The available water capacity is moderate. Organic matter content also is moderate. The shrink-swell potential is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is friable but can be easily tilled only within a narrow range in moisture content.

Most areas are used for cultivated crops, pasture, or hay (fig. 5). This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces surface crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture or hay is effective in controlling erosion. The soil is moderately well suited to reed canarygrass and switchgrass and moderately suited to tall fescue, birdsfoot trefoil, big bluestem, and indiangrass. It is not suited to deep-rooted plants. It is best suited to the grasses and legumes that can withstand wetness. Erosion is the main management problem. Timely tillage is needed, and the soil should be tilled on the contour. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

Some areas support stands of native hardwoods. This soil is suited to trees. The equipment limitation, seedling mortality, and the windthrow hazard are management concerns. To overcome the equipment limitation, operations should be planned for periods when the soil is dry or frozen. Planting container-grown seedlings helps to ensure better survival rates. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well if the sites are leveled. If dwellings are built, measures that overcome the shrink-swell potential and wetness are needed. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IVe. The woodland ordination symbol is 2W.

11—Edina silt loam. This very deep, nearly level, poorly drained soil is on ridgetops and wide upland divides. Individual areas are irregular in shape and range from about 10 to more than 400 acres in size.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The subsurface layer is gray, mottled silt loam about 9 inches thick. The subsoil is mottled silty clay about 34 inches thick. It is very dark gray in the upper part, dark grayish brown in the next part, and grayish brown in the lower part. The substratum to a depth of 60 inches or more is gray, mottled silty clay loam. In places the surface layer is less than 8 inches thick.

Included with this soil in mapping are small areas of the somewhat poorly drained Seymour soils. These soils are gently sloping and are slightly lower on the landscape than the Edina soil. They make up less than 10 percent of this unit.

Permeability is very slow in the Edina soil. Surface runoff also is very slow. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is very high. A perched water table is at a depth of 0.5 foot to 2.0 feet during most winter and spring months. The surface layer is very friable but can be easily tilled only under favorable moisture conditions.

Most areas are used for row crops (fig. 6). A few areas are used for pasture or hay. This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Wetness is the major management concern. In large areas of cropland, land grading and installing shallow surface drains help to remove excess water. The excess water is not likely to affect the yield of hay and pasture plants.

Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, and switchgrass. It is moderately suited to tall fescue, big bluestem, and indiangrass. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well on this soil. If dwellings are built, measures that overcome the shrink-swell potential and wetness are needed. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIw.

12C2—Adair loam, 3 to 9 percent slopes, eroded. This very deep, gently sloping and moderately sloping, somewhat poorly drained soil is on narrow, convex ridgetops, on side slopes, and at the head of drainageways in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper

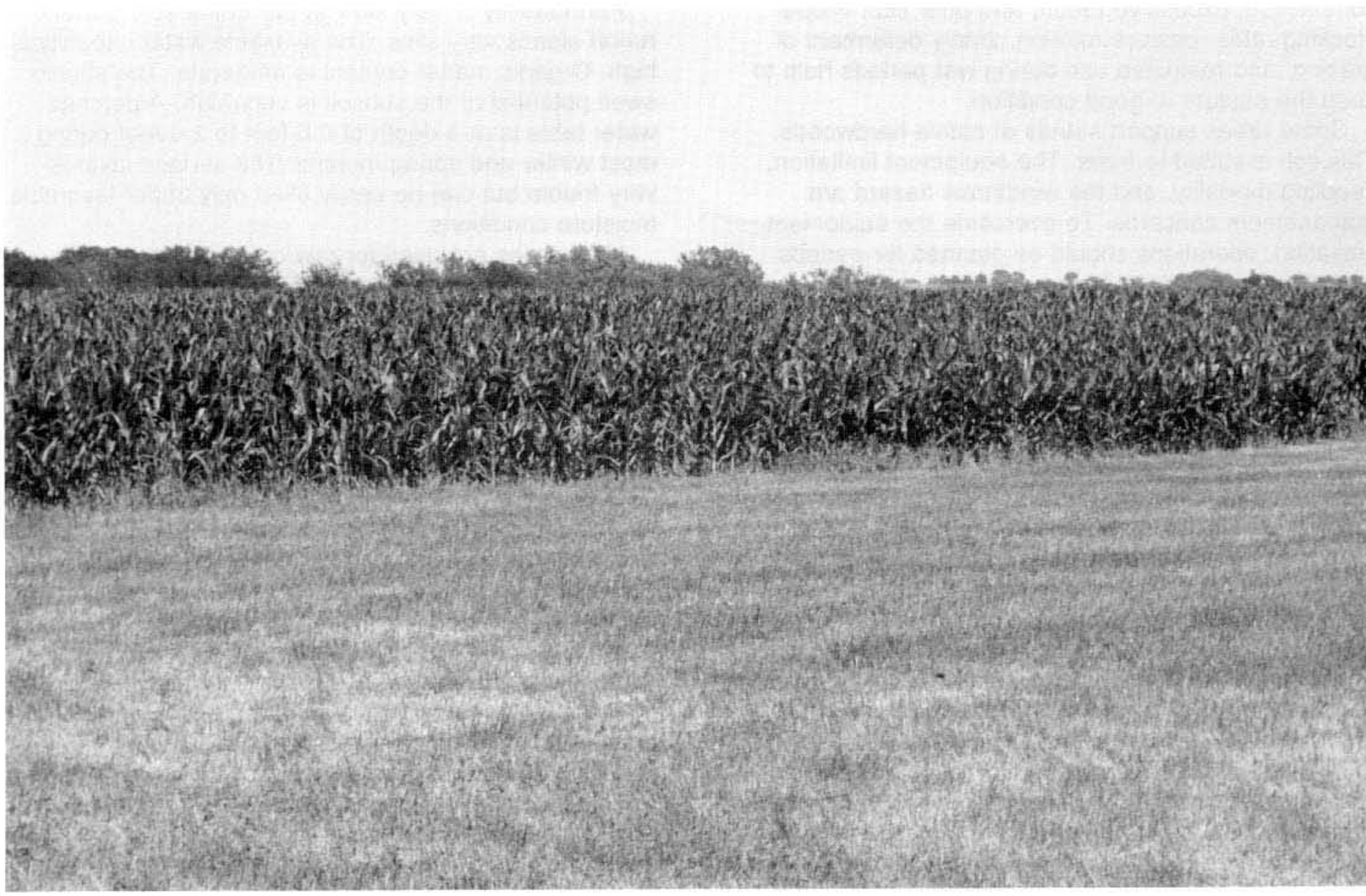

Figure 6.—Corn in an area of Edina silt loam in the background. Grass in an area of Seymour soils is in the foreground.

part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 200 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The subsoil is about 50 inches thick. It is brown, mottled clay loam and clay in the upper part and dark yellowish brown and brown, mottled clay loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled clay loam. In some places the surface layer is brown clay loam. In a few places, the surface layer is silty clay loam and the subsoil has less glacial sand and pebbles.

Included with this soil in mapping are small areas of Clarinda and Shelby soils. Clarinda soils are poorly drained and have more clay than the Adair soil. They are mainly at the head of large drainageways. Shelby soils are moderately well drained and are on the steeper slopes below the Adair soil. Included soils make up about 5 percent of this unit.

Permeability is slow in the Adair soil. Surface runoff is medium in cultivated areas. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for row crops, hay, or pasture. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. In some areas seep spots delay cultivation in fall and spring. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. A few small areas have slopes that are long and smooth enough to be terraced and farmed on the contour. Some type of grade stabilization structure generally 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.

Growing grasses and legumes for pasture or hay is very effective in controlling erosion. This soil is moderately well suited to birdsfoot trefoil, tall fescue, reed canarygrass, big bluestem, indiangrass, and switchgrass. It is moderately suited to orchardgrass, smooth bromegrass, alfalfa, and red clover.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function adequately if the sites are leveled. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe.

13E2—Gara loam, 14 to 20 percent slopes, eroded. This very deep, moderately steep, moderately well drained soil is on dissected upland side slopes, commonly adjacent to stream valleys. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 20 to more than 600 acres in size.

Typically, the surface layer is very dark grayish brown loam about 5 inches thick. The subsoil is about 32 inches thick. It is brown clay loam in the upper part and yellowish brown, mottled clay loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Armstrong soils. These soils are on moderately sloping and strongly sloping, narrow ridgetops and convex side slopes. Also included are a few areas of severely eroded soils that have a surface layer of brown clay loam. Included soils make up about 5 percent of this unit.

Permeability is moderately slow in the Gara soil. Surface runoff is rapid. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential also is moderate.

Most areas are used for pasture or hay. A few areas are used for trees. Because of the slope, this soil generally is unsuitable for cultivated crops. It is well suited to red clover, birdsfoot trefoil, tall fescue, and switchgrass. It is moderately well suited to alfalfa, orchardgrass, smooth bromegrass, big bluestem, and indiangrass. Further erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary.

Some areas support stands of native hardwoods. This soil is suited to trees. The hazard of erosion and the equipment limitation are the main management concerns. Special erosion-control measures are required. Carefully designing and constructing logging roads and skid trails minimizes the steepness and length of slopes and the concentration of water. Seeding of disturbed areas may be necessary after harvesting is completed. Because of the slope, operating equipment is hazardous. Roads and skid trails should be constructed on the contour. In the steepest areas the logs should be yarded uphill to logging roads or skid trails. Direct seeding or hand planting may be necessary.

This soil is suitable for some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons or dwellings should be graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness. Cut-and-fill may be necessary in some areas because of the slope.

The land capability classification is VIe. The woodland ordination symbol is 3R.

13F2—Gara loam, 20 to 30 percent slopes, eroded. This very deep, steep, moderately well drained soil is on dissected, upland side slopes that are commonly adjacent to stream valleys. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 15 to more than 575 acres in size.

Typically, the surface layer is very dark grayish brown loam about 6 inches thick. The subsoil is about

36 inches thick. It is dark yellowish brown and yellowish brown clay loam in the upper part and yellowish brown, mottled clay loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled clay loam. In areas the surface layer is clay loam.

Included with this soil in mapping are small areas of the somewhat poorly drained Armstrong soils. These soils are on strongly sloping convex side slopes. They make up less than 5 percent of the unit.

Permeability is moderately slow in the Gara soil. Surface runoff is rapid. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential also is moderate.

Most areas are used as pasture. A few areas are used for trees. Because of the slope, this soil is unsuitable for cultivated crops. It is well suited to red clover, birdsfoot trefoil, tall fescue, and switchgrass. It is moderately well suited to alfalfa, orchardgrass, smooth bromegrass, big bluestem, and indiangrass. Further erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary.

Some areas support stands of native hardwoods. This soil is suited to trees. The hazard of erosion and the equipment limitation are the main management concerns. Special erosion-control measures are required. Carefully designing and constructing logging roads and skid trails minimizes the steepness and length of slopes and the concentration of water. Seeding of disturbed areas may be necessary after harvesting is completed. Because of the slope, operating equipment is hazardous. Roads and skid trails should be constructed on the contour. In the steepest areas the logs should be yarded uphill to logging roads and skid trails. Direct seeding or hand planting may be necessary.

This soil is generally not used for sanitary facilities and building site development because of the slope.

The land capability classification is VIIe. The woodland ordination symbol is 3R.

15C2—Gorin silt loam, 3 to 9 percent slopes, eroded. This very deep, gently sloping and moderately sloping, somewhat poorly drained soil commonly is on narrow, convex ridgetops and on side slopes adjacent to flood plains. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 60 acres in size.

Typically, the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil extends to a depth of 60 inches or more. In sequence downward it is yellowish brown silty clay loam; yellowish brown, mottled silty clay; dark yellowish brown, mottled silty clay loam; grayish brown, mottled silty clay loam; and yellowish brown, mottled clay loam. In areas the lower part of the subsoil has less sand and glacial pebbles.

Included with this soil in mapping are a few small areas of the moderately well drained Keswick soils. These soils are on the lower parts of ridgetops and on secondary ridges. They make up about 5 percent of the unit.

Permeability is slow in the Gorin soil. Surface runoff is medium. The available water capacity is high. Organic matter content is low. The shrink-swell potential is high in the subsoil. A perched water table is at a depth of 2 to 4 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range in moisture conditions.

Most areas are used for pasture or hay. A few areas are used for row crops and trees. If row crops are grown, erosion is a hazard. It can be controlled, however, by conservation tillage that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping system that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways.

Growing grasses and legumes for pasture or hay is effective in controlling erosion. This soil is moderately well suited to tall fescue, reed canarygrass, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to smooth bromegrass, orchardgrass, red clover, and alfalfa. Species that are tolerant of wetness grow best. Erosion control during seedbed preparation is the main management problem. Timely tillage and a quickly established ground cover help to prevent excessive erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

Some areas support stands of native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown seedlings helps to ensure better survival rates. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well if the sites are leveled or graded. The shrink-swell potential and wetness are problems on sites for dwellings. Installing tile drains around foundations and footings can reduce the wetness. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

16C2—Clarinda silty clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, poorly drained soil is on concave slopes at the head of drainageways and on the sides of ridges in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 220 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. The subsoil extends to a depth of 60 inches or more. It is dark gray and gray, mottled silty clay in the upper part and gray and olive gray, mottled clay in the lower part.

Included with this soil in mapping are areas of the somewhat poorly drained Seymour and moderately well drained Shelby soils. Seymour soils are on ridgetops above the Clarinda soil. Shelby soils are on the lower side slopes. Also included are some areas of severely eroded soils that have a surface layer of grayish brown silty clay. Included soils make up about 5 to 10 percent of this unit.

Permeability is very slow in the Clarinda soil. Surface runoff is medium in cultivated areas. The available water capacity is moderate. Organic matter content also is moderate. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during winter and spring. The surface layer is friable but can be easily tilled only within a narrow range in moisture content.

Most areas are used for row crops, pasture, or hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways. Returning crop residue to the soil or regularly adding other organic material improves fertility, reduces crusting, and increases the rate of water infiltration.

Growing grasses and legumes for pasture or hay is very effective in controlling erosion. This soil is moderately well suited to reed canarygrass and switchgrass and moderately suited to tall fescue, birdsfoot trefoil, big bluestem, and indiangrass. Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. Erosion is the main management problem. Disking during reseeding should be timely and on the contour. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well if the sites are leveled. If dwellings are built, measures that overcome the shrink-swell potential and wetness are needed. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IVe.

17C2—Armstrong clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, somewhat poorly drained soil is on narrow, convex ridgetops and side slopes. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 250 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 5 inches thick. The subsoil extends to a depth of 60 inches or more. It is brown, mottled clay loam in the upper part; brown, strong brown, and yellowish brown, mottled clay in the next part; and yellowish brown, mottled clay loam in the lower part. In several slightly eroded areas, the surface layer is loam.

Included with this soil in mapping are small areas of the poorly drained Rinda soils. These soils have less glacial sand and pebbles than the Armstrong soil. They are on the less dissected parts of the landscape and at the head of drainageways. Also included are areas of severely eroded soils that have a brown surface layer. Included soils make up about 5 percent of this unit.

Permeability is slow in the Armstrong soil. Surface runoff is medium. The available water capacity is moderate. Organic matter content is moderately low. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during winter and spring. The surface layer is very friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for row crops, hay, or pasture. A few areas are used for trees. This soil is suited to corn, soybeans, and small grain grown in a crop rotation that includes some close-growing pasture or hay plants. If cultivated crops are grown, further erosion is a hazard. Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed in grassed waterways. Leaving crop residue on the field throughout the winter helps to protect 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 or hay is very effective in controlling erosion. Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, big bluestem, indiangrass, and switchgrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. Erosion control is a problem. A good ground cover is necessary at all times to maintain forage production. Nurse crops help to prevent excessive erosion in newly seeded areas. Timely tillage is needed, and the soil should be tilled on the contour. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few areas support stands of native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown seedlings helps to ensure better survival rates. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function adequately if the sites are leveled. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

17D2—Armstrong clay loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, somewhat poorly drained soil is on side slopes and narrow convex ridgetops. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 5 to more than 450 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 5 inches thick. The subsoil to a depth of 60 inches or more is mottled clay loam. It is dark yellowish brown and strong brown in the upper part, yellowish brown in the next part, and yellowish brown and dark yellowish brown in the lower part.

Included with this soil in mapping are small areas of the moderately well drained Gara soils on side slopes. Also included are areas of severely eroded soils that have a brown surface layer. Included soils make up about 10 percent of this unit.

Permeability is slow in the Armstrong soil. Surface runoff is medium. The available water capacity is moderate. Organic matter content is moderately low. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for hay or pasture. Some areas are used for row crops. A few areas are used for trees.

If crop rotations that include small grain and close-growing pasture or hay plants are used, this soil is suited to row crops on a limited basis. The hazard of erosion is severe if row crops are grown continually. Conservation tillage that leaves protective amounts 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 in grassed waterways. Leaving crop residue on the field throughout the winter helps to protect 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 or hay is very effective in controlling erosion. Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, 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 to maintain forage production. Nurse crops help to prevent excessive erosion in newly seeded areas. Measures that maintain fertility and control brush and weeds are necessary. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few areas support native hardwoods. This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown seedlings helps to ensure better survival rates. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons and dwellings should be graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IVe. The woodland ordination symbol is 3C.

19D2—Keswick loam, 5 to 14 percent slopes, eroded. This very deep, moderately sloping and strongly sloping, moderately well drained soil is on narrow ridges and convex side slopes. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 400 acres in size.

Typically, the surface layer is dark grayish brown loam about 4 inches thick. The subsoil extends to a depth of 60 inches or more. It is reddish brown, mottled clay loam in the upper part; brown and strong brown, mottled clay in the next part; and yellowish brown, mottled clay loam in the lower part.

Included with this soil in mapping are small areas of the somewhat poorly drained Gorin soils on narrow ridges. Also included are a few areas of severely eroded soils that have a surface layer of brown clay loam. Included soils make up about 10 percent of this unit.

Permeability is slow in the Keswick soil. Surface runoff is medium. The available water capacity is moderate. Organic matter content is moderately low. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for pasture, hay, or trees. Growing grasses and legumes for pasture or hay is effective in controlling erosion. Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, big bluestem, switchgrass, and indiangrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. Erosion is the main management concern. A good ground cover is necessary at all times to maintain forage production. Nurse crops help to prevent excessive erosion in newly seeded areas. Measures that maintain fertility and control brush and weeds are necessary. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

Figure 7.—A forest on Keswick loam, 5 to 14 percent slopes, eroded.

This soil is suited to trees (fig. 7). Windthrow is the main management concern. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suited to cultivated crops on a limited basis. Erosion is a severe hazard. It can be controlled, however, by conservation tillage that leaves protective amounts of crop residue on the surface, winter cover crops, terraces, grassed waterways, contour farming, and a cropping system that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons and dwellings should be graded. Installing tile drains around foundations and footings can reduce the wetness. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness. Cut-and-fill may be necessary in some areas because of the slope. Roads should be constructed on the contour.

The land capability classification is IVe. The woodland ordination symbol is 3C.

21B2—Seymour silty clay loam, 2 to 5 percent slopes, eroded. This very deep, gently sloping, somewhat poorly drained soil is on convex ridgetops and side slopes below nearly level, upland divides. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 475 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsurface layer also is very dark grayish brown silty clay loam. It is about 3 inches thick. The subsoil extends to a depth of 60 inches or more. It is dark grayish brown, mottled silty clay in the upper part; grayish brown, mottled silty clay in the next part; and grayish brown, mottled silty clay loam in the lower part. In some slightly eroded areas, the surface layer is silt loam.

Included with this soil in mapping are small areas of the poorly drained Edina soils. These soils have a surface layer that is thicker than that of the Seymour soil. They are in areas slightly above the Seymour soil, on nearly level to concave, upland divides. They make up about 5 percent of this unit.

Permeability is very slow in the Seymour soil. Surface runoff is medium. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 2 to 4 feet during winter and spring. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, grain sorghum, and small grain and to grasses and legumes for hay and pasture. Further erosion is a hazard if the soil is used for cultivated crops. It can be controlled, however, by conservation tillage that leaves protective amounts of crop residue on the surface, winter cover crops, underground tile outlets, grassed waterways, contour farming, and a cropping system that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways.

Growing grasses and legumes for pasture or hay is effective in controlling erosion (fig. 8). This soil is moderately well suited to tall fescue, reed canarygrass, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to smooth bromegrass, orchardgrass, red clover, and alfalfa. Species that are tolerant of wetness grow best. Erosion control during seedbed preparation is the main management problem. Timely tillage and a quickly established ground cover help to prevent excessive erosion. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well if the sites are leveled or graded. The shrink-swell potential and wetness are problems on sites for dwellings. Installing tile drains around foundations and footings can reduce the wetness. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe.

25C2—Lamoni clay loam, 5 to 9 percent slopes, eroded. This very deep, moderately sloping, somewhat poorly drained soil is on the upper side slopes, on narrow ridgetops, and at the head of drainageways in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 150 acres in size.

Typically, the surface layer is very dark gray clay loam about 8 inches thick. The subsoil is about 44 inches thick. It is dark grayish brown and grayish brown, mottled clay in the upper part; grayish brown, mottled clay in the next part; and coarsely mottled yellowish brown, dark yellowish brown, and gray clay loam in the lower part. The substratum to a depth of 60 inches or more is yellowish brown, mottled clay loam. In some slightly eroded areas, the surface layer is silt loam.

Included with this soil in mapping are small areas of the poorly drained Clarinda and moderately well drained Shelby soils. Clarinda soils are at the head of drainageways and in landscape positions higher than those of the Lamoni soil. Shelby soils are on the steeper side slopes. Also included are areas of severely eroded soils that have a surface layer of dark grayish brown clay loam. Included soils make up about 10 percent of this unit.

Permeability is slow in the Lamoni soil. Surface

Figure 8.—Hay in an area of Seymour silty clay loam, 2 to 5 percent slopes, eroded.

runoff is medium. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is very friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops, hay, or pasture. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a severe hazard. It can be controlled, however, by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways. In some areas slopes are long enough and smooth enough for terracing and for farming on the contour.

Growing grasses and legumes for pasture or hay is effective in controlling erosion. Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, big bluestem, switchgrass, and indiangrass. It is moderately suited to alfalfa, red clover, orchardgrass, and smooth bromegrass. Erosion is the main management concern. A good ground cover is necessary at all times to maintain forage production. Nurse crops help to prevent excessive erosion in newly seeded areas. Timely tillage is needed, and the soil should be tilled on the contour. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function adequately if the sites are leveled or graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe.

25D2—Lamoni clay loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, somewhat poorly drained soil is on upland side slopes. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 125 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. The subsoil is 44 or more inches thick. It is dark grayish brown, mottled clay in the upper part and grayish brown, mottled clay loam in the lower part. The substratum to a depth of 60 inches or more is strong brown, mottled clay loam.

Included with this soil in mapping are small areas of the poorly drained Clarinda and moderately well drained Shelby soils. Clarinda soils are at the head of drainageways and in landscape positions higher than those of the Lamoni soil. Shelby soils are on the lower side slopes. Also included are a few areas of severely eroded soils that have a surface layer of dark grayish brown clay loam. Included soils make up about 5 percent of this unit.

Permeability is slow in the Lamoni soil. Surface runoff is medium. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for hay or pasture. Some areas are used for row crops. If crop rotations that include small grain and close-growing pasture or hay plants are used, this soil is suited to row crops on a limited basis. The hazard of erosion is severe if row crops are grown continually. Conservation tillage that leaves protective amounts of crop residue on the surface throughout the year, winter cover crops, stripcropping, and grassed waterways help to prevent excessive soil loss. Some type of grade stabilization structure generally is needed in grassed waterways. Leaving crop residue on the field throughout the winter helps to protect 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 or hay is effective in controlling erosion. Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to birdsfoot trefoil, reed canarygrass, tall fescue, big bluestem, switchgrass, and indiangrass. 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 to maintain forage production. Nurse crops help to prevent excessive erosion in newly seeded areas. Timely tillage is needed, and the soil should be tilled on the contour. Measures that maintain fertility and control brush and weeds are necessary. Overgrazing or grazing when the soil is very wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons and dwellings can be graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IVe.

29E2—Winnegan loam, 14 to 20 percent slopes, eroded. This very deep, moderately steep, moderately well drained soil is on dissected side slopes in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 500 acres in size.

Typically, the surface layer is dark grayish brown loam about 4 inches thick. The subsoil is about 28 inches thick. It is yellowish brown clay loam in the upper part and yellowish brown, mottled clay loam in the lower part. The substratum to a depth of 60 inches or more is mottled dark yellowish brown, yellowish brown, and light brownish gray clay loam. In places the surface layer is clay loam.

Included with this soil in mapping are areas of Keswick soils on the upper side slopes and areas of the moderately deep Vanmeter soils on the lower side slopes. Keswick soils are redder than the Winnegan soil and have grayer mottles in the upper part of the subsoil. Vanmeter soils are calcareous in the lower part. Also included are a few areas of severely eroded soils that have a surface layer of yellowish brown clay loam. Included soils make up about 5 percent of this unit.

Permeability is slow in the Winnegan soil. Surface runoff is rapid. The available water capacity is moderate. Organic matter content is low. The shrink-swell potential of the subsoil is high. A seasonal high water table is at a depth of 2.0 to 3.5 feet during most winter and spring months.

Most areas are used for pasture or trees. Because of the slope, this soil is unsuitable for cultivated crops. It is well suited to red clover, birdsfoot trefoil, tall fescue, and switchgrass. It is moderately well suited to alfalfa, orchardgrass, smooth bromegrass, big bluestem, and indiangrass. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary.

Many areas support stands of native hardwoods. This soil is suited to trees. The hazard of erosion and the equipment limitation are the main management concerns. Special erosion-control measures are required. Carefully designing and constructing logging roads and skid trails minimizes the steepness and length of slopes and the concentration of water. Seeding of disturbed areas may be necessary after harvesting is completed. Because of the slope, operating equipment is hazardous. Roads and skid trails should be constructed on the contour. In the steepest areas the logs should be yarded uphill to logging roads and skid trails. Direct seeding or hand planting may be necessary.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons or dwellings should be graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness. Cut-and-fill may be necessary in some areas because of the slope. Roads should be constructed on the contour.

The land capability classification is VIe. The woodland ordination symbol is 3R.

29F—Winnegan loam, 20 to 35 percent slopes. This very deep, steep and very steep, moderately well drained soil is on dissected side slopes in the uplands. Individual areas are irregular in shape and range from about 20 to more than 700 acres in size.

Typically, the surface layer is very dark grayish brown loam about 3 inches thick. The subsurface layer is brown loam about 3 inches thick. The subsoil extends to a depth of 60 inches or more. It is yellowish brown clay loam in the upper part; dark yellowish brown and yellowish brown, mottled clay loam in the next part; and coarsely mottled dark yellowish brown, yellowish brown, and light brownish gray clay loam and loam in the lower part. In several areas the surface layer is brown or dark grayish brown clay loam.

Included with this soil in mapping are areas of Keswick soils on the upper side slopes and areas of the moderately deep Vanmeter soils on the lower side slopes. Keswick soils are redder than the Winnegan soil and have grayer mottles in the upper part of the subsoil. Vanmeter soils are calcareous in the lower part. Also included are areas of soils that have been subject to severe erosion and sloughing and have a calcareous substratum that is only a few inches from the surface. Most of these areas are on very steep side slopes and have distinct natural terraces, or catsteps, which formed as a result of soil slumping. Included soils make up about 10 percent of this unit.

Permeability is slow in the Winnegan soil. Surface runoff is rapid. The available water capacity is moderate. Organic matter content is low. The shrink-swell potential of the subsoil is high. A seasonal high water table is at a depth of 2.0 to 3.5 feet during most winter and spring months.

Most areas are used for pasture or trees (fig. 9). Because of the slope, this soil is unsuitable for cultivated crops. It is suited to red clover, birdsfoot trefoil, tall fescue, and switchgrass. It is moderately well suited to alfalfa, orchardgrass, smooth bromegrass, big

Figure 9.—Pasture and trees in an area of Winnegan loam, 20 to 35 percent slopes.

bluestem, and indiangrass. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Overgrazing should be avoided. Measures that maintain fertility and control brush are necessary.

Many areas support stands of native hardwoods. This soil is suited to trees. The hazard of erosion and the equipment limitation are the main management concerns. Special erosion-control measures are required. Carefully designing and constructing logging roads and skid trails minimizes the steepness and length of slopes and the concentration of water. Seeding of disturbed areas may be necessary after harvesting is completed. Because of the slope, operating equipment is hazardous. Roads and skid trails should be constructed on the contour. In the steepest areas the logs should be yarded uphill to logging roads and skid trails. Direct seeding or hand planting may be necessary.

This soil generally is unsuited to sanitary facilities and building site development because of the slope.

The land capability classification is VIIe. The woodland ordination symbol is 3R.

30B—Pershing silty clay loam, 2 to 5 percent slopes. This very deep, gently sloping, somewhat poorly drained soil typically is on convex ridgetops. Individual areas are long and narrow and range from about 7 to more than 400 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 6 inches thick. The subsoil is about 46 inches thick. It is brown silty clay loam in the upper part; dark grayish brown, mottled silty clay in the next part; and grayish brown, mottled silty clay loam in the lower part. The substratum to a depth of 60 inches or more is grayish brown, mottled silty clay loam.

In some places the solum has more glacial sand and pebbles throughout. In other places the surface layer is silt loam.

Permeability is slow in the Pershing soil. Surface runoff is medium in cultivated areas. The available water capacity is high. Organic matter content is moderately low. The shrink-swell potential of the subsoil is high. A perched water table is at a depth of 2 to 4 feet during most winter and spring months. The surface layer is very friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for row crops, pasture, or hay. A few areas are used for trees. This soil is moderately well suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a hazard. It can be controlled by a conservation tillage system that leaves protective amounts of crop residue on the surface, winter cover crops, underground tile outlets, terraces, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture or hay plants. Some type of grade stabilization structure generally is needed in grassed waterways. 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 or hay is effective in controlling erosion. This soil is moderately well suited to tall fescue, reed canarygrass, birdsfoot trefoil, big bluestem, indiangrass, and switchgrass. It is moderately suited to smooth bromegrass, orchardgrass, red clover, and alfalfa. Species that are tolerant of wetness grow best. Erosion control during seedbed preparation is the main management problem. Timely tillage and a quickly established ground cover help to prevent excessive erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

A few areas support stands of hardwoods. This soil is suited to trees. Seedling mortality and windthrow are management concerns. Planting container-grown seedlings helps to ensure better survival rates. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well if the sites are leveled or graded. The shrink-swell potential and wetness are problems on sites for dwellings. Installing tile drains around foundations and footings can reduce the wetness. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe. The woodland ordination symbol is 3C.

31D2—Shelby loam, 9 to 14 percent slopes, eroded. This very deep, strongly sloping, moderately well drained soil is on convex side slopes in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 150 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The upper part of the subsoil is dark yellowish brown clay loam. The next part is dark yellowish brown and dark brown, mottled clay loam. The lower part to a depth of 60 inches or more is dark yellowish brown and yellowish brown, mottled clay loam that has about 10 percent soft masses of calcium carbonate.

Included with this soil in mapping are small areas of the somewhat poorly drained Adair and Lamoni and poorly drained Clarinda soils. These soils are on the higher side slopes and at the head of drainageways. Also included are a few areas of severely eroded soils that have a surface layer of brown clay loam. Included soils make up about 10 percent of this unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is moderate. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops, pasture, or hay. If crop rotations that include small grain and close-growing pasture or hay plants are used, this soil is suited to row crops on a limited basis. The hazard of erosion is severe if row crops are grown continually. Conservation tillage that leaves protective amounts 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 in grassed waterways. Leaving crop residue on the field throughout the winter helps to protect 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 or hay is very effective in controlling erosion. This soil is well suited to timothy, red clover, tall fescue, birdsfoot trefoil, and switchgrass. It is moderately well suited to smooth bromegrass, orchardgrass, alfalfa, big bluestem, and indiangrass. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Measures that maintain fertility and control brush and weeds are necessary. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons and dwellings should be graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness. Cut-and-fill may be necessary in some areas because of the slope. Roads should be constructed on the contour.

The land capability classification is IVe.

31E2—Shelby loam, 14 to 20 percent slopes, eroded. This very deep, moderately steep, moderately well drained soil is on convex side slopes in the uplands. Water erosion has removed some of the original surface layer. The remaining surface soil has been mixed with the upper part of the subsoil. Individual areas are irregular in shape and range from about 10 to more than 500 acres in size.

Typically, the surface layer is very dark grayish brown loam about 8 inches thick. The upper part of the subsoil is dark yellowish brown and yellowish brown clay loam. The next part is yellowish brown, mottled clay loam. The lower part to a depth of 60 inches or more is yellowish brown, mottled clay loam that has about 10 percent soft masses of calcium carbonate.

Included with this soil in mapping are small areas of the somewhat poorly drained Adair and Lamoni and poorly drained Clarinda soils. These soils are on the higher side slopes and at the head of drainageways. Also included are a few areas of severely eroded soils that have a surface layer of brown clay loam. Included soils make up about 10 percent of this unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is moderate.

Most areas are used for pasture or hay. Because of the slope, this soil is unsuitable for cultivated crops. It is well suited to timothy, red clover, tall fescue, birdsfoot trefoil, and reed canarygrass. It is moderately well suited to smooth bromegrass, orchardgrass, alfalfa, big bluestem, and indiangrass. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Measures that maintain fertility and control brush and weeds are necessary. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suitable for some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sites for sewage lagoons, dwellings, and roads should be graded. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness. Cut-and-fill may be necessary in some areas because of the slope. Roads should be constructed on the contour.

The land capability classification is VIe.

Figure 10.—A water-filled pit in an area of Putco silty clay loam, 30 to 60 percent slopes.

32F—Putco silty clay loam, 30 to 60 percent slopes. This very steep soil is mainly in areas of spoil associated with coal-mining activities. It also is in a few open pits or trenches from which coal was removed. At certain times of the year, some of the pits contain water (fig. 10). Individual areas are irregular in shape and range from about 10 to more than 100 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 4 inches thick. The substratum to a depth of 60 inches or more is mixed grayish brown, very dark gray, and dark reddish brown very channery silty clay.

The properties of this soil vary considerably. In most places the soil is dominantly clayey, but in some places it is loamy. In some areas shale, limestone and sandstone boulders, flagstones, and cobbles are on and below the surface. Some areas have slopes of less than 30 percent.

Permeability is slow in the Putco soil. Surface runoff is rapid. The available water capacity is low. Organic matter content also is low. The shrink-swell potential of the subsoil is high.

Areas of this soil have been left idle and are reverting to natural vegetation. Cottonwood and willow are the dominant trees. The potential for production of commercial timber is low and generally cannot justify the required management costs.

Areas of this soil are too steep and uneven for farm machinery. The soil provides limited food and cover for wildlife.

The land capability classification is VIIe. The woodland ordination symbol is 2R.

33F—Vanmeter silty clay loam, 14 to 30 percent slopes. This moderately deep, moderately steep and steep, moderately well drained soil is on upland side slopes adjacent to the larger streams and their tributaries. Individual areas are irregular in shape and range from about 20 to more than 200 acres in size.

Typically, the surface layer is dark grayish brown silty clay loam about 5 inches thick. The subsoil is about 21 inches thick. It is dark brown silty clay loam in the upper part and dark brown, mottled silty clay in the lower part. Weathered shale bedrock is at a depth of about 26 inches. In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of the deep Keswick and Winnegan soils that formed in glacial till. Keswick soils are on the upper side slopes and narrow ridges. Winnegan soils are in positions on side slopes similar to those of the Vanmeter soil. Also included are a few small rocky areas and some areas of rock outcrop and ledges. Included areas make up about 10 percent of this unit.

Permeability is very slow in the Vanmeter soil. Surface runoff is rapid. The available water capacity is low. Organic matter content is moderately low. The shrink-swell potential of the subsoil is high. Root development is restricted by clay shale at a depth of about 26 inches.

Most areas are used for trees or pasture. This soil is moderately well suited to tall fescue, birdsfoot trefoil, reed canarygrass, big bluestem, and indiangrass. It is moderately suited to smooth bromegrass, orchardgrass, and switchgrass. Operating machinery can be dangerous because of rock outcrops, rocky ledges, and stones on the surface and in the upper part of the soil. Erosion during seedbed preparation and overgrazing are the main management problems. Preparing seedbeds on the contour and in a timely manner helps to ensure the rapid growth of a ground cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture in good condition. Measures that maintain fertility and control brush and weeds are necessary.

Many areas support stands of native hardwoods. This soil is suited to trees. The main problems are erosion in disturbed areas, the equipment limitation caused by the slope, rock outcrops and ledges, seedling mortality, and windthrow. Carefully designing and constructing logging roads and skid trails on the contour minimizes the steepness and length of slopes and the concentration of water. Disturbed areas may need to be seeded after harvesting. Planting larger than normal seedlings helps to ensure better survival rates. The stands on this soil should be thinned less intensively and more frequently than the stands in areas where windthrow is less likely.

This soil generally is not used for sanitary facilities and building site development because of the slope, the depth to bedrock, and the shrink-swell potential. Sites should be selected on nearby soils that are better suited to these uses.

The land capability classification is VIIe. The woodland ordination symbol is 2R.

35—Belinda silt loam. This very deep, nearly level, poorly drained soil is on high terraces. Individual areas are irregular in shape and range from about 10 to more than 400 acres in size.

Typically, the surface layer is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is grayish brown, mottled silt loam about 6 inches thick. The subsoil extends to a depth of 60 inches or more. It is dark grayish brown, mottled silty clay in the upper part and grayish brown, mottled silty clay loam in the lower part.

Included with this soil in mapping are soils in small, slightly concave areas. These soils are very poorly drained. They make up about 5 to 10 percent of this unit.

Permeability is very slow in the Belinda soil. Surface runoff is slow in cultivated areas. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is high. A seasonal high water table is at a depth of 0.5 foot to 2.0 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for row crops, pasture, or hay. This soil is suited to corn, soybeans, and small grain. Wetness can be a problem if cultivated crops are grown. Returning crop residue to the soil or regularly adding other organic material improves fertility, minimizes crusting, and increases the rate of water infiltration.

Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to reed canarygrass and moderately suited to birdsfoot trefoil and alsike clover. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function well on this soil. The shrink-swell potential and wetness are problems on sites for dwellings. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the

Figure 11.—A cutbank, a hayfield, and mixed grasses and trees in an area of Schuline clay loam, 9 to 35 percent slopes.

damage caused by shrinking and swelling. Installing tile drains around foundations and footings can reduce the wetness.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIw.

37F—Schuline clay loam, 9 to 35 percent slopes. This very deep, strongly sloping to very steep, well drained soil is on upland ridgetops and side slopes, in areas that have been surface mined for coal. Areas of the soil were excavated during surface mining activities and have since been graded and reclaimed (fig. 11). Individual areas are rectangular and range from about 10 to more than 300 acres in size.

Typically, the surface layer is mixed brown and yellowish brown clay loam about 3 inches thick. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam.

Included with these soils in mapping are a few areas that have slopes of less than 9 percent. Also included are a few open pits that contain water. Included areas make up about 10 to 15 percent of this unit.

Permeability is slow in the Schuline soil. Surface runoff is medium. The available water capacity is moderate. Organic matter content is very low. The shrink-swell potential of the subsoil is moderate.

Most areas are used for pasture or hay. This soil is well suited to tall fescue, birdsfoot trefoil, reed canarygrass, red clover, and switchgrass. It is moderately well suited to smooth bromegrass, orchardgrass, alfalfa, big bluestem, and indiangrass. The rooting depth of some forage species may be limited somewhat by the compactness of the substratum. Species that are tolerant of a limited rooting depth grow best. Erosion control during seedbed preparation is the major concern. Timely tillage and a quickly established ground cover help to prevent excessive erosion.

This soil is suited to some kinds of sanitary facilities and building site development. Permeability, the slope, and the shrink-swell potential are problems. Generally, some land shaping is needed. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling. This soil is unsuited to septic tank systems because of the permeability. Sewage lagoons can function adequately if slopes are modified.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling and by frost action.

The land capability classification is VIIe.

50—Amana silty clay loam. This very deep, nearly level, somewhat poorly drained soil is in the slightly higher areas on flood plains along the Chariton River. It is occasionally flooded. Individual areas are irregular in shape and range from about 10 to more than 300 acres in size.

Typically, the surface layer and subsurface layer to a depth of about 17 inches are very dark gray silty clay loam. The subsoil is dark grayish brown, mottled silt loam about 31 inches thick. The substratum to a depth of about 60 inches or more is mottled dark grayish brown and dark yellowish brown silt loam. In some areas the surface layer is silt loam.

Included with this soil in mapping are a few small areas of the poorly drained Colo soils. These soils are in low or slightly depressional areas and in old stream channels. Also included are a few areas of soils that have a substratum that is browner than that of the Amana soil. Included soils make up about 10 percent of this unit.

Permeability is moderate in the Amana soil. Surface runoff is slow in cultivated areas. The available water capacity is very high. Organic matter content is moderate. The shrink-swell potential of the subsoil also is moderate. A seasonal high water table is at a depth of 2 to 4 feet during winter and spring. The surface layer is friable and can be tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops. The main crops are corn, soybeans, and small grain. Excess surface water can be removed by graded drainage ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is suited to trees. No hazards or limitations affect timber management.

This soil is unsuited to sanitary facilities and building site development because of the occasional flooding and the seasonal high water table.

The land capability classification is IIw. The woodland ordination symbol is 8A.

57B—Vigar-Zook-Nodaway complex, 1 to 5 percent slopes. These very deep, nearly level and gently sloping soils are along narrow drainageways and in other areas adjacent to moderately sloping to very steep side slopes in the uplands. The Zook and Nodaway soils are frequently flooded. The Vigar soil is subject to rare flooding. Individual areas of these soils are long and narrow or irregular in shape. They range from about 200 to 1,000 feet in width and from about 1,500 feet to more than a mile in length.

The Vigar soil makes up about 40 percent of the map unit, the Zook soil 30 percent, and the Nodaway soil 20 percent. The Vigar soil occurs as bands on foot slopes and alluvial fans. The Zook soil is in depressions. The Nodaway soil is along drainageways. The three soils occur as areas too small, irregular, narrow, or intermingled to be separated in mapping.

Typically, the surface layer of the Vigar soil is very dark brown loam about 12 inches thick. The subsurface layer is very dark gray clay loam about 18 inches thick. The subsoil to a depth of 60 inches or more is very dark grayish brown and dark brown clay loam.

Typically, the surface layer of the Zook soil is black silty clay loam about 7 inches thick. The subsurface layer is about 29 inches of black and very dark gray silty clay loam and very dark gray silty clay. The subsoil and the substratum to a depth of 60 inches or more are dark gray, mottled silty clay.

Typically, the surface layer of the Nodaway soil is very dark grayish brown silt loam about 8 inches thick. The substratum to a depth of 60 inches or more is stratified dark grayish brown, brown, and very dark grayish brown silt loam and silty clay loam.

Included with these soils in mapping are small areas of the poorly drained Humeston soils on low terraces and concave foot slopes. Also included are entrenched drainageways that carry water part of the year. Included areas make up about 10 percent of this unit.

Permeability is moderately slow in the Vigar soil, slow in the Zook soil, and moderate in the Nodaway soil. Surface runoff is medium on the Vigar soil and slow on the Zook and Nodaway soils. The available water capacity is high in the Vigar and Zook soils and very high in the Nodaway soil. Organic matter content is high in the Zook soil and moderate in the Vigar and Nodaway soils. A seasonal high water table is at a depth of 2 to 3 feet in the Vigar soil, within a depth of 3 feet in the Zook soil, and at a depth of 3 to 5 feet in the Nodaway soil. The surface layer of the Vigar soil is friable and can be easily tilled throughout a moderate range in moisture conditions. The surface layer of the Zook soil is sticky when wet and can be tilled only under optimum moisture conditions. The surface layer of the Nodaway soil is friable and can be tilled throughout a fairly wide range of moisture conditions.

Most areas are used as pasture. Some areas are used for trees. A few accessible areas are used for row crops. These soils are poorly suited to row crops because of the meandering drainageways and the flooding. Ditchbank erosion and runoff from the uplands also are problems.

These soils are suited to pasture and hay. Because low areas hold water for long periods after rains, the growth of stands of legumes and of some grasses is limited. Reed canarygrass, alsike clover, and birdsfoot trefoil grow better than other species. On the Zook soil, deep-rooted legumes, such as alfalfa, do not grow well because of the high water table. Most of the grasses and legumes commonly grown in the survey area grow well on the Vigar and Nodaway soils. Overgrazing reduces the production of grasses and legumes and increases the amount of weeds. Timely mowing helps to control the competition from undesirable plants and encourages uniform grazing. Grazing when the soils are too wet causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture in good condition.

These soils are suitable as habitat for openland, woodland, and wetland wildlife. Wetness-tolerant plants should be grown for food and cover.

These soils are unsuited to sanitary facilities and building site development. Most areas of the Vigar soil occur as small, narrow bands and are not large enough for development. The Zook and Nodaway soils are unsuitable because of the flooding.

The land capability classification is IVw. The woodland ordination symbol is 3A for the Nodaway soil. No woodland ordination symbol was assigned to the Vigar and Zook soils.

58—Colo silt loam. This very deep, nearly level, poorly drained soil is on flood plains. It is frequently flooded. Individual areas are irregular in shape and range from about 10 to more than 150 acres in size.

Typically, the surface layer is very dark gray silt loam about 11 inches thick. The subsurface layer is about 30 inches thick. It is black silt loam in the upper part and black silty clay loam in the lower part. The subsoil to a depth of 60 inches or more is very dark gray, mottled silty clay loam. In some places the surface layer is overwash of silty clay loam. In other places the subsoil has more clay throughout.

Included with this soil in mapping are small areas of the moderately well drained Nodaway soils. These soils are adjacent to stream channels and are stratified with recent sediments. They make up about 10 percent of this unit.

Permeability is moderate in the Colo soil. Surface runoff is slow in cultivated areas. The available water capacity is high. Organic matter content also is high. The shrink-swell potential is moderate. A seasonal high water table is at a depth of 1 to 3 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range in moisture content.

Most areas are used for cultivated crops, pasture, or hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, flooding may cause damage. Excess surface water can be removed by graded drainage ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to reed canarygrass and alsike clover. Flooding and wetness are problems if this soil is used for hay. The flooding should be considered when the grazing system is designed. Preparing a seedbed is difficult only during wet periods. Land grading and ditches help to remove excess water.

This soil is unsuited to sanitary facilities and building site development because of the frequent flooding and the seasonal high water table.

The land capability classification is IIIw.

63—Humeston silty clay loam. This very deep, nearly level, poorly drained soil is on high flood plains. It is occasionally flooded. Individual areas are irregular in shape and range from about 15 to more than 80 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 12 inches thick. The subsurface layer is dark gray, mottled silt loam about 9 inches thick. The subsoil extends to a depth of 60 inches or more. It is very dark gray, mottled silty clay loam in the upper part; black and very dark gray, mottled silty clay and silty clay loam in the next part; and very dark gray, mottled silty clay in the lower part. In some places the surface layer is silt loam.

Included with this soil in mapping are small areas of Colo and Zook soils. These soils have a dark surface layer that is thicker than that of the Humeston soil and commonly are in the lower areas on the flood plains. Also included are a few small depressional areas that are subject to ponding. Included areas make up about 5 to 10 percent of this unit.

Permeability is very slow in the Humeston soil. Surface runoff is slow in cultivated areas. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential of the subsoil is high. A seasonal high water table is at a depth of 1 foot or less during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops, pasture, or hay. This soil is suited to corn, soybeans, and small grain. If cultivated crops are grown, flooding may cause damage. Excess surface water can be removed by graded drainage ditches. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

Mixtures of pasture and hay plants that include wetness-tolerant species grow best on this soil. The soil is moderately well suited to reed canarygrass and moderately suited to alsike clover, birdsfoot trefoil, and ladino clover. Flooding and wetness are problems if this soil is used for hay. The flooding should be considered when the grazing system is designed. Preparing a seedbed is difficult only during wet periods. The deeper rooted species grow better if a surface drainage system is installed.

This soil is unsuited to sanitary facilities and building site development because of the occasional flooding and the seasonal high water table.

The land capability classification is IIIw.

66—Nodaway silt loam. This very deep, nearly level, moderately well drained soil is on flood plains adjacent to old stream channels. It is frequently flooded. Individual areas are long and narrow and range from about 20 to more than 400 acres in size.

Typically, the surface layer is very dark gray silt loam about 7 inches thick. The substratum to a depth of 60 inches or more is silt loam. It is stratified very dark gray and grayish brown in the upper part and stratified very dark grayish brown, dark grayish brown, and brown in the lower part. In a few areas the substratum has grayer colors.

Included with this soil in mapping are small areas of the poorly drained Colo and Zook soils. These soils are farther from the stream channels than the Nodaway soil and are at the slightly lower elevations. Also included are a few old stream channels. Included areas make up about 10 percent of this unit.

Permeability is moderate in the Nodaway soil. Surface runoff is slow in cultivated areas. The available water capacity is very high. Organic matter content is moderate. A seasonal high water table is at a depth of 3 to 5 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops (fig. 12). A few areas are used as pasture or woodland. This soil is well suited to corn, soybeans, and small grain. It is subject to scouring and sedimentation during periods of flooding in spring and fall. Conservation tillage that leaves protective amounts of crop residue on the surface helps to prevent excessive soil loss. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration.

This soil is well suited to tall fescue, reed canarygrass, orchardgrass, birdsfoot trefoil, alfalfa, red clover, and switchgrass. It is moderately well suited to smooth bromegrass, big bluestem, and indiangrass. Flooding is the main management problem. Flooding should be considered when the grazing system is designed.

This soil is suited to trees. No hazards or limitations affect timber management.

This soil is unsuited to sanitary facilities and building site development because of the frequent flooding.

The land capability classification is IIw. The woodland ordination symbol is 3A.

68C—Vigar silt loam, 2 to 9 percent slopes. This very deep, gently sloping and moderately sloping, moderately well drained soil is on slightly concave or plane foot slopes. It is subject to rare flooding. Individual areas are long and narrow or irregular in shape and range from about 20 to more than 125 acres in size.

Typically, the surface layer is black silt loam about 6 inches thick. The subsurface layer also is black silt loam. It is about 9 inches thick. The subsoil extends to a depth of 60 inches or more. It is very dark grayish brown and very dark gray silty clay loam in the upper part; dark grayish brown, mottled clay loam in the next part; and grayish brown, mottled clay loam in the lower part.

Included with this soil in mapping are small areas of the poorly drained Colo and Zook soils. These soils are on flood plains adjacent to the Vigar soil. They make up about 5 percent of this unit.

Permeability is moderately slow in the Vigar soil.

Figure 12.—Corn in an area of Nodaway silt loam. Winnegan soils are in the background.

Surface runoff is medium in cultivated areas. The available water capacity is high. Organic matter content is moderate. The shrink-swell potential is moderate. A seasonal high water table is at a depth of 2 to 3 feet during most winter and spring months. The surface layer is friable and can be easily tilled throughout a moderate range of moisture conditions.

Most areas are used for cultivated crops, pasture, or hay. This soil is suited to row crops, such as corn, soybeans, and small grain. Erosion can be a hazard if cultivated crops are grown. Conservation tillage that leaves protective amounts of crop residue on the surface throughout the year, winter cover crops, grassed waterways, contour farming, and a cropping sequence that includes close-growing pasture plants helps to prevent excessive soil loss. In a few areas slopes are long and smooth enough for terracing and for farming on the contour. Some type of grade stabilization structure generally is needed in grassed waterways. Returning crop residue to the soil or regularly adding other organic material helps to maintain fertility.

This soil is moderately well suited to timothy, tall fescue, birdsfoot trefoil, reed canarygrass, big bluestem, indiangrass, and switchgrass. It is moderately suited to smooth bromegrass, orchardgrass, alfalfa, and red clover. Species that are tolerant of wetness grow best. Erosion is a hazard in newly seeded areas. It can be controlled, however, by timely seedbed preparation, which helps to ensure that a good ground cover is established.

This soil is suited to some kinds of sanitary facilities and building site development if proper designs and installation procedures are used. Sewage lagoons can function if the site is protected from flooding and the bottom of the lagoon is sealed with slowly permeable material. The flooding, the shrink-swell potential, and the wetness are problems on sites for dwellings. The sites should be protected from flooding. Installing tile drains around foundations and footings can reduce the wetness. Footings, foundations, and basement walls should be constructed with adequately reinforced concrete and backfilled with sand or gravel. These measures help to prevent the damage caused by shrinking and swelling.

This soil is suitable as a site for local roads and streets. Strengthening the subgrade with crushed rock or other suitable material or mixing the soil with additives helps to prevent the damage caused by low strength. Grading the roads so that they shed water, constructing side ditches, and installing culverts minimize the damage caused by shrinking and swelling, frost action, and wetness.

The land capability classification is IIIe.

76—Zook silty clay loam. This very deep, nearly level, poorly drained soil is on low flood plains along rivers and large and small streams. It is frequently flooded. Individual areas are irregular in shape and range from about 10 to more than 400 acres in size.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is about 29 inches thick. It is black silty clay loam in the upper part and black silty clay in the lower part. The subsoil is very dark gray silty clay about 9 inches thick. The substratum to a depth of 60 inches or more is dark gray, mottled silty clay. In a few areas the surface layer is silty clay.

Included with this soil in mapping are small areas of the moderately well drained Nodaway soils adjacent to the stream channels. These soils are silt loam throughout. They make up about 5 percent of this unit.

Permeability is slow in the Zook soil. Surface runoff is slow in cultivated areas. The available water capacity is high. Organic matter content also is high. The shrink-swell potential is high. A seasonal high water table is within a depth of 2 feet during most winter and spring months. The surface layer is sticky when wet and can be easily tilled only under optimum moisture conditions. If cultivated when wet, the soil is cloddy and cannot be easily managed.

Most areas are used for cultivated crops, pasture, or hay. A few small areas are used for trees. This soil is suited to corn, soybeans, and small grain. Excess water generally can be removed by surface ditches. Land grading helps to fill in potholes and results in a plane surface that is suitable for drainage. A cover of crop residue and deep tillage improves tilth and internal drainage.

This soil is moderately well suited to reed canarygrass and moderately suited to birdsfoot trefoil and alsike clover. It is best suited to the shallow-rooted grasses and legumes that can withstand wetness. Flooding and wetness are problems if the soil is used for hay. The flooding should be considered when the grazing system is designed. The deeper rooted species grow better if a surface drainage system is installed. Land grading and ditches help to remove excess surface water.

This soil is unsuited to sanitary facilities and building site development because of the frequent flooding.

The land capability classification is IIIw.

Prime Farmland

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

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

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

About 33,510 acres in Putnam County, or about 10 percent of the total acreage, meets the soil requirements for prime farmland. An additional 8,890 acres qualifies as prime farmland if the soils are drained, and another 19,280 acres qualifies if the soils are protected from flooding or not frequently flooded during the growing season. About 21,920 acres meets the requirements for prime farmland where drained and either protected from flooding or not frequently flooded during the growing season. Most of the acreage of prime farmland is used for crops, but a small amount is used as pasture or hayland.

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 as 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.

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 to prevent soil-related failures in land uses.

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

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

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in 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

Larry Brewer, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The pasture plants or crops best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops 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 the heading "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

In 1989, Putnam County had about 31,000 acres of cropland and 55,000 acres of hay *(7)*. The rest of the acreage was commercial forest land, pastureland, pastured woodland, house lots, ponds, roads, areas of idle land, or land in other uses.

Soil erosion is a major concern in Putnam County. The highest intensity of precipitation occurs in the period May through June, when crop fields traditionally are bare before planting. The topography of the county ranges from nearly level to very steep. Because the slopes are irregular, the use of conservation practices, such as terraces, contour farming, and stripcropping, is limited on many fields.

A heavy clay subsoil restricts the infiltration of precipitation. Adair, Armstrong, Seymour, Clarinda, Lamoni, and Pershing soils have a clayey subsoil. In areas of these soils, most of the rainfall runs off the surface. This excessive runoff increases the potential for soil erosion. Loss of the surface layer through erosion results in reduced productivity. It is especially damaging on soils that have a clayey subsoil, which becomes incorporated into the plow layer when the soils are cultivated.

Erosion on farmland results in the sedimentation of streams, lakes, and ponds. Controlling erosion minimizes this pollution and improves the quality of water for municipal use, for recreation, and for fish and wildlife. It also prolongs the useful life of ponds and lakes.

Erosion-control practices provide a protective cover, help to control runoff, and increase the rate of water infiltration. A cropping system that keeps vegetation or crop residue on the surface can hold soil 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 included in crop rotations, legumes, such as clover and alfalfa, also improve tilth and provide nitrogen for the following crop.

Pasture and Hayland

Pasture and hayland are primary land uses in Putnam County. A wide variety of grasses and legumes is grown. Grassland management in the county has not developed as much as the management of cattle production. The low level of grassland management, primarily due to the low economic value of pastureland and the expenses of labor and fertilizer, has allowed the amount of pasture weeds and undesirable grasses to increase.

Poor pasture management can result in overgrazing, a lower quality pasture, an increased rate of runoff, and gully erosion. The moderately sloping to steep Armstrong, Clarinda, Gara, Keswick, Winnegan, and Shelby soils are the most common soils used for pasture in the county. Management of these soils for pasture or hayland is more difficult if the surface layer erodes.

Pasture rotation is a key factor in improving grassland management. It is becoming more common as the news media and resource specialists promote proper pasture rotation and as the cost of seed, fertilizer, land, and fuel increase.

As grassland management improves, warm-season grasses will be included in many pasture systems. These grasses can help to maintain the average daily gains throughout the drier summer months and can be particularly useful in pasture systems for steer operations.

Farmers harvest most hay for use on their farms, particularly for use as winter feed for cow-calf operations. Very little of the hay is raised as a cash crop. Small, square bales of quality alfalfa and smooth bromegrass, or orchardgrass, are in high demand and pay well. High-level management, however, is required to make hay profitable as a cash crop.

In Putnam County, most of the livestock enterprises are cow-calf or steer operations. A few producers profit from raising sheep. Raising hogs is somewhat common. Only a few dairy farms remain in the county.

Cropland

Putnam County has about 46,490 acres of land on flood plains. Much of this land is used for crop production, although flooding does limit production in many areas. Approved watershed projects can help to remedy many of the flooding problems.

Tilth is a problem in areas of Zook soils because these clayey soils commonly stay wet until late spring. If these soils are plowed when wet, they tend to be cloddy when dry. Because of the cloddiness, preparing a seedbed is difficult. Plowing these nearly level soils in fall generally results in better tilth and minimizes the hazard of erosion.

Areas of Edina, Seymour, and Pershing soils on level to gently sloping ridgetops are used for crops. These soils have a surface layer of silt loam or silty clay loam that is dark and moderately low or moderate in organic matter content. The moderately sloping and strongly sloping soils, such as Armstrong, Clarinda, Lamoni, and Keswick soils, are used in crop production. Conservation practices, however, are needed to control erosion on these soils.

The conservation practices primarily include conservation tillage, such as no-till farming or leaving at least 30 percent of the ground covered with plant residue. Buffer stripcropping that uses rows of crops about 100 feet wide and strips of permanent grass about 25 to 50 feet wide is becoming a more common erosion-control practice. Crop rotations that include 2 or more years of hay also are used to control erosion. Terraces are used in a few areas. The use of terraces, however, is very limited because the county is dissected by several creeks and has an irregular topography. Therefore, most fields are unsuited to farming on a set of parallel terraces.

Because of past extensive cropping on soils that are generally unsuited to crop production, the growing potential of many fields in the county has been damaged. The current grass production on these previously cropped fields is less than it would have been if the fields had not been cropped.

Row crops can be used on the steeper side slopes for grassland renovation. Two or three years of row crops generally are grown to reduce the extent of the less productive or otherwise low-quality grasses. This practice enables the planting of better quality grasses and legumes. The renovation crops result in very little average annual soil erosion when the long-term grass cover is considered.

In the late 1980's, more than 25,000 acres of cropland on highly erodible soils in Putnam County was entered into the 10-year Conservation Reserve Program (CRP). This program has considerably reduced the extent of erosion, is helping to rebuild the soil, and is increasing the amount of wildlife habitat.

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 also is shown in the table.

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

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

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

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

Land Capability Classification

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

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit *(9)*. 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 or hazards that restrict their use.

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

Class III soils have severe limitations or hazards 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 or hazards that make them generally unsuitable for cultivation.

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

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

Putnam County has no class I, class V, or class VIII soils.

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

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

John S. Fleming, forester, Missouri Department of Conservation, helped prepare this section.

When the early settlers arrived in Putnam County, the areas on broad ridges and rolling hills were prairie and the areas on flood plains and the steeper slopes were woodland. Wildfires, which occurred naturally or were set by Indians, kept 38 percent of the county in prairie *(8)*. Throughout the history of Putnam County, people have cleared woodland and established pastures when cattle prices were good, abandoned the pastures when cattle prices became poor, and allowed the pastures to return to woodland. In the last 30 to 40 years, eastern redcedar has become an early invader species. Early settlers probably introduced the species to the survey area, and birds probably spread the seed. In 1985, only about 13 percent of the county, or 44,215 acres, was wooded *(4)*.

The western half of the county supports very little timber. A few small oak-hickory stands grow in some areas of the steeper Gara and Armstrong soils and in a few areas of the Winnegan-Keswick association. The rest of the woodland occurs along drainageways in the Nodaway-Zook-Colo association. Pin oak, shingle oak, elm, cherry, eastern redcedar, and hickory grow at the upper end of the drainageways. These trees have little commercial value except as firewood. Nodaway soils support some stands of black walnut that can be profitably managed. A few stands of silver maple, cottonwood, hackberry, and bur oak in the larger drainageways are commercially harvested. Most of these timbered areas have been grazed at some time.

In the eastern part of the county, approximately 70 percent of the soils are included in the Winnegan-Keswick association. This area generally has steep timbered slopes. Most of the original forests that were not grazed contain high-quality white oak and red oak. Areas on ridges and slopes that were cleared of trees and then abandoned generally support post oak, elm, cherry, eastern redcedar, honeylocust, and hawthorn. Because the timbered areas were either high-graded or totally cutover in the early 1900's, the majority of the better timber is large pole to small sawlog in size. About half of these areas has been grazed. Some of the areas in very steep ravines were never heavily harvested and contain some stands of excellent-quality, mature red oak.

The area of the Chariton River valley and the river's major tributaries is mainly in the Nodaway-Zook-Colo association. Although most of this area has been cleared, the remaining timber includes high-quality oaks, black walnut, silver maple, cottonwood, hackberry, ash, and river birch.

Sugar maple grows along the bluffs of the Chariton River and its major tributaries. Since the control of wildfires and the end of high-grading, logging practices, this species has been rapidly spreading throughout the uplands. This very shade-tolerant species threatens to eventually replace oaks. Oaks are commercially more valuable and much more important to wildlife than sugar maple. Sugar maple grows well in areas of the Gara-Armstrong and the Winnegan-Keswick associations.

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 feet per acre 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 *N*, snowpack. 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 N.

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, and fire lanes and in log-handling areas. Forests that have been burned or overgrazed also are subject to erosion. Ratings of the erosion hazard are based on the percent of the slope. A rating of *slight* indicates that no particular prevention measures are needed under ordinary conditions. A rating of *moderate* indicates that erosion-control measures are needed in certain silvicultural activities. A rating of *severe* indicates that special precautions are needed to control erosion in most silvicultural activities.

Equipment limitation reflects the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. The chief characteristics and conditions considered in the ratings are slope, stones on the surface, rock outcrops, soil wetness, and texture of the surface layer. A rating of *slight* indicates that under normal conditions the kind of equipment and season of use are 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 in a fully stocked, even-aged, unmanaged stand.

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

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

Windbreaks and Environmental Plantings

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 the local office of the Soil Conservation Service or the Cooperative Extension Service or from a commercial nursery.

Recreation

Putnam County has three public recreational areas. Rebel's Cove, the largest, is in the northeastern part of the county, north of Livonia. It consists of 3,912 acres in the uplands and on the flood plain along the Chariton River. It is used primarily for hunting and fishing. Mineral Hills State Forest consists of 1,860 acres and is about 4 miles southeast of Unionville. It is managed for demonstration timber production, wildlife, watershed protection, hunting, and fishing. Unionville City Lake is 2 miles northwest of the town. It is 85 acres in size. It provides opportunities for picnicking and fishing and also supplies the city's water.

Lake Thunderhead also is located in the county, about 5 miles north of Unionville. This privately owned lake is approximately 1,050 acres in size. The lake and surrounding areas are used for fishing, waterskiing, swimming, and hunting and for residential development.

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 sewer lines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation also are important. Soils subject to flooding are limited for recreational uses by the duration and intensity of flooding and the season when flooding occurs. In planning recreational facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 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 are gently sloping 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

Roger Peecher, conservation agent, Missouri Department of Conservation, helped prepare this section.

Putnam County has an excellent population of wildlife and a wide variety of nongame and game species. The diverse land types in the county provide good habitat for many species of wildlife. Many different game species are hunted each year.

The big game species are wild turkey and white-tailed deer. These species are found throughout the county. The wild turkey, however, is more abundant in the eastern half of the county, where more woodland habitat is available. The populations of the turkey and deer have been increasing since about 1980. Turkeys may be in flocks of 50 to 100 or more during winter. Deer also yard during winter, and herds of 50 to 75 are common.

The county has good populations of upland birds. Bobwhite quail is found throughout the survey area. The larger populations tend to be in the eastern part of the county, where wildlife habitat is more available. Good populations of ring-necked pheasant occur in the western half of the county, which provides suitable habitat for these birds. Doves also thrive in this area but migrate south for the winter. They provide good hunting opportunities. Small populations of woodcock and a few common snipe and rails inhabit areas along some of the streams and on lowlands.

Fox squirrel and gray squirrel inhabit woodlands. The gray squirrel is predominantly in the more heavily wooded areas, and the fox squirrel is in areas along the edge of woodland, along creeks, and near farmsteads. Cottontail rabbit is plentiful and can be seen throughout the survey area.

Many species of furbearers inhabit Putnam County. The county has good populations of raccoon, the most sought after furbearer in the survey area. Good populations of opossum and coyote, furbearers that are both hunted and trapped, are also found throughout the county. Gray fox primarily inhabits heavily wooded areas, and red fox inhabits areas throughout the county. Both fox species do not have dense populations. A few badgers also inhabit the survey area. Beaver, mink, and muskrat are other furbearers that are trapped. These species have established good populations and inhabit the Chariton River and some of the creeks, lakes, and ponds in the county.

Waterfowl are abundant during spring and fall migrations, especially along the Chariton River bottom and on Lake Thunderhead. Many species of duck inhabit the lakes in the county and the marshes at Rebel's Cove Wildlife Area. Ducks and geese feed on waste grain in the harvested crop fields during fall and winter. Some mallards and wood ducks nest locally on the river, marshes, and lakes.

Three new wildlife species have been brought to the county. In 1980 and 1981, the Missouri Department of Conservation released ruffed grouse at Rebel's Cove Wildlife Area. In 1983 and 1984, grouse were released at Mineral Hills State Forest and at East Locust Creek, north of U.S. Highway 136. During the fall of 1984 and 1985, the river was stocked with otter. During the summer of 1988, a group of 60 young Giant Canada geese was released at Lake Thunderhead.

The county has many nongame species of wildlife. A great variety of songbirds inhabit areas throughout the countryside and near water. Several species of hawks and owls, including good populations of red-tailed hawk and marsh owl and smaller populations of Cooper's hawk and sharp-shinned hawk, inhabit the survey area. The most abundant species of owl are great horned owl, barred owl, and screech owl. During spring and fall migrations, several different species of shore birds commonly are observed in the area around Lake Thunderhead. Bald eagles and osprey also have been sighted around the lake.

The Great Blue Heron Rookery, located in Rebel's Cove Wildlife Area, is a unique place for birdwatchers. It has approximately 25 to 30 active nests, and the populations of the birds have been increasing.

Putnam County provides very good opportunities for fishing. It has numerous ponds, and most of the ponds have been stocked by landowners. The ponds support populations of bass, bluegill, and channel catfish. Lake Thunderhead and Unionville City Lake have good populations of bass, crappie, bluegill, and channel catfish. Since the spring of 1989, fishing for walleye has been permitted at Lake Thunderhead, which was previously stocked with that species. Several creeks and streams also offer opportunities for fishing. The fish most commonly harvested are channel catfish, bluegill, and carp.

The Chariton River is the only river in the county. The upper portion of the river that has not been channelized provides the best fishing opportunities. The primary fish caught in the river include channel catfish, blue catfish, flathead catfish, carp, and a few buffalo fish. Walleye also have been caught in portions of the river.

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

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flooding, and slope. Soil temperature and soil moisture also are 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 flooding. Soil temperature and soil moisture also are considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, wheatgrass, and grama.

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 hardwoods 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 blueberry. 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, saltgrass, cordgrass, rushes, sedges, and reeds.

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

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

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. Wildlife attracted to these areas include bobwhite quail, 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. Ratings are given for building site development, sanitary facilities, construction materials, and water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

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

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

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

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 or 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, the shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

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

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

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

Building Site Development

Table 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, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and depth to the water table.

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

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material; a base of gravel, crushed rock, or stabilized soil material; and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. The depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), the shrink-swell potential, potential for frost action, 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 or to a cemented pan, 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 landfill. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

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

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

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

Table 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 resulting from rapid permeability in the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. 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 should be considered.

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench 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 sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

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

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock 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 to determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

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

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, a low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have a moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet and have a water table at a depth of 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. They 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 as much as 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

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

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

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

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

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

The surface layer of most soils is generally preferred for topsoil because of its organic matter content.

Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 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 in the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

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

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

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

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

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

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to help to control water 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 soil blowing or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of soil blowing, low available water capacity, restricted rooting depth, 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 to characterize key soils.

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

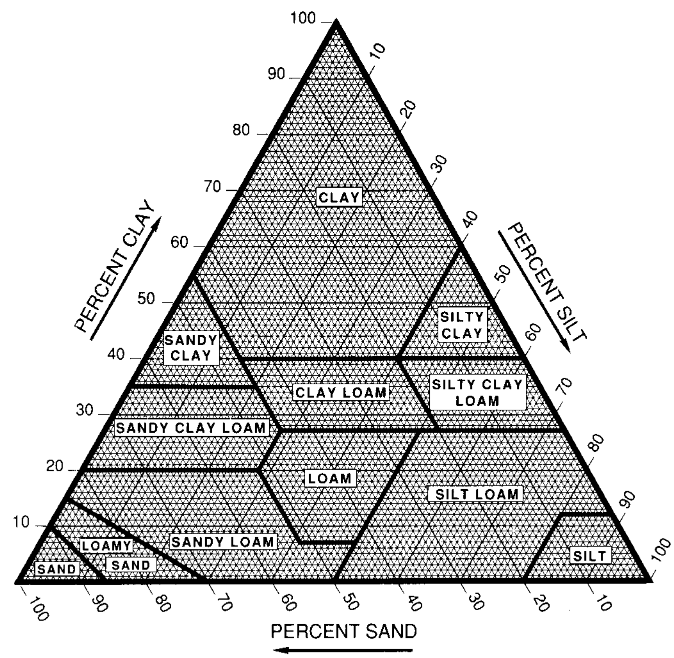

Figure 13.—Percentages of clay, silt, and sand in the basic USDA soil textural classes.

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 the heading "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. 13). "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is as much as about 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the "Glossary."

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, CL-ML.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

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

Rock fragments 3 to 10 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

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

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

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

Physical and Chemical Properties

Table 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 content of clay in each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

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

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

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

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 classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

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

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

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

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

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

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

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

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

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

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

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

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

Organic matter is the plant and animal residue in the soil at various stages of decomposition. In table 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 in a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 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 infiltration of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

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

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

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

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

If a soil is assigned to two hydrologic groups in table 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 (the chance of flooding is nearly 0 percent to 5 percent in any year); *occasional* that it occurs infrequently under normal weather conditions (the chance of flooding is 5 to 50 percent in any year); and *frequent* that it occurs often under normal weather conditions (the chance of flooding is more than 50 percent in any year). *Common* is used when the occasional and frequent classes are grouped for certain purposes. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, *long* if 7 days to 1 month, and *very long* if more than 1 month. Probable dates are expressed in months. About two-thirds to three-fourths of all flooding occurs during the stated period.

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 little or no horizon development.

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 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. Only saturated zones within a depth of about 6 feet are indicated.

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

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

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

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

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

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

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(10)*. 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. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Alfisol.

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 Udalf (*Ud*, meaning humid, plus *alf*, from Alfisol).

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 Hapludalfs *(Hapl*, meaning minimal horizonation, plus *udalf*, the suborder of the Alfisols 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 Hapludalfs.

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

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" *(11)*. Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" *(10)*. 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."

Adair Series

The Adair series consists of very deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in pedisediments and weathered glacial till. Slopes range from 3 to 9 percent.

The Adair soils in this county do not have a mollic epipedon. This difference, however, does not significantly affect the use or behavior of the soils.

Typical pedon of Adair loam, 3 to 9 percent slopes, eroded, in a pasture, 1,400 feet east and 250 feet south of the northwest corner of sec. 2, T. 65 N., R. 21 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; many fine roots; about 1 or 2 percent gravel at the base of the horizon; moderately acid; clear smooth boundary.

2Bt1—8 to 15 inches; brown (7.5YR 4/4) clay loam; many medium prominent yellowish red (5YR 4/6) mottles; moderate medium subangular blocky structure; firm; common fine roots; very dark grayish brown (10YR 3/2) material in some channels; few distinct clay films on faces of peds; about 1 or 2 percent gravel; moderately acid; gradual smooth boundary.

2Bt2—15 to 21 inches; brown (10YR 4/3) clay; few fine faint grayish brown (10YR 5/2) and few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; common fine roots; very dark grayish brown (10YR 3/2) material in some channels; common distinct clay films on faces of peds; about 1 or 2 percent gravel; slightly acid; gradual smooth boundary.

2Bt3—21 to 35 inches; dark yellowish brown (10YR 4/4) clay loam; common medium prominent grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; firm; few fine roots; very dark grayish brown (10YR 3/2) material in some channels; common distinct clay films; about 1 or 2 percent gravel; slightly acid; gradual smooth boundary.

2Bt4—35 to 50 inches; brown (10YR 4/3) clay loam; many medium distinct grayish brown (2.5Y 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; common very dark brown (10YR 2/2) stains; moderate medium subangular blocky structure; firm; common distinct clay films; about 1 or 2 percent gravel; neutral; gradual smooth boundary.

2BC—50 to 58 inches; dark yellowish brown (10YR 4/6) clay loam; common medium prominent grayish brown (2.5Y 5/2) and olive gray (5Y 5/2) and few fine faint yellowish brown (10YR 5/6) mottles; common very dark brown (10YR 2/2) stains; weak coarse prismatic structure parting to weak medium angular blocky; firm; about 1 or 2 percent gravel; neutral; clear smooth boundary.

2C—58 to 62 inches; yellowish brown (10YR 5/6) clay loam; common medium prominent grayish brown (2.5Y 5/2) mottles; weak coarse prismatic structure; firm; about 1 or 2 percent gravel; few soft masses of calcium carbonate; violently effervescent; mildly alkaline.

The A horizon has chroma of 1 or 2. The 2Bt horizon has value of 3 to 5 and chroma of 3 to 6. It is clay loam or clay and less commonly is silty clay. The 2C horizon has value of 4 or 5 and chroma of 4 to 6. Mottles with low chroma are common or many.

Amana Series

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

Typical pedon of Amana silty clay loam, in a cultivated field, 2,400 feet north and 200 feet east of the southwest corner of sec. 9, T. 65 N., R. 16 W.

Ap1—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; few fine roots; slightly acid; clear smooth boundary.

Ap2—8 to 17 inches; very dark gray (10YR 3/1) silty clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; few fine roots; slightly acid; clear smooth boundary.

Bw1—17 to 26 inches; dark grayish brown (10YR 4/2) silt loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; few fine roots; moderately acid; clear smooth boundary.

Bw2—26 to 48 inches; dark grayish brown (10YR 4/2) silt loam; many fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; moderately acid; gradual smooth boundary.

C—48 to 60 inches; coarsely mottled dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) silt loam; massive; friable; moderately acid.

The mollic epipedon ranges from 10 to 24 inches in thickness. The A horizon has chroma of 1 or 2. The Bw horizon has hue of 10YR or 2.5Y and value of 4 or 5. The C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 4.

Armstrong Series

The Armstrong series consists of very deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in a thin mantle of loess or sediments and in weathered glacial till. Slopes range from 5 to 14 percent.

Typical pedon of Armstrong clay loam, 5 to 9 percent slopes, eroded, in a pasture, 2,200 feet west and 200 feet south of the northeast corner of sec. 32, T. 67 N., R. 19 W.

A—0 to 5 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; very friable; many fine roots; slightly acid; clear smooth boundary.
Bt1—5 to 8 inches; brown (7.5YR 4/4) clay loam; common fine prominent red (2.5YR 4/6) mottles; moderate fine subangular blocky structure; firm; few distinct clay films on faces of peds; common fine roots; slightly acid; clear smooth boundary.
2Bt2—8 to 17 inches; brown (7.5YR 4/4) clay; common fine prominent red (2.5YR 4/6) and few fine prominent dark grayish brown (10YR 4/2) mottles in the lower part; moderate fine subangular blocky structure; firm; many fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; clear smooth boundary.
2Bt3—17 to 28 inches; strong brown (7.5YR 5/6) clay; common medium distinct yellowish brown (10YR 5/6) and common fine prominent grayish brown (2.5Y 5/2) mottles; moderate fine subangular blocky structure; firm; common fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; very strongly acid; clear smooth boundary.
2Bt4—28 to 46 inches; yellowish brown (10YR 5/6) clay; common medium prominent gray (N 5/0) mottles; moderate medium subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; gradual smooth boundary.
2BC—46 to 60 inches; yellowish brown (10YR 5/6) clay loam; common medium prominent gray (N 5/0) mottles; weak medium subangular blocky structure; firm; clay flows in some channels; about 1 or 2 percent gravel; neutral.

The A horizon has chroma of 1 or 2. Some pedons have an E horizon that has value of 4 or 5 and chroma of 2 or 3. The Bt horizon has hue of 10YR and 7.5YR, value of 4 or 5, and chroma of 2 to 6. The 2Bt horizon has hue of 10YR to 5YR, value of 4 or 5, and chroma of 3 to 6. It is clay loam or clay. The 2BC horizon and the 2C horizon, if it occurs, have value of 4 or 5 and chroma of 3 to 6.

Belinda Series

The Belinda series consists of very deep, poorly drained, very slowly permeable soils on terraces along the major streams and the Chariton River. These soils formed in loess. Slopes range from 0 to 2 percent.

Typical pedon of Belinda silt loam, in a cultivated field, 1,100 feet east and 1,300 feet south of the northwest corner of sec. 27, T. 65 N., R. 16 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine roots; moderately acid; clear smooth boundary.
E—9 to 15 inches; grayish brown (10YR 5/2) silt loam; common fine faint dark grayish brown (10YR 4/2) and few fine prominent dark yellowish brown (10YR 4/6) mottles; weak medium platy structure parting to weak very fine subangular blocky; friable; many fine roots; strongly acid; abrupt smooth boundary.
Btg1—15 to 28 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent dark yellowish brown (10YR 4/6) mottles; weak fine subangular blocky structure; very firm; few fine roots; few faint silt coatings on vertical faces of peds in the upper part; very dark grayish brown (10YR 3/2) coatings on vertical faces of some peds; common faint clay films on faces of peds; very strongly acid; clear smooth boundary.
Btg2—28 to 45 inches; grayish brown (2.5Y 5/2) silty clay; common fine prominent dark yellowish brown (10YR 4/4) and common fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very firm; few fine roots; common distinct clay films on faces of peds; many fine black concretions; very strongly acid; clear smooth boundary.
Btg3—45 to 57 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent dark yellowish brown (10YR 4/4) and few fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; firm; common distinct clay films on faces of peds; many fine black concretions; strongly acid; clear smooth boundary.
BCg—57 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent strong brown (7.5YR 5/8) and common fine prominent dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; few faint clay films on vertical faces of peds; many fine black concretions; slightly acid.

The A horizon has chroma of 1 or 2.

Clarinda Series

The Clarinda series consists of very deep, poorly drained, very slowly permeable soils on uplands. These soils formed in gray weathered glacial till. Slopes range from 5 to 9 percent.

The Clarinda soils in this county are taxadjuncts to the series because they do not have a mollic epipedon. This difference, however, does not significantly affect the use or behavior of the soils.

Typical pedon of Clarinda silty clay loam, 5 to 9 percent slopes, eroded, in a meadow, 1,500 feet east and 250 feet north of the southwest corner of sec. 30, T. 67 N., R. 19 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

2Btg1—8 to 12 inches; dark gray (10YR 4/1) silty clay; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; common distinct clay films on faces of peds; about 3 percent white sand grains; moderately acid; clear smooth boundary.

2Btg2—12 to 21 inches; gray (10YR 5/1) silty clay; common fine prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; very firm; common distinct clay films on faces of peds; about 3 percent white sand grains; strongly acid; gradual smooth boundary.

2Btg3—21 to 34 inches; gray (10YR 5/1) clay; common fine prominent strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; very firm; common distinct clay films on faces of peds; about 4 or 5 percent white sand grains; moderately acid; gradual smooth boundary.

2Btg4—34 to 50 inches; gray (5Y 5/1) and olive gray (5Y 5/2) clay; few fine prominent olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; very firm; common distinct clay films on faces of peds; about 4 or 5 percent white sand grains; moderately acid; gradual smooth boundary.

2Btg5—50 to 60 inches; gray (5Y 5/1) clay; few fine prominent brown (10YR 4/3) mottles; moderate medium subangular blocky structure; very firm; common distinct clay films on faces of peds; about 5 or 6 percent white sand grains; moderately acid.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. It is silty clay loam or silty clay. The content of white sand grains increases as depth increases.

Colo Series

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

Typical pedon of Colo silt loam, in a meadow, 300 feet west and 400 feet north of the southeast corner of sec. 6, T. 65 N., R. 19 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; common fine roots; slightly acid; clear smooth boundary.

A1—11 to 21 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; common fine roots; moderately acid; gradual smooth boundary.

A2—21 to 29 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; few distinct dark yellowish brown (10YR 4/4) stains; moderate medium subangular blocky structure; firm; few fine roots; moderately acid; gradual smooth boundary.

A3—29 to 41 inches; black (10YR 2/1) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; firm; moderately acid; gradual smooth boundary.

Bg—41 to 60 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; firm; slightly acid.

The mollic epipedon is 36 or more inches thick. Some pedons have strata or overwash sediments 6 to 18 inches thick. The Bg horizon has value of 2 or 3.

Edina Series

The Edina series consists of very deep, poorly drained, very slowly permeable soils on ridgetops and wide upland divides. These soils formed in loess. Slopes range from 0 to 2 percent.

Typical pedon of Edina silt loam, in a cultivated field, 500 feet north and 1,000 feet east of the southwest corner of sec. 32, T. 67 N., R. 19 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine granular structure; very friable; common fine roots; neutral; abrupt smooth boundary.

E—9 to 18 inches; gray (10YR 5/1) silt loam, light gray (10YR 7/1) dry; common fine faint dark gray (10YR 4/1) and few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; very friable; common fine roots; moderately acid; abrupt smooth boundary.

Bt1—18 to 23 inches; very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) dry; common fine faint dark grayish brown (10YR 4/2) and common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; few fine roots; common faint clay films on faces of peds; moderately acid; clear smooth boundary.

Bt2—23 to 35 inches; dark grayish brown (10YR 4/2) silty clay; few fine faint brown (10YR 4/3) mottles; moderate fine subangular blocky structure; very firm; common fine black stains of iron and manganese oxide; common distinct clay films on faces of peds; moderately acid; clear smooth boundary.

Bt3—35 to 52 inches; grayish brown (2.5Y 5/2) silty clay; common medium prominent yellowish brown (10YR 5/6) and common fine prominent dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; very firm; common distinct clay films on faces of peds; common fine black stains of iron and manganese oxide; slightly acid; gradual smooth boundary.

C—52 to 60 inches; gray (10YR 5/1) silty clay loam; common medium prominent strong brown (7.5YR 5/6) mottles; massive; firm; common fine black stains of iron and manganese oxide; slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The E horizon has value of 4 or 5. The upper part of the Bt horizon has hue of 2.5Y or 10YR and value of 2 or 3. The lower part has hue of 10YR to 5Y, value of 3 to 5, and chroma of 1 or 2. The C horizon has colors similar to those of the B horizon.

Gara Series

The Gara series consists of very deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 14 to 30 percent.

Typical pedon of Gara loam, 20 to 30 percent slopes, eroded, in a pasture, 2,500 feet east and 1,400 feet south of the northwest corner of sec. 21, T. 66 N., R. 20 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; common fine pebbles; slightly acid; clear smooth boundary.

Bt1—6 to 15 inches; dark yellowish brown (10YR 4/4) clay loam; moderate fine subangular blocky structure; friable; common fine roots; few distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; clear smooth boundary.

Bt2—15 to 24 inches; dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) clay loam; moderate medium subangular blocky structure; firm; common fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; very strongly acid; clear smooth boundary.

Bt3—24 to 35 inches; yellowish brown (10YR 5/4) clay loam; common medium prominent grayish brown (2.5Y 5/2) mottles; moderate fine subangular blocky structure; firm; few distinct clay films on faces of peds; about 1 or 2 percent gravel; moderately acid; clear smooth boundary.

Bt4—35 to 42 inches; yellowish brown (10YR 5/4) clay loam; common fine prominent grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; firm; few faint clay films on faces of peds; about 1 or 2 percent gravel; slightly acid; clear smooth boundary.

Bk—42 to 60 inches; yellowish brown (10YR 5/6) clay loam; common medium prominent grayish brown (2.5Y 5/2) and common medium distinct dark yellowish brown (10YR 4/4) mottles; weak coarse prismatic structure; firm; many soft masses of calcium carbonate; about 1 or 2 percent gravel; strong effervescence; moderately alkaline.

The A horizon has chroma of 1 or 2. The Bt horizon has chroma of 3 to 6. The C horizon has value of 5 or 6 and chroma of 2 to 6.

Gara loam, 14 to 20 percent slopes, eroded, has a thinner dark surface layer than is definitive for the Gara series. This difference, however, does not significantly affect the use or behavior of the soils.

Gorin Series

The Gorin series consists of very deep, somewhat poorly drained, slowly permeable soils on uplands and benches. These soils formed in loess and pedisediments of glacial till. Slopes range from 3 to 9 percent.

Typical pedon of Gorin silt loam, 3 to 9 percent slopes, eroded, in a pasture, 1,500 feet west and 1,375 feet north of the southeast corner of sec. 30, T. 66 N., R. 17 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; many fine roots; slightly acid; clear smooth boundary.

Bt1—6 to 11 inches; yellowish brown (10YR 5/4) silty clay loam; weak fine subangular blocky structure; friable; common fine roots; common distinct clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt2—11 to 20 inches; yellowish brown (10YR 5/4) silty clay; common fine distinct grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt3—20 to 26 inches; dark yellowish brown (10YR 4/4) silty clay loam; common medium prominent grayish brown (2.5Y 5/2) and common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt4—26 to 32 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; very strongly acid; clear smooth boundary.

Bt5—32 to 47 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium distinct gray (10YR 6/1) and many medium prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; firm; few distinct clay films on faces of peds; strongly acid; clear smooth boundary.

2Bt6—47 to 60 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak fine subangular blocky structure; common faint clay films on faces of peds; about 1 percent gravel; moderately acid.

The A horizon has value of 3 or 4 and chroma of 1 to 3. The E horizon, if it occurs, has value of 4 or 5 and chroma of 1 to 3. The upper part of the Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 or 4. The lower part of the 2Bt horizon has hue of 7.5YR to 2.5Y, value of 4 or 5, and chroma of 2 to 6.

Humeston Series

The Humeston series consists of very deep, poorly drained, very slowly permeable soils. These soils generally are on high flood plains. They formed in silty alluvium. In a few areas the soils extend to the first bottoms. Slopes range from 0 to 2 percent.

Typical pedon of Humeston silty clay loam, in a cultivated field, 1,500 feet east and 750 feet north of the southwest corner of sec. 20, T. 66 N., R. 20 W.

Ap—0 to 12 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; common fine roots; neutral; clear smooth boundary.

E—12 to 21 inches; dark gray (10YR 4/1) silt loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak coarse platy structure parting to moderate fine granular; friable; common fine roots; moderately acid; clear smooth boundary.

BE—21 to 25 inches; very dark gray (10YR 3/1) silty clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; friable; few fine roots; moderately acid; clear smooth boundary.

Bt—25 to 38 inches; black (10YR 2/1) silty clay; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid; clear smooth boundary.

Btg—38 to 53 inches; very dark gray (10YR 3/1) silty clay loam; common fine distinct dark yellowish brown (10YR 4/4) and common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid; clear smooth boundary.

BCg—53 to 60 inches; very dark gray (10YR 3/1) silty clay; few fine distinct brown (10YR 4/3) mottles; weak medium subangular blocky structure; firm; slightly acid.

The A horizon has value of 2 or 3. The E horizon has value of 4 or 5. The BE and 2BCg horizons have value of 2 to 4. The 2BCg horizon is silty clay or silty clay loam.

Keswick Series

The Keswick series consists of very deep, moderately well drained, slowly permeable soils on uplands. These soils formed in a thin mantle of loess or sediments and weathered glacial till. Slopes range from 5 to 14 percent.

Typical pedon of Keswick loam, 5 to 14 percent slopes, eroded, in a meadow, 135 feet west and 2,100 feet north of the southeast corner of sec. 1, T. 66 N., R. 17 W.

A—0 to 4 inches; dark grayish brown (10YR 4/2) loam, pale brown (10YR 6/3) dry; weak fine granular structure; friable; common fine roots; neutral; clear smooth boundary.

2Bt1—4 to 12 inches; reddish brown (5YR 4/4) clay loam; few fine prominent dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; firm; common fine roots; few distinct clay films on faces of peds; about 1 or 2 percent gravel; very strongly acid; clear smooth boundary.

2Bt2—12 to 20 inches; brown (7.5YR 4/4) clay; few fine prominent dark grayish brown (10YR 4/2) and many fine prominent red (2.5YR 4/6) mottles; moderate medium subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; very strongly acid; clear smooth boundary.

2Bt3—20 to 32 inches; strong brown (7.5YR 5/6) clay; common fine distinct yellowish red (5YR 5/6) and many medium prominent grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; about 1 or 2 percent gravel; very strongly acid; clear smooth boundary.

2Bt4—32 to 54 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct strong brown (7.5YR 5/6) and common medium prominent gray (10YR 5/1) mottles; weak medium subangular blocky structure; firm; common distinct clay films on faces of peds; about 1 or 2 percent gravel; very strongly acid; clear smooth boundary.

2Bt5—54 to 60 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct yellowish brown (10YR 5/6) and common medium prominent gray (5Y 5/1) mottles; weak medium subangular blocky structure; firm; few distinct clay films on faces of peds; about 1 or 2 percent gravel; common black stains; very strongly acid.

The A horizon has value of 2 to 4. Some pedons have an E horizon that has value of 4 or 5 and chroma of 2 or 3. The BC horizon has hue of 10YR, 7.5YR, or 5Y, value of 4 or 5, and chroma of 1 to 6.

Lamoni Series

The Lamoni series consists of very deep, somewhat poorly drained, slowly permeable soils on uplands. These soils formed in weathered glacial till. Slopes range from 5 to 14 percent.

The Lamoni soils in this county typically have a thinner dark A horizon than is definitive for the series. This difference, however, does not significantly affect the use or behavior of the soils.

Typical pedon of Lamoni clay loam, 5 to 9 percent slopes, eroded, in a meadow, 1,000 feet east and 1,050 feet south of the northwest corner of sec. 6, T. 65 N., R. 20 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine roots; moderately acid; clear smooth boundary.

2Bt1—8 to 14 inches; dark grayish brown (10YR 4/2) clay; common fine prominent yellowish red (5YR 5/6) and common fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; common fine roots; few distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; clear smooth boundary.

2Bt2—14 to 22 inches; grayish brown (10YR 5/2) clay; many medium prominent yellowish brown (10YR 5/6) mottles; moderate medium angular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; clear smooth boundary.

2Bt3—22 to 33 inches; grayish brown (2.5Y 5/2) clay; common fine prominent yellowish brown (10YR 5/6) and common medium distinct olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; gradual smooth boundary.

2BC—33 to 52 inches; coarsely mottled yellowish brown (10YR 5/6), dark yellowish brown (10YR 4/4), and gray (10YR 5/1) clay loam; weak fine prismatic and weak medium subangular blocky structure; firm; few distinct clay films on faces of peds; about 1 or 2 percent gravel; moderately acid; clear smooth boundary.

2C—52 to 60 inches; yellowish brown (10YR 5/6) clay loam; moderate medium prominent gray (10YR 5/1) and common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; about 1 percent gravel; slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The upper part of the 2Bt horizon has hue of 10YR or 2.5Y. The lower part has hue of 10YR to 5Y, value of 5 or 6, and chroma of 1 to 6. This horizon is clay loam or clay. The 2C horizon has hue of 7.5YR to 2.5Y, value of 4 to 6, and chroma of 1 to 6.

Nodaway Series

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

Typical pedon of Nodaway silt loam, in a cultivated field, 220 feet south and 2,250 feet west of the northeast corner of sec. 10, T. 65 N., R. 20 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; clear smooth boundary.

C1—7 to 35 inches; stratified very dark gray (10YR 3/1) and grayish brown (10YR 5/2) silt loam; massive; friable; slightly acid; gradual smooth boundary.

C2—35 to 60 inches; stratified very dark grayish brown (10YR 3/2), dark grayish brown (10YR 4/2), and brown (10YR 4/3) silt loam; massive; friable; slightly acid.

The Ap horizon has chroma of 1 or 2. The strata in the C horizon vary in sequence and thickness. Some thin lenses of material coarser than silt loam are within a depth of 40 inches.

Pershing Series

The Pershing series consists of very deep, somewhat poorly drained, slowly permeable soils on loess-covered uplands and terraces. Slopes range from 2 to 5 percent.

Typical pedon of Pershing silty clay loam, 2 to 5 percent slopes, in a pasture, 600 feet south and 2,400 feet west of the northeast corner of sec. 32, T. 67 N., R. 19 W.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; very friable; many fine roots; moderately acid; clear smooth boundary.

BE—6 to 11 inches; brown (10YR 4/3) silty clay loam; weak fine subangular blocky structure; friable; common fine roots; very dark grayish brown (10YR 3/2) coatings on some peds; strongly acid; clear smooth boundary.

Bt1—11 to 30 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) and common fine distinct dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; common distinct clay films on faces of peds; common black concretions of iron and manganese oxide; moderately acid; gradual smooth boundary.

Bt2—30 to 52 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; common faint clay films on faces of peds; few black concretions of iron and manganese oxide; moderately acid; gradual smooth boundary.

C—52 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; many medium prominent dark yellowish brown (10YR 4/4), common fine prominent yellowish brown (10YR 5/6), and few fine distinct gray (N 5/0) mottles; massive; friable; few black concretions of iron and manganese oxide; slightly acid.

The Ap horizon has chroma of 1 or 2. The BE horizon has chroma of 2 or 3. The upper part of the Bt horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 2 to 4 and is silty clay loam or silty clay. The lower part has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 1 to 6. The C horizon is silt loam or silty clay loam.

Putco Series

The Putco series consists of very deep, moderately well drained, slowly permeable soils on uplands. These soils formed in spoil resulting from surface mining activities. Slopes range from 0 to 70 percent.

Typical pedon of Putco silty clay loam, 30 to 60 percent slopes, in an area of mixed hardwoods, grasses, and legumes, 600 feet south and 1,200 feet east of the northwest corner of sec. 32, T. 67 N., R. 17 W.

Ap—0 to 4 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak fine granular structure; friable; common fine roots; about 30 percent soft shale fragments; strong effervescence; moderately alkaline; clear wavy boundary.

C—4 to 60 inches; mixed grayish brown (2.5Y 5/2), very dark gray (N 3/0), and dark reddish brown (2.5YR 3/4) silty clay; massive; firm; few fine roots; about 50 percent soft shale fragments; strong effervescence; moderately alkaline.

The depth to bedrock is more than 5 feet. The content of soft shale fragments ranges from 15 to 45 percent in the A or Ap horizon and from 25 to 60 percent in the C horizon. The content of hard fragments of shale and limestone ranges from 0 to 15 percent throughout the profile.

The A or Ap horizon has hue of 10YR or 2.5Y or is neutral in hue, has value of 2 to 5, and has chroma of 1 to 6. It is silty clay loam or silty clay. The C horizon has hue of 10R to 2.5Y or is neutral in hue, has value of 3 to 6, and has chroma of 1 to 6. It is silty clay or clay.

Rinda Series

The Rinda series consists of very deep, poorly drained, very slowly permeable soils on uplands. These soils formed in gray clayey paleosols. Slopes range from 5 to 9 percent.

The Rinda soils in this county typically have a thinner dark A horizon than is definitive for the series. This difference, however, does not significantly affect the use or behavior of the soils.

Typical pedon of Rinda silty clay loam, 5 to 9 percent slopes, eroded, in a pasture, 1,700 feet north and 900 feet west of the southeast corner of sec. 23, T. 65 N., R. 19 W.

Ap—0 to 4 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; moderate fine granular structure; friable; common fine roots; slightly acid; clear smooth boundary.

2Btg1—4 to 11 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; firm; common fine roots; few distinct clay films on faces of peds; about 5 percent white sand grains; moderately acid; clear smooth boundary.

2Btg2—11 to 17 inches; gray (10YR 5/1) silty clay; common fine faint dark grayish brown (10YR 4/2) and common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; very firm; few fine roots; common distinct clay films on faces of peds; about 5 percent white sand grains; strongly acid; clear smooth boundary.

2Btg3—17 to 31 inches; gray (10YR 5/1) silty clay; few fine distinct dark yellowish brown (10YR 3/4) mottles; moderate medium subangular blocky structure; very firm; common distinct clay films on faces of peds; about 5 percent white sand grains; moderately acid; gradual smooth boundary.

2Btg4—31 to 48 inches; gray (10YR 5/1) silty clay; common fine prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; very firm; common distinct clay films on faces of peds; about 5 percent white sand grains; few accumulations of iron and manganese oxide; moderately acid; gradual smooth boundary.

2Btg5—48 to 60 inches; gray (10YR 5/1) silty clay; many fine prominent strong brown (7.5YR 4/6) mottles; weak medium subangular blocky structure; very firm; few distinct clay films on faces of peds; few accumulations of iron and manganese oxide; about 5 percent white sand grains; moderately acid.

The A horizon has chroma of 1 or 2. The 2Bt horizon has hue of 10YR to 5Y, value of 4 to 6, and chroma of 1 or 2. It is clay or silty clay.

Schuline Series

The Schuline series consists of very deep, well drained, slowly permeable, manmade soils on uplands. These soils formed in nonacid spoil resulting from surface mining activities. Slopes range from 9 to 35 percent.

Typical pedon of Schuline clay loam, 9 to 35 percent slopes, in a pasture, 1,700 feet south and 800 feet west of the northeast corner of sec. 12, T. 65 N., R. 17 W.

A—0 to 3 inches; mixed brown (10YR 5/3) and yellowish brown (10YR 5/6) clay loam; weak fine granular structure; friable; many fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C1—3 to 20 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few soft shale fragments; few fine roots; strong effervescence; moderately alkaline; clear smooth boundary.

C2—20 to 60 inches; yellowish brown (10YR 5/6) clay loam; common medium prominent gray (10YR 5/1) and common medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; few soft shale fragments; strong effervescence; moderately alkaline.

The depth to bedrock is more than 5 feet. The A horizon has hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 2 to 6. The C horizon has a hue of 7.5YR to 5Y, value of 3 to 6, and chroma of 1 to 6. The content of coarse fragments ranges from 0 to 15 percent.

Seymour Series

The Seymour series consists of very deep, somewhat poorly drained, very slowly permeable soils on uplands. These soils formed in loess. Slopes range from 2 to 5 percent.

The Seymour soils in this county typically have a thinner dark A horizon than is definitive for the series. This difference, however, does not significantly affect the use or behavior of the soils.

Typical pedon of Seymour silty clay loam, 2 to 5 percent slopes, eroded, in a meadow, 1,100 feet west and 150 feet south of the northeast corner of sec. 32, T. 67 N., R. 20 W.

A1—0 to 5 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine roots; slightly acid; clear smooth boundary.

A2—5 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; common fine faint dark grayish brown (10YR 4/2) mottles; weak fine subangular blocky structure; friable; many fine roots; slightly acid; clear smooth boundary.

Bt1—8 to 13 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate very fine subangular blocky structure; firm; common fine roots; common distinct clay films on faces of peds; discontinuous light gray (10YR 7/2) silt coatings on some peds; slightly acid; clear smooth boundary.

Bt2—13 to 21 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent yellowish brown (10YR 5/6) mottles; moderate fine subangular blocky structure; very firm; few fine roots; many prominent clay films on faces on peds; moderately acid; clear smooth boundary.

Bt3—21 to 27 inches; dark grayish brown (10YR 4/2) silty clay; common fine prominent strong brown (7.5YR 4/6) and common fine faint brown (10YR 4/3) mottles; moderate fine subangular blocky structure; very firm; common distinct clay films on faces of peds; few accumulations of iron and manganese oxide; moderately acid; clear smooth boundary.

Btg1—27 to 37 inches; grayish brown (2.5Y 5/2) silty clay; common medium prominent strong brown (7.5YR 5/6) and common medium prominent dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; very firm; common distinct clay films on faces of peds; few accumulations of iron and manganese oxide; moderately acid; clear smooth boundary.

Btg2—37 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; common fine prominent strong brown (7.5YR 5/6) and few fine distinct brown (10YR 4/3) mottles; weak medium subangular blocky structure; firm; few distinct clay films on faces of peds; slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is silty clay loam or silt loam. The upper part of the Bt horizon has hue of 10YR or 2.5Y and value of 3 or 4. The lower part of the Bt horizon and the Btg horizon have hue of 10YR or 2.5Y and value of 4 or 5. They are silty clay or silty clay loam.

Shelby Series

The Shelby series consists of very deep, moderately well drained, moderately slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 9 to 20 percent.

The Shelby soils in this county typically have a thinner dark A horizon than is definitive for the series. This difference, however, does not significantly affect the use or behavior of the soils.

Typical pedon of Shelby loam, 14 to 20 percent slopes, eroded, in a pasture, 400 feet south and 200 feet east of the northwest corner of sec. 33, T. 67 N., R. 20 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; many fine roots; about 1 or 2 percent gravel; neutral; clear smooth boundary.

Bt1—8 to 12 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; friable; common fine roots; very dark grayish brown (10YR 3/2) material in root channels and holes; few distinct clay films on faces of peds; about 1 or 2 percent gravel; neutral; clear smooth boundary.

Bt2—12 to 22 inches; yellowish brown (10YR 5/4) clay loam; moderate fine subangular blocky structure; firm; common fine roots; common distinct clay films on faces of peds; about 1 or 2 percent gravel; strongly acid; gradual smooth boundary.

Bt3—22 to 30 inches; yellowish brown (10YR 5/4) clay loam; moderate fine and medium subangular blocky structure; firm; common fine roots; common distinct clay films on faces of peds; brown (10YR 5/3) coatings on some peds; about 1 or 2 percent gravel; few small pebbles; strongly acid; gradual smooth boundary.

Bt4—30 to 38 inches; yellowish brown (10YR 5/4) clay loam; common fine distinct grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; firm; few distinct clay films on faces of peds; grayish brown (10YR 5/2) coatings on some peds; about 1 or 2 percent gravel; moderately acid; gradual smooth boundary.

Bk—38 to 60 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct grayish brown (10YR 5/2) mottles; weak coarse prismatic structure; firm; about 10 percent soft masses of calcium carbonate; about 1 or 2 percent gravel; strong effervescence; moderately alkaline.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has value of 3 to 5 and chroma of 3 or 4.

Vanmeter Series

The Vanmeter series consists of moderately deep, moderately well drained, very slowly permeable soils on uplands. These soils formed in calcareous shale and limestone residuum. Slopes range from 14 to 30 percent.

Typical pedon of Vanmeter silty clay loam, 14 to 30 percent slopes, in a pasture, 2,500 feet north and 1,800 feet west of the southeast corner of sec. 35, T. 66 N., R. 18 W.

A—0 to 5 inches; dark grayish brown (10YR 4/2) silty clay loam; weak medium subangular blocky structure; friable; common fine roots; neutral; clear smooth boundary.

BA—5 to 7 inches; dark brown (10YR 4/3) silty clay loam; weak medium subangular blocky structure; friable; common fine roots; neutral; clear smooth boundary.

Bw1—7 to 16 inches; dark brown (7.5YR 4/4) silty clay; common fine distinct brown (10YR 4/3) and few fine distinct reddish brown (5YR 4/4) mottles; moderate fine subangular blocky structure; firm; few fine roots; mildly alkaline; clear smooth boundary.

Bw2—16 to 26 inches; dark brown (7.5YR 4/4) silty clay; common fine distinct strong brown (7.5YR 5/6) and common fine prominent olive (5Y 5/3) mottles; moderate fine subangular blocky structure; firm; mildly alkaline; abrupt smooth boundary.

Cr—26 to 60 inches; weathered shale.

The depth to weathered bedrock ranges from 20 to 40 inches. The A horizon has value of 3 or 4 and chroma of 1 or 2. The Bw horizon has hue of 2.5Y to 5YR, value of 4 to 6, and chroma of 2 to 6.

Vigar Series

The Vigar series consists of very deep, moderately well drained, moderately slowly permeable soils on foot slopes. These soils formed in local alluvium. Slopes range from 2 to 9 percent.

Typical pedon of Vigar silt loam, 2 to 9 percent slopes, in a pasture, 1,250 feet east and 1,675 feet north of the southwest corner of sec. 15, T. 65 N., R. 20 W.

Ap—0 to 6 inches; black (10YR 2/1) silt loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; many fine roots; neutral; clear smooth boundary.

A—6 to 15 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; many fine roots; neutral; clear smooth boundary.

BA—15 to 25 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; many fine roots; slightly acid; gradual smooth boundary.

Bt1—25 to 38 inches; dark grayish brown (10YR 4/2) clay loam; few fine faint dark gray (10YR 4/1) and common medium prominent strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; firm; common distinct clay films; common fine roots; common medium concretions; slightly acid; gradual smooth boundary.

Bt2—38 to 52 inches; dark grayish brown (10YR 4/2) clay loam; common medium prominent strong brown (7.5YR 4/6) mottles; weak moderate subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt3—52 to 62 inches; grayish brown (10YR 5/2) clay loam; common medium prominent strong brown (7.5YR 4/6) mottles; medium subangular blocky structure; firm; common distinct clay films on faces of peds; slightly acid.

The A horizon has value of 2 or 3 and chroma of 1 or 2.

Winnegan Series

The Winnegan series consists of very deep, moderately well drained, slowly permeable soils on uplands. These soils formed in glacial till. Slopes range from 14 to 35 percent.

Typical pedon of Winnegan loam, 20 to 35 percent slopes, in a wooded area, 850 feet east and 1,350 feet south of the northwest corner of sec. 7, T. 66 N., R. 16 W.

A—0 to 3 inches; very dark grayish brown (10YR 3/2) loam, light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; common fine roots; about 1 percent gravel; moderately acid; clear wavy boundary.

E—3 to 6 inches; brown (10YR 5/3) loam, light gray (10YR 7/2) dry; moderate medium platy structure parting to weak fine granular; friable; common fine roots; about 1 percent gravel; very strongly acid; clear smooth boundary.

Bt1—6 to 12 inches; yellowish brown (10YR 5/4) clay loam; moderate fine subangular blocky structure; firm; few fine roots; few faint dark yellowish brown (10YR 4/4) coatings on faces of peds; few distinct clay films on faces of peds; about 1 percent gravel; very strongly acid; gradual smooth boundary.

Bt2—12 to 18 inches; yellowish brown (10YR 5/6) clay loam; moderate medium subangular blocky structure; firm; few fine roots; common distinct clay films on faces of peds; about 1 percent gravel; very strongly acid; gradual smooth boundary.

Bt3—18 to 27 inches; dark yellowish brown (10YR 4/6) clay loam; common fine distinct strong brown (7.5YR 5/6) and common fine prominent light brownish gray (10YR 6/2) mottles; moderate medium subangular blocky structure; firm; common distinct clay films on faces of peds; about 1 percent gravel; strongly acid; gradual smooth boundary.

Bt4—27 to 34 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct light brownish gray (10YR 6/2) and common fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; firm; few faint clay films on faces of peds; about 1 percent gravel; moderately acid; gradual smooth boundary.

Bk1—34 to 41 inches; coarsely mottled dark yellowish brown (10YR 4/6), yellowish brown (10YR 5/6), and light brownish gray (10YR 6/2) clay loam; weak coarse prismatic structure; firm; common fine black (10YR 2/1) stains; few soft masses of calcium carbonate; about 1 percent gravel; strong effervescence; mildly alkaline; gradual smooth boundary.

Bk2—41 to 60 inches; coarsely mottled yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2) loam; weak coarse prismatic structure; friable; about 10 percent soft masses of calcium carbonate; about

1 percent gravel; strong effervescence; mildly alkaline.

The A horizon has value and chroma of 2 or 3. The E horizon has value of 4 to 6 and chroma of 2 to 4. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 4 to 6. The Bk horizon has value of 4 to 6 and chroma of 2 to 6.

Zook Series

The Zook series consists of very deep, poorly drained, slowly permeable soils on low flood plains. These soils formed in silty and clayey alluvium. Slopes are 0 to 2 percent.

Typical pedon of Zook silty clay loam, in a meadow, 1,100 feet north and 375 feet west of the southeast corner of sec. 16, T. 65 N., R. 20 W.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; friable; common fine roots; neutral; gradual smooth boundary.

A1—9 to 26 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; few fine roots; slightly acid; gradual smooth boundary.

A2—26 to 38 inches; black (N 2/0) silty clay, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; firm; slightly acid; gradual smooth boundary.

Bg—38 to 47 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; firm; slightly acid; clear smooth boundary.

Cg—47 to 60 inches; dark gray (10YR 4/1) silty clay; few fine distinct brown (10YR 4/3) and few fine prominent yellowish brown (10YR 5/6) mottles; massive; firm; neutral.

The thickness of the mollic epipedon ranges from 36 to 50 inches. The A horizon has value of 2 or 3 and chroma of 0 or 1. The B and C horizons have hue of 10YR or 5Y and value of 3 to 5. They are silty clay or silty clay loam.

Formation of the Soils

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil are determined by the physical and mineralogical composition of the parent material, the plant and animal life on and in the soil, the climate under which the soil material accumulated, the relief of the land, and the length of time that these forces of soil formation have acted on the soil material.

Climate and vegetation are the active forces in soil formation. They act on the parent material that has accumulated through the weathering of rocks, slowly changing it into a natural body that has genetically related horizons. The effects of climate and vegetation are conditioned by relief. Parent material affects the kind of profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed to change the parent material into a soil. Generally, a long time is needed for the development of distinct horizons. The factors of soil formation are so closely interrelated that few generalizations can be made about the effect of any one factor unless conditions are specified for the others.

Parent Material

Parent material is the unconsolidated mass in which soils form. The deposition of this material is the first step in the development of a soil profile. The characteristics of the material affect the chemical and mineralogical composition of the soil. Four principal kinds of parent material, alone or in combination, have contributed to the formation of the soils in Putnam County. These materials are loess, or wind-deposited material; glacial till; residual material weathered from bedrock; and alluvium, or water-deposited material. Of lesser importance is colluvium that has been transported short distances downslope by gravity and the action of water.

Loess is silty material transported by the wind. It is an extensive parent material in the western and central parts of the county. The principal local source of loess probably was material on the flood plains of the Grand River and Medicine Creek. Seymour and Edina soils formed in this loess on upland flats and gently sloping ridges.

Glaciers are large masses of slowly moving ice. They transported clay, silt, sand, and gravel into the area of present-day Missouri. The deposited material is referred to as glacial till. Gara, Shelby, and Winnegan soils formed in glacial till. Some soils formed in more than one kind of parent material. For example, Armstrong soils formed in loess and glacial till.

Residual parent material develops in place from the underlying bedrock. Vanmeter soils formed in weathered limestone and shale. They are on moderately steep to very steep, convex side slopes that parallel the major streams in the eastern part of the county.

Alluvium is the parent material of soils on the flood plains. Sand, silt, and clay were deposited on the flood plains by rivers and streams according to the velocity of floodwater. The floodwater moves slower the farther it flows away from the stream channel. Nodaway and Amana soils formed in silty alluvium adjacent to stream channels. In slack-water areas, the areas furthest from the stream channel, the finer clay particles settled. Zook soils formed in these areas.

Living Organisms

Living organisms in or on the soil alter parent materials and influence the properties of a soil. Plants, bacteria, fungi, burrowing animals, and human activities affect the content of organic matter and nutrients, soil structure, soil aeration, and other properties of the soil.

Plants greatly affect soil formation. Plant communities vary depending on soil fertility, available water capacity, drainage, and depth. In the eastern part of Putnam County, trees were the dominant vegetative cover during soil formation. Gorin soils formed under forest. In the western part of the county, soils formed under native grasses and developed a thick, dark surface layer. Seymour soils are an example. Nutrients taken from the soil by plants are eventually returned through decomposition. The annual return of grass residue affects the physical, chemical, and biological nature of the surface layer.

Micro-organisms are important in the decomposition of plant residue. By reducing raw material to soil humus, micro-organisms release plant nutrients, enhance soil structure, and improve the general physical condition of the surface layer. Soils in which biological activity is high have a high content of organic matter, are moderately acid to neutral, are well aerated, have a low bulk density, and are medium textured.

Human activities, such as intensive cultivation and the clearing of trees, affect soil formation. Cultivation can mix the surface layer and subsurface layers. The result is a lower content of organic matter, reduced biological activity in the soil, and a less stable soil structure. The combination of these factors can increase the runoff rate and the susceptibility of the soil to erosion. In some areas, erosion has removed the original surface layer and thus lowered the fertility and productivity of the soil. Introducing new crops and adding chemicals, such as fertilizer and lime, to the soil also can affect soil formation.

Climate

Climate has been an important factor affecting soil formation in Putnam County. In the past 1 million years, climatic variations have drastically affected the survey area. The county currently has a subhumid midcontinental climate.

Rainfall and temperature continually affect soil formation. In past climates, different parent materials were deposited by ice, wind, and water. The past climatic patterns affected the development of soils in these parent materials. The rate of geologic erosion, which affects the shape and character of landforms, varies according to the climate. Climatic changes also affect the abundance and kinds of plants and animals. The present climatic conditions favor the growth of trees.

The midcontinental climate promotes the chemical change and physical disintegration of soil. If calcium carbonate and other soluble salts are removed by leaching, soil fertility is reduced. The physical and chemical characteristics of most soils in Putnam County reflect these climatically induced changes. An example of weathering is the development of the argillic horizon in Armstrong soils.

Relief

Relief affects soil formation mostly through its effects on drainage, runoff, and erosion. The amount of water that enters the soil depends on the slope, the permeability, and the intensity of rainfall. On steep slopes, runoff is rapid, very little water passes through the soil, and soil formation is slow. On gently sloping and nearly level slopes, runoff is slow and most of the water passes through the soil. Soils in these areas have maximum soil development. On similar slopes, however, rapidly permeable soils form slower than slowly permeable soils.

Soils on steep, south-facing ridges generally are more droughty than soils on north-facing slopes. Droughtiness affects soil formation by influencing the amount and kind of vegetation on a soil and the susceptibility of a soil to erosion and to freezing and thawing.

Time

The degree of profile development depends on the length of time that the parent material has been in place and subject to the soil-forming processes. The older soils show the effects of leaching and clay movement and have distinct horizons. Young soils show little profile development.

The youngest soils in Putnam County are alluvial. Nodaway soils do not have developed profiles because they receive alluvial material nearly every year. Humeston soils on stream terraces are older alluvial soils and have more distinct horizons.

The moderately sloping to steep, moderately deep Vanmeter soils formed in material weathered from calcareous clay shale. This residuum is much older than the parent material of other soils in the county.

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Glossary

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

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

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.

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

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

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

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

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

Bedding 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.

Bench terrace. A raised, level or nearly level strip of earth constructed on or nearly on the contour, supported by a barrier of rocks or similar material, and designed to make the soil suitable for tillage and to prevent accelerated erosion.

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

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

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

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.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

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.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

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

Conservation tillage. A tillage system that does not invert the soil and that leaves a protective amount of crop residue on the surface throughout the year.

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

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

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

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

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

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.

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.

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.

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 human or animal activities 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.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

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

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 38 centimeters) long.

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.

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 as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

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 the 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.

Hardpan. A hardened or cemented soil horizon, or layer. The soil material is sandy, loamy, or clayey and is cemented by iron oxide, silica, calcium carbonate, or other substance.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, any plowed or disturbed surface layer.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) granular, prismatic, or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

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

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

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.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

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 the 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, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or 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).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

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

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

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.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Pan. A compact, dense layer in a soil that impedes the movement of water and the growth of roots. For example, *hardpan, fragipan, claypan, plowpan,* and *traffic pan.*

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

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

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

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil, adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

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

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

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

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

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 degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately 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.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 drawbar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

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

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

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

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

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.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

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.

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

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.

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. The classes used in this survey to refer to the depth of the soil to bedrock are defined as follows:

Very shallow	less than 25 cm (10 inches) deep
Shallow	25 to 50 cm (10 to 20 inches) deep
Moderately deep	50 to 100 cm (20 to 40 inches) deep
Deep	100 to 150 cm (40 to 60 inches) deep
Very deep	more than 150 cm (60 inches) deep

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes of separates, in millimeters, recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of coarse fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediments of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to soil blowing and water erosion.

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

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

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

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 that is too thin for the specified use.

Till plain. An extensive area of nearly level to undulating soils 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, 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 a 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 1951-87 at Kirksville, Missouri)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average daily	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	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-----	32.5	14.1	23.3	61	-16	0	1.28	0.28	2.07	3	7.2
February----	38.7	19.7	29.2	66	-12	10	1.14	.48	1.69	3	5.2
March-------	49.6	28.8	39.2	80	2	45	2.67	1.36	3.81	6	4.7
April-------	63.8	41.2	52.5	86	20	148	3.45	1.87	4.83	7	.9
May---------	74.0	51.5	62.8	89	33	406	4.41	2.51	6.09	8	.0
June--------	82.2	60.2	71.2	94	43	636	4.20	2.28	5.89	7	.0
July--------	87.2	64.7	76.0	99	49	806	4.15	1.56	6.31	6	.0
August------	85.1	62.3	73.7	99	46	735	3.82	1.39	5.84	6	.0
September---	77.5	54.3	65.9	94	33	477	4.27	1.65	6.46	6	.0
October-----	66.7	44.0	55.4	87	24	212	3.42	1.41	5.11	6	.1
November----	50.9	31.4	41.2	75	7	24	1.94	.54	3.06	4	1.6
December----	37.6	20.4	29.0	65	-10	10	1.81	.72	2.71	4	5.6
Yearly:											
Average---	62.2	41.1	51.6	---	---	---	---	---	---	---	---
Extreme---	---	---	---	100	-17	---	---	---	---	---	---
Total-----	---	---	---	---	---	3,509	36.56	29.31	43.35	66	25.3

* 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 1951-87 at Kirksville, 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. 16	Apr. 22	May 6
2 years in 10 later than--	Apr. 12	Apr. 19	May 1
5 years in 10 later than--	Apr. 3	Apr. 11	Apr. 21
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 20	Oct. 10	Sept. 26
2 years in 10 earlier than--	Oct. 25	Oct. 16	Oct. 1
5 years in 10 earlier than--	Nov. 4	Oct. 26	Oct. 10

TABLE 3.--GROWING SEASON

(Recorded in the period 1951-87 at Kirksville, 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	193	179	151
8 years in 10	200	185	158
5 years in 10	214	197	171
2 years in 10	228	208	184
1 year in 10	235	214	191

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

Map symbol	Soil name	Acres	Percent
10C2	Rinda silty clay loam, 5 to 9 percent slopes, eroded	1,400	0.4
11	Edina silt loam	3,600	1.1
12C2	Adair loam, 3 to 9 percent slopes, eroded	24,000	7.2
13E2	Gara loam, 14 to 20 percent slopes, eroded	53,485	16.1
13F2	Gara loam, 20 to 30 percent slopes, eroded	11,200	3.4
15C2	Gorin silt loam, 3 to 9 percent slopes, eroded	5,200	1.6
16C2	Clarinda silty clay loam, 5 to 9 percent slopes, eroded	8,000	2.4
17C2	Armstrong clay loam, 5 to 9 percent slopes, eroded	26,500	7.9
17D2	Armstrong clay loam, 9 to 14 percent slopes, eroded	3,550	1.1
19D2	Keswick loam, 5 to 14 percent slopes, eroded	27,500	8.3
21B2	Seymour silty clay loam, 2 to 5 percent slopes, eroded	15,900	4.8
25C2	Lamoni clay loam, 5 to 9 percent slopes, eroded	6,000	1.8
25D2	Lamoni clay loam, 9 to 14 percent slopes, eroded	551	0.2
29E2	Winnegan loam, 14 to 20 percent slopes, eroded	11,300	3.4
29F	Winnegan loam, 20 to 35 percent slopes	41,250	12.4
30B	Pershing silty clay loam, 2 to 5 percent slopes	6,500	1.9
31D2	Shelby loam, 9 to 14 percent slopes, eroded	2,400	0.7
31E2	Shelby loam, 14 to 20 percent slopes, eroded	13,800	4.1
32F	Putco silty clay loam, 30 to 60 percent slopes	1,550	0.5
33F	Vanmeter silty clay loam, 14 to 30 percent slopes	7,100	2.1
35	Belinda silt loam	1,350	0.4
37F	Schuline clay loam, 9 to 35 percent slopes	3,650	1.1
50	Amana silty clay loam	1,350	0.4
57B	Vigar-Zook-Nodaway complex, 1 to 5 percent slopes	17,400	5.2
58	Colo silt loam	4,800	1.4
63	Humeston silty clay loam	2,200	0.7
66	Nodaway silt loam	15,800	4.7
68C	Vigar silt loam, 2 to 9 percent slopes	2,800	0.8
76	Zook silty clay loam	11,900	3.6
	Water	1,065	0.3
	Total	333,101	100.0

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
11	Edina silt loam (where drained)
21B2	Seymour silty clay loam, 2 to 5 percent slopes, eroded
30B	Pershing silty clay loam, 2 to 5 percent slopes
35	Belinda silt loam (where drained)
50	Amana silty clay loam
57B	Vigar-Zook-Nodaway complex, 1 to 5 percent slopes (where the Zook soil is drained and where the Nodaway and Zook soils are either protected from flooding or not frequently flooded during the growing season)
58	Colo silt loam (where drained and either protected from flooding or not frequently flooded during the growing season)
63	Humeston silty clay loam (where drained)
66	Nodaway silt loam (where protected from flooding or not frequently flooded during the growing season)
68C	Vigar silt loam, 2 to 9 percent slopes
76	Zook silty clay loam (where drained and either protected from flooding or not frequently flooded during the growing season)

TABLE 6.--LAND CAPABILITY 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	Winter wheat	Bromegrass-alfalfa hay	Orchard-grass-red clover hay	Orchard-grass-trefoil	Smooth bromegrass
		Bu	Bu	Bu	Tons	Tons	AUM*	AUM*
10C2------------ Rinda	IVe	80	25	30	---	2.5	5.0	4.5
11-------------- Edina	IIw	100	36	40	3.4	3.7	7.4	7.3
12C2------------ Adair	IIIe	90	30	36	3.3	3.4	6.8	6.4
13E2------------ Gara	VIe	---	---	---	3.4	3.0	6.0	5.6
13F2------------ Gara	VIIe	---	---	---	---	---	5.0	4.6
15C2------------ Gorin	IIIe	82	29	31	3.5	2.9	6.0	5.6
16C2------------ Clarinda	IVe	81	27	30	---	2.7	5.4	4.8
17C2------------ Armstrong	IIIe	88	30	36	3.3	3.2	6.4	6.2
17D2------------ Armstrong	IVe	80	25	30	3.1	3.0	6.0	5.8
19D2------------ Keswick	IVe	78	23	28	3.0	3.0	6.0	6.0
21B2------------ Seymour	IIIe	99	34	40	4.0	3.8	7.6	7.3
25C2------------ Lamoni	IIIe	93	31	34	3.3	3.4	6.8	6.6
25D2------------ Lamoni	IVe	82	24	27	2.9	3.1	6.2	6.0
29E2------------ Winnegan	VIe	---	---	---	2.3	2.0	4.0	3.6
29F------------- Winnegan	VIIe	---	---	---	---	---	3.2	3.0
30B------------- Pershing	IIIe	92	40	38	4.0	3.5	7.0	6.6
31D2------------ Shelby	IVe	89	40	---	4.0	3.5	7.0	6.6
31E2------------ Shelby	VIe	---	---	33	3.8	3.2	6.4	5.9
32F------------- Putco	VIIe	---	---	---	---	---	.5	.5

See footnote at end of table.

TABLE 6.--LAND CAPABILITY AND YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Land capability	Corn	Soybeans	Winter wheat	Bromegrass-alfalfa hay	Orchard-grass-red clover hay	Orchard-grass-trefoil	Smooth bromegrass
		Bu	Bu	Bu	Tons	Tons	AUM*	AUM*
33F------------- Vanmeter	VIIe	---	---	---	---	---	3.2	3.0
35-------------- Belinda	IIw	112	38	43	3.4	3.7	7.4	6.8
37F------------- Schuline	VIIe	---	---	---	1.5	.9	3.1	2.2
50-------------- Amana	IIw	130	45	55	4.5	4.4	8.8	8.4
57B------------- Vigar-Zook-Nodaway	IVw	90	30	36	3.0	3.2	6.4	6.0
58-------------- Colo	IIIw	108	36	43	3.2	3.5	7.0	6.4
63-------------- Humeston	IIIw	102	34	40	3.0	3.4	6.8	6.0
66-------------- Nodaway	IIw	110	37	45	3.5	3.5	7.0	6.6
68C------------- Vigar	IIIe	125	41	50	4.3	4.0	8.0	7.6
76-------------- Zook	IIIw	85	28	34	2.0	2.5	5.0	4.6

* 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.

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
10C2------------ Rinda	2W	Slight	Severe	Severe	Moderate	White oak-----------	45	30	Silver maple, American sycamore, green ash, hackberry.
						Northern red oak----	45	30	
13E2, 13F2------ Gara	3R	Moderate	Moderate	Slight	Slight	White oak-----------	56	38	White oak, northern red oak, eastern white pine, red pine.
						Northern red oak----	57	38	
15C2------------ Gorin	3C	Slight	Slight	Slight	Severe	White oak-----------	53	38	White oak, white ash, black oak.
						Northern red oak----	62	---	
17C2, 17D2------ Armstrong	3C	Slight	Slight	Slight	Severe	White oak-----------	55	38	Eastern white pine, sugar maple, white oak.
						Northern red oak----	55	38	
19D2------------ Keswick	3C	Slight	Slight	Slight	Severe	White oak-----------	57	38	Eastern white pine, black oak.
						Black oak-----------	62	38	
29E2, 29F------- Winnegan	3R	Moderate	Moderate	Slight	Slight	White oak-----------	60	43	White oak, white ash, black oak, northern red oak.
						Black oak-----------	---	---	
						Northern red oak----	---	---	
30B------------- Pershing	3C	Slight	Slight	Slight	Severe	White oak-----------	55	38	Eastern white pine, white oak, red pine.
32F------------- Putco	2R	Severe	Severe	Severe	Slight	Cottonwood----------	---	---	Eastern white pine, green ash, white ash, white oak.
						River birch---------	---	---	
						American elm--------	---	---	
33F------------- Vanmeter	2R	Severe	Severe	Severe	Severe	White oak-----------	45	30	Eastern white pine, red pine, black oak.
50-------------- Amana	8A	Slight	Slight	Slight	Slight	Eastern cottonwood--	95	116	Eastern cottonwood, pin oak, green ash.
						Pin oak-------------	80	62	
						Green ash-----------	---	---	

See footnote at end of table.

TABLE 7.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Potential productivity: Common trees	Potential productivity: Site index	Potential productivity: Volume*	Trees to plant
57B**:									
Vigar.									
Zook.									
Nodaway--------	3A	Slight	Slight	Slight	Slight	White oak-----------	65	48	Black walnut, white oak, eastern cottonwood.
66-------------- Nodaway	3A	Slight	Slight	Slight	Slight	White oak-----------	65	48	Black walnut, white oak, eastern cottonwood.

* 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.

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
10C2 Rinda	---	American cranberrybush, eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet.	Green ash, Austrian pine.	Eastern white pine, pin oak.	---
11 Edina	---	Amur honeysuckle, Amur privet, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, northern whitecedar, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
12C2 Adair	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, American cranberrybush.	Austrian pine, green ash.	Eastern white pine, pin oak.	---
13E2, 13F2 Gara	---	Amur honeysuckle, American cranberrybush, Amur privet, silky dogwood.	Northern whitecedar, white fir, Washington hawthorn, blue spruce.	Austrian pine, Norway spruce.	Eastern white pine, pin oak.
15C2 Gorin	---	Amur honeysuckle, Washington hawthorn, eastern redcedar, Amur privet, arrowwood, American cranberrybush.	Green ash, Austrian pine.	Pin oak, eastern white pine.	---
16C2 Clarinda	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, American cranberrybush.	Green ash, northern white cedar.	Eastern white pine, pin oak, Austrian pine.	---
17C2, 17D2 Armstrong	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, American cranberrybush, Amur honeysuckle.	Austrian pine, green ash.	Eastern white pine, pin oak.	---

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
19D2--------------Keswick	---	Eastern redcedar, American cranberrybush, Washington hawthorn, arrowwood, Amur privet, Amur honeysuckle.	Austrian pine, green ash.	Eastern white pine, pin oak.	---
21B2--------------Seymour	---	Eastern redcedar, Washington hawthorn, Amur privet, arrowwood, Amur honeysuckle, American cranberrybush.	Austrian pine, green ash.	Eastern white pine, pin oak.	---
25C2, 25D2--------Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, American cranberrybush.	Austrian pine, green ash.	Eastern white pine, pin oak.	---
29E2, 29F---------Winnegan	---	American cranberrybush, Amur honeysuckle, Amur privet, arrowwood, Washington hawthorn, eastern redcedar.	Austrian pine, green ash, white fir.	Pin oak, eastern white pine.	---
30B---------------Pershing	---	Eastern redcedar, American cranberrybush, Washington hawthorn, Amur privet, Amur honeysuckle, arrowwood.	Austrian pine, green ash.	Eastern white pine, pin oak.	---
31D2, 31E2--------Shelby	---	Silky dogwood, American cranberrybush, Amur honeysuckle, Amur privet.	Washington hawthorn, northern whitecedar, blue spruce, white fir.	Norway spruce, Austrian pine.	Pin oak, eastern white pine.
32F---------------Putco	Siberian peashrub, Tatarian honeysuckle.	Russian-olive, Washington hawthorn, eastern redcedar, Osageorange.	Black locust, bur oak, green ash, honeylocust, northern catalpa.	Siberian elm------	---
33F---------------Vanmeter	Siberian peashrub	Eastern redcedar, Osageorange, Russian-olive, Washington hawthorn.	Northern catalpa, honeylocust, green ash.	---	---

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
35----------------- Belinda	---	Amur privet, silky dogwood, Amur honeysuckle, American cranberrybush.	Austrian pine, Norway spruce, blue spruce, northern whitecedar, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
37F---------------- Schuline	Siberian peashrub	Eastern redcedar, jack pine, silky dogwood, Washington hawthorn, Russian-olive.	Honeylocust, northern catalpa.	---	---
50----------------- Amana	---	American cranberrybush, silky dogwood, Amur privet.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce-----	Pin oak, eastern white pine.
57B*:					
Vigar------------	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
Zook-------------	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	Norway spruce, northern whitecedar, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
Nodaway----------	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
58----------------- Colo	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, blue spruce, white fir, northern whitecedar, Washington hawthorn.	Eastern white pine	Pin oak.

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
63: Humeston	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Norway spruce, Austrian pine, northern whitecedar, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.
66: Nodaway	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
68C: Vigar	---	Amur privet, Amur honeysuckle, American cranberrybush, silky dogwood.	Austrian pine, white fir, blue spruce, northern whitecedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
76: Zook	---	Silky dogwood, Amur honeysuckle, American cranberrybush, Amur privet.	Norway spruce, northern whitecedar, Austrian pine, blue spruce, white fir, Washington hawthorn.	Eastern white pine	Pin oak.

* 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")

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
10C2------------------ Rinda	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness.
11-------------------- Edina	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
12C2------------------ Adair	Severe: wetness.	Moderate: wetness.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
13E2------------------ Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
13F2------------------ Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
15C2------------------ Gorin	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Severe: slope.	Severe: erodes easily.	Slight.
16C2------------------ Clarinda	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness.
17C2------------------ Armstrong	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
17D2------------------ Armstrong	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
19D2------------------ Keswick	Severe: wetness.	Moderate: slope, wetness, percs slowly.	Severe: slope, wetness.	Severe: erodes easily.	Moderate: wetness, slope.
21B2------------------ Seymour	Severe: percs slowly.	Severe: percs slowly.	Severe: percs slowly.	Severe: erodes easily.	Slight.
25C2------------------ Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness.
25D2------------------ Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness, slope.
29E2------------------ Winnegan	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.

TABLE 9.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
29F Winnegan	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
30B Pershing	Moderate: wetness, percs slowly.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Severe: erodes easily.	Slight.
31D2 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
31E2 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
32F Putco	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
33F Vanmeter	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: erodes easily.	Severe: slope.
35 Belinda	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
37F Schuline	Severe: slope.	Severe: slope.	Severe: slope.	Severe: erodes easily.	Severe: slope.
50 Amana	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight	Moderate: flooding.
57B*:					
Vigar	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight	Slight.
Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
58 Colo	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.
63 Humeston	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.
66 Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: 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
68C------------------- Vigar	Severe: flooding.	Moderate: wetness, percs slowly.	Moderate: slope, wetness, percs slowly.	Slight----------	Slight.
76-------------------- Zook	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.

* 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")

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
10C2---------------- Rinda	Poor	Fair	Poor	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
11------------------ Edina	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
12C2---------------- Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
13E2---------------- Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
13F2---------------- Gara	Very poor.	Very poor.	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
15C2---------------- Gorin	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
16C2---------------- Clarinda	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
17C2, 17D2---------- Armstrong	Fair	Good	Fair	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.
19D2---------------- Keswick	Fair	Good	Fair	Good	Fair	Very poor.	Poor	Fair	Good	Very poor.
21B2---------------- Seymour	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
25C2, 25D2---------- Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
29E2---------------- Winnegan	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
29F----------------- Winnegan	Very poor.	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
30B----------------- Pershing	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
31D2---------------- Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
31E2---------------- Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
32F----------------- Putco	Very poor.	Very poor.	Poor	Poor	Poor	Very poor.	Very poor.	Very poor.	Poor	Very poor.
33F----------------- Vanmeter	Very poor.	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
35------------------ Belinda	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.

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
37F----------------- Schuline	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
50------------------ Amana	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Good.
57B*:										
Vigar---------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Zook----------------	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Nodaway-------------	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
58------------------ Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
63------------------ Humeston	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
66------------------ Nodaway	Poor	Fair	Fair	Poor	Poor	Good	Fair	Poor	Poor	Fair.
68C----------------- Vigar	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
76------------------ Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.

* 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." 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
10C2: Rinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, frost action.	Moderate: wetness.
11: Edina	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, wetness, shrink-swell.	Severe: wetness.
12C2: Adair	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength.	Moderate: wetness.
13E2, 13F2: Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
15C2: Gorin	Severe: wetness.	Severe: shrink-swell.	Severe: wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
16C2: Clarinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength.	Moderate: wetness.
17C2: Armstrong	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength.	Moderate: wetness.
17D2: Armstrong	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
19D2: Keswick	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness.	Severe: wetness, shrink-swell, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
21B2: Seymour	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.	Slight.
25C2: Lamoni	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength.	Moderate: wetness.
25D2: Lamoni	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.

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
29E2, 29F---------Winnegan	Severe: wetness, slope.	Severe: shrink-swell, slope.	Severe: wetness, slope.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.	Severe: slope.
30B---------------Pershing	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength, frost action.	Slight.
31D2--------------Shelby	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
31E2--------------Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
32F---------------Putco	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.	Severe: droughty, slope.
33F---------------Vanmeter	Severe: slope.	Severe: shrink-swell, slope.	Severe: slope.	Severe: shrink-swell, slope.	Severe: shrink-swell, low strength, slope.	Severe: slope.
35----------------Belinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
37F---------------Schuline	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
50----------------Amana	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
57B*:						
Vigar------------	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Slight.
Zook-------------	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, flooding.
Nodaway----------	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Severe: flooding.
58----------------Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, flooding, frost action.	Severe: flooding.

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
63----------------- Humeston	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness.
66----------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Severe: flooding.
68C---------------- Vigar	Severe: wetness.	Severe: flooding.	Severe: flooding, wetness.	Severe: flooding.	Severe: low strength, frost action.	Slight.
76----------------- Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, low strength, wetness.	Severe: wetness, flooding.

* 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," "fair," and other terms. 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
10C2 Rinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
11 Edina	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
12C2 Adair	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
13E2, 13F2 Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
15C2 Gorin	Severe: wetness, percs slowly.	Moderate: slope.	Moderate: wetness, too clayey.	Moderate: wetness.	Poor: thin layer.
16C2 Clarinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
17C2, 17D2 Armstrong	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
19D2 Keswick	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness.	Severe: wetness.	Poor: wetness.
21B2 Seymour	Severe: wetness, percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
25C2, 25D2 Lamoni	Severe: wetness, percs slowly.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack.
29E2, 29F Winnegan	Severe: wetness, percs slowly, slope.	Severe: slope.	Severe: wetness, slope.	Severe: wetness, slope.	Poor: slope.
30B Pershing	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
31D2 Shelby	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.

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
31E2: Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
32F: Putco	Severe: percs slowly, slope.	Severe: slope.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack.
33F: Vanmeter	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, slope.
35: Belinda	Severe: wetness, percs slowly.	Moderate: seepage.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
37F: Schuline	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
50: Amana	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
57B*:					
Vigar	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
58: Colo	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
63: Humeston	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
66: Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: too clayey, wetness.
68C: Vigar	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, 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
76------------------- Zook	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.

* 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. 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
10C2: Rinda	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
11: Edina	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, wetness.
12C2: Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
13E2: Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
13F2: Gara	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
15C2: Gorin	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
16C2: Clarinda	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
17C2, 17D2: Armstrong	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
19D2: Keswick	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
21B2: Seymour	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
25C2, 25D2: Lamoni	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
29E2: Winnegan	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
29F: Winnegan	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
30B: Pershing	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
31D2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
31E2: Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
32F: Putco	Poor: shrink-swell, low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
33F: Vanmeter	Poor: depth to rock.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, slope.
35: Belinda	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
37F: Schuline	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
50: Amana	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
57B*:				
Vigar	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
58: Colo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
63: Humeston	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
66: Nodaway	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
68C: Vigar	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
76: Zook	Poor: shrink-swell, low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

* 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." 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-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
10C2 Rinda	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
11 Edina	Slight	Severe: hard to pack, wetness.	Percs slowly	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
12C2 Adair	Moderate: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Slope, wetness.	Wetness	Wetness, percs slowly.
13E2, 13F2 Gara	Severe: slope.	Slight	Deep to water	Slope, rooting depth.	Slope	Slope, rooting depth.
15C2 Gorin	Moderate: slope.	Moderate: thin layer, piping, wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
16C2 Clarinda	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
17C2 Armstrong	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
17D2 Armstrong	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.	Wetness, slope, percs slowly.
19D2 Keswick	Severe: slope.	Moderate: wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Slope, erodes easily, wetness.	Wetness, slope, erodes easily.
21B2 Seymour	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.
25C2 Lamoni	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
25D2 Lamoni	Severe: slope.	Moderate: hard to pack, wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Slope, erodes easily, wetness.	Wetness, slope, erodes easily.
29E2, 29F Winnegan	Severe: slope.	Moderate: wetness.	Percs slowly, slope.	Slope, wetness, percs slowly.	Slope, wetness.	Slope, percs slowly.
30B Pershing	Moderate: slope.	Moderate: hard to pack, wetness.	Percs slowly, frost action, slope.	Slope, wetness, percs slowly.	Erodes easily, wetness.	Erodes easily, percs slowly.

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
31D2, 31E2: Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
32F: Putco	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope, droughty.	Slope, percs slowly.	Slope, droughty, percs slowly.
33F: Vanmeter	Severe: slope.	Slight	Deep to water	Slope, percs slowly, depth to rock.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
35: Belinda	Slight	Severe: wetness.	Percs slowly	Wetness, percs slowly, erodes easily.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
37F: Schuline	Severe: slope.	Moderate: thin layer, piping.	Deep to water	Slope, percs slowly, rooting depth.	Slope, erodes easily.	Slope, erodes easily, rooting depth.
50: Amana	Moderate: seepage.	Moderate: piping, wetness.	Flooding, frost action.	Wetness, erodes easily, flooding.	Erodes easily, wetness.	Erodes easily.
57B*: Vigar	Moderate: slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Wetness	Favorable.
Zook	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
58: Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
63: Humeston	Moderate: seepage.	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.
66: Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding	Erodes easily	Erodes easily.
68C: Vigar	Moderate: slope.	Moderate: wetness.	Frost action, slope.	Wetness, slope.	Wetness	Favorable.
76: Zook	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly.	Erodes easily, wetness, percs slowly.	Wetness, erodes easily, percs slowly.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

(Absence of an entry indicates that data were not estimated)

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag-ments 3-10 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas-ticity index
	In				Pct					Pct	
10C2-------------	0-4	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
Rinda	4-60	Clay, silty clay	CH, CL	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
11---------------	0-9	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
Edina	9-18	Silt loam--------	CL-ML, CL	A-4, A-6	0	100	100	95-100	85-100	25-40	5-15
	18-52	Silty clay, clay	CH	A-7	0	100	100	95-100	90-100	55-75	30-45
	52-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	35-60	15-35
12C2-------------	0-8	Loam-------------	CL, CL-ML	A-6, A-4	0	95-100	95-100	90-100	85-100	20-35	5-15
Adair	8-35	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
	35-62	Clay loam--------	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-50	15-25
13E2, 13F2-------	0-6	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
Gara	6-42	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	42-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
15C2-------------	0-6	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-18
Gorin	6-11	Silty clay loam, silty clay.	CL	A-6, A-7	0	100	100	95-100	90-100	35-50	15-30
	11-47	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	50-65	30-40
	47-60	Silty clay loam, clay loam.	CL	A-6, A-7	0	100	95-100	80-95	70-90	30-50	12-30
16C2-------------	0-8	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
Clarinda	8-34	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	34-60	Clay, silty clay	CH	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
17C2, 17D2-------	0-5	Clay loam--------	CL	A-6, A-7	0-5	90-100	80-95	75-90	55-80	35-45	15-25
Armstrong	5-46	Clay loam, clay, silty clay loam.	CL, CH, ML, MH	A-7	0-5	90-100	80-95	70-90	55-80	45-70	20-35
	46-60	Clay loam--------	CL	A-6	0-5	90-100	80-95	70-90	55-80	30-40	15-20
19D2-------------	0-4	Loam-------------	CL, CL-ML	A-6, A-4	0-5	90-100	80-100	75-90	60-80	20-30	5-15
Keswick	4-32	Clay loam, clay	CH, CL	A-7	0-5	90-100	80-100	70-90	55-80	40-70	20-40
	32-60	Clay loam--------	CL	A-6	0-5	90-100	80-100	70-90	55-80	30-40	15-25
21B2-------------	0-8	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
Seymour	8-37	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	55-70	30-40
	37-60	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	40-55	20-30
25C2, 25D2-------	0-8	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
Lamoni	8-52	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	52-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
29E2, 29F--------	0-6	Loam-------------	CL-ML, CL	A-4, A-6	0	95-100	95-100	80-90	60-80	20-30	5-15
Winnegan	6-34	Clay loam, clay	CL	A-7	0	95-100	95-100	85-95	65-85	40-50	20-30
	34-60	Clay loam, loam	CL	A-6	0	95-100	95-100	85-95	60-80	25-40	10-20
30B--------------	0-6	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
Pershing	6-11	Silty clay loam	CL, CH	A-7	0	100	100	100	95-100	40-55	15-30
	11-52	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	100	95-100	40-65	20-40
	52-60	Silty clay loam, silt loam.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-55	20-35

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments 3-10 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
31D2, 31E2	0-8	Loam	CL	A-6	0	95-100	85-95	75-90	55-70	30-40	10-20
Shelby	8-38	Clay loam	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	38-60	Clay loam	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
32F	0-4	Silty clay loam	CL	A-6, A-7	0-10	75-100	75-100	70-95	65-95	35-50	15-25
Putco	4-60	Silty clay	CL, CH	A-7	0-5	75-100	75-100	70-95	70-95	45-65	25-40
33F	0-7	Silty clay loam	ML, MH	A-7	0-5	95-100	75-100	70-100	65-100	40-55	11-25
Vanmeter	7-26	Silty clay, clay	CH, CL	A-7	0-5	95-100	75-100	70-100	65-100	40-65	24-40
	26-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
35	0-9	Silt loam	CL, ML	A-4, A-6	0	100	100	100	95-100	30-40	5-15
Belinda	9-15	Silt loam	CL-ML, CL, ML	A-4	0	100	100	100	95-100	25-35	5-10
	15-45	Silty clay, silty clay loam.	CH	A-7	0	100	100	100	95-100	40-55	20-30
	45-60	Silty clay loam	CH	A-7	0	100	100	100	95-100	50-65	25-35
37F	0-3	Clay loam	CL, ML	A-6, A-7	0-2	90-100	85-100	80-95	70-85	35-50	10-25
Schuline	3-60	Loam, silty clay loam, clay loam.	CL	A-6, A-7	0-5	90-100	85-100	80-95	70-85	30-50	10-25
50	0-17	Silty clay loam	CL	A-6	0	100	100	95-100	90-95	30-40	10-20
Amana	17-60	Silt loam	CL	A-6	0	100	100	95-100	75-95	30-40	10-20
57B*:											
Vigar	0-12	Loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	60-75	20-30	5-15
	12-60	Clay loam, silty clay loam, loam.	CL	A-6	0	95-100	90-100	70-95	60-90	30-40	15-25
Zook	0-22	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	22-48	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
	48-60	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	95-100	95-100	45-60	25-35
Nodaway	0-7	Silt loam	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
	7-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-40	5-15
58	0-21	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	95-100	95-100	25-40	5-15
Colo	21-41	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	41-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
63	0-12	Silty clay loam	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
Humeston	12-21	Silt loam	CL, CL-ML	A-6, A-4	0	100	100	95-100	95-100	25-40	5-15
	21-60	Silty clay loam, silty clay.	CH, CL	A-7	0	100	100	95-100	95-100	45-55	25-35
66	0-7	Silt loam	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
Nodaway	7-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-40	5-15
68C	0-15	Silt loam	CL-ML, CL	A-4, A-6	0	95-100	90-100	85-95	60-75	20-30	5-15
Vigar	15-60	Clay loam, silty clay loam, loam.	CL	A-6	0	95-100	90-100	70-95	60-90	30-40	15-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Fragments 3-10 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
76----------------- Zook	0-26	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	26-47	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55
	47-60	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	95-100	95-100	45-60	25-35

* 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 K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	g/cc	In/hr	In/in	pH					Pct
10C2-------------- Rinda	0-4	27-35	1.45-1.50	0.2-0.6	0.20-0.22	5.6-7.3	Moderate-----	0.43	2	7	1-3
	4-60	40-60	1.45-1.60	<0.06	0.14-0.16	5.1-7.3	High---------	0.32			
11---------------- Edina	0-9	15-27	1.35-1.45	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.37	3	6	2-4
	9-18	15-27	1.35-1.45	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.37			
	18-52	45-60	1.30-1.45	<0.06	0.11-0.13	5.1-7.3	Very high----	0.37			
	52-60	27-40	1.35-1.50	0.06-0.2	0.18-0.20	6.1-7.3	High---------	0.37			
12C2-------------- Adair	0-8	24-27	1.45-1.50	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.32	2	6	2-3
	8-35	38-60	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High---------	0.32			
	35-62	30-38	1.60-1.70	0.2-0.6	0.14-0.16	5.6-7.8	Moderate-----	0.32			
13E2, 13F2-------- Gara	0-6	18-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	2-3
	6-42	25-35	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.32			
	42-60	24-38	1.65-1.75	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
15C2-------------- Gorin	0-6	12-27	1.30-1.50	0.6-2.0	0.22-0.24	5.1-7.3	Moderate-----	0.43	3	6	.5-2
	6-11	27-42	1.30-1.45	0.06-0.6	0.18-0.20	4.5-6.0	Moderate-----	0.32			
	11-47	35-60	1.30-1.40	0.06-0.2	0.11-0.16	4.5-6.0	High---------	0.32			
	47-60	27-40	1.30-1.45	0.2-0.6	0.18-0.20	4.5-6.0	Moderate-----	0.32			
16C2-------------- Clarinda	0-8	27-38	1.45-1.50	0.2-0.6	0.17-0.19	5.1-7.3	Moderate-----	0.37	2	7	2-3
	8-34	40-60	1.45-1.60	<0.6	0.14-0.16	5.1-6.5	High---------	0.37			
	34-60	40-60	1.50-1.60	<0.06	0.14-0.16	5.6-8.4	High---------	0.37			
17C2, 17D2-------- Armstrong	0-5	35-42	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.32	2	4	2-3
	5-46	36-60	1.45-1.55	0.06-0.2	0.11-0.16	4.5-6.5	High---------	0.32			
	46-60	30-36	1.55-1.70	0.2-0.6	0.14-0.16	5.1-7.8	Moderate-----	0.32			
19D2-------------- Keswick	0-4	22-27	1.45-1.50	0.6-2.0	0.17-0.22	4.5-7.3	Moderate-----	0.37	2	6	1-2
	4-32	35-60	1.45-1.60	0.06-0.2	0.11-0.15	4.5-6.0	High---------	0.37			
	32-60	30-40	1.60-1.75	0.2-0.6	0.12-0.16	4.5-7.8	Moderate-----	0.37			
21B2-------------- Seymour	0-8	28-38	1.40-1.45	0.2-0.6	0.18-0.20	5.6-7.3	Moderate-----	0.37	3	7	2-3
	8-37	36-55	1.40-1.45	<0.06	0.12-0.18	5.1-6.5	High---------	0.28			
	37-60	35-40	1.45-1.50	0.2-0.6	0.18-0.20	5.6-7.3	High---------	0.43			
25C2, 25D2-------- Lamoni	0-8	27-40	1.45-1.50	0.2-0.6	0.17-0.21	5.1-7.3	Moderate-----	0.37	3	7	2-3
	8-52	38-50	1.55-1.65	0.06-0.2	0.13-0.17	5.1-6.5	High---------	0.37			
	52-60	32-40	1.60-1.70	0.06-0.2	0.14-0.18	5.6-7.3	High---------	0.37			
29E2, 29F--------- Winnegan	0-6	18-27	1.20-1.40	0.6-2.0	0.20-0.24	4.5-7.3	Low----------	0.32	3	6	.5-1
	6-34	35-45	1.35-1.55	0.06-0.2	0.09-0.15	4.5-6.5	High---------	0.32			
	34-60	20-35	1.40-1.60	0.2-0.6	0.09-0.15	7.4-8.4	Moderate-----	0.32			
30B--------------- Pershing	0-6	27-38	1.30-1.40	0.2-0.6	0.22-0.24	4.5-7.3	Moderate-----	0.37	3	7	2-3
	6-11	27-35	1.30-1.40	0.2-0.6	0.20-0.22	5.1-6.0	Moderate-----	0.43			
	11-52	35-48	1.35-1.45	0.06-0.2	0.18-0.20	5.1-6.0	High---------	0.43			
	52-60	24-40	1.35-1.50	0.2-0.6	0.18-0.20	5.1-6.5	High---------	0.43			
31D2, 31E2-------- Shelby	0-8	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.1-7.3	Moderate-----	0.28	5	6	2-3
	8-38	30-35	1.55-1.65	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.37			
	38-60	30-35	1.55-1.65	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
32F--------------- Putco	0-4	27-40	1.10-1.30	0.06-0.2	0.08-0.16	6.6-8.4	Moderate-----	0.28	5	8	.5-1
	4-60	40-60	1.40-1.60	0.06-0.2	0.04-0.10	7.4-8.4	High---------	0.24			

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
33F------------- Vanmeter	0-7	27-35	1.30-1.40	0.2-0.6	0.14-0.16	6.1-8.4	Moderate-----	0.43	2	4L	1-2
	7-26	40-60	1.50-1.60	<0.06	0.12-0.14	6.1-8.4	High---------	0.32			
	26-60	---	---	<0.06	---	---	-------------	----			
35--------------- Belinda	0-9	16-22	1.35-1.40	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.37	3	6	2-3
	9-15	18-27	1.30-1.35	0.6-2.0	0.20-0.22	4.5-6.0	Low----------	0.43			
	15-45	28-52	1.30-1.45	<0.06	0.12-0.14	4.5-6.5	High---------	0.32			
	45-60	28-40	1.40-1.50	0.06-0.6	0.18-0.20	5.1-6.0	High---------	0.43			
37F------------- Schuline	0-3	27-35	1.30-1.60	0.6-2.0	0.17-0.19	5.6-8.4	Moderate-----	0.37	5	6	<.5
	3-60	18-35	1.60-1.80	0.06-0.2	0.08-0.12	7.4-8.4	Moderate-----	0.37			
50--------------- Amana	0-17	27-35	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.37	5	7	2-4
	17-60	18-27	1.25-1.40	0.6-2.0	0.20-0.22	5.6-6.5	Moderate-----	0.37			
57B*:											
Vigar-----------	0-12	15-27	1.25-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	5	5	2-4
	12-60	---	1.20-1.40	0.2-0.6	0.14-0.16	5.6-7.3	Moderate-----	0.32			
Zook------------	0-22	35-40	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.37	5	7	5-7
	22-48	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
	48-60	27-45	1.30-1.45	0.06-0.6	0.11-0.22	5.6-7.8	High---------	0.28			
Nodaway---------	0-7	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Low----------	0.32	5	6	2-3
	7-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.43			
58--------------- Colo	0-21	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
	21-41	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.28			
	41-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	Moderate-----	0.32			
63--------------- Humeston	0-12	27-30	1.35-1.40	0.2-0.6	0.21-0.23	5.1-7.3	Moderate-----	0.37	4	7	3-4
	12-21	20-26	1.30-1.35	0.2-2.0	0.20-0.22	4.5-6.0	Moderate-----	0.43			
	21-60	30-48	1.35-1.50	<0.06	0.13-0.15	4.5-6.5	High---------	0.32			
66--------------- Nodaway	0-7	18-27	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Low----------	0.32	5	6	2-3
	7-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.43			
68C-------------- Vigar	0-15	15-27	1.25-1.45	0.6-2.0	0.20-0.22	5.6-7.3	Low----------	0.24	5	5	2-4
	15-60	---	1.20-1.40	0.2-0.6	0.14-0.16	5.6-7.3	Moderate-----	0.32			
76--------------- Zook	0-26	35-40	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.37	5	7	5-7
	26-47	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
	47-60	27-45	1.30-1.45	0.06-0.6	0.11-0.22	5.6-7.8	High---------	0.28			

* 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				
10C2-------------- Rinda	D	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Moderate.
11---------------- Edina	D	None---------	---	---	0.5-2.0	Perched	Nov-Apr	>60	---	Moderate	High-----	Moderate.
12C2-------------- Adair	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
13E2, 13F2-------- Gara	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
15C2-------------- Gorin	C	None---------	---	---	2.0-4.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
16C2-------------- Clarinda	D	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Moderate.
17C2, 17D2-------- Armstrong	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
19D2-------------- Keswick	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
21B2-------------- Seymour	C	None---------	---	---	2.0-4.0	Apparent	Nov-Apr	>60	---	Moderate	High-----	Moderate.
25C2, 25D2-------- Lamoni	C	None---------	---	---	1.0-3.0	Perched	Nov-Apr	>60	---	Moderate	High-----	Moderate.
29E2, 29F--------- Winnegan	C	None---------	---	---	2.0-3.5	Apparent	Nov-Apr	>60	---	Moderate	High-----	High.
30B--------------- Pershing	C	None---------	---	---	2.0-4.0	Perched	Nov-Apr	>60	---	High-----	High-----	Moderate.
31D2, 31E2-------- Shelby	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
32F--------------- Putco	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.

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				
33F----------------- Vanmeter	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	Low.
35----------------- Belinda	D	None---------	---	---	0.5-2.0	Apparent	Nov-Apr	>60	---	Moderate	High-----	Moderate.
37F----------------- Schuline	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
50----------------- Amana	B	Occasional	Very brief to brief.	Nov-Jun	2.0-4.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
57B*:												
Vigar-------------	C	Rare---------	---	---	2.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
Zook-------------	C/D	Frequent----	Brief to long.	Feb-Nov	0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
Nodaway-----------	B	Frequent----	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Nov-Apr	>60	---	High-----	Moderate	Low.
58----------------- Colo	B/D	Frequent----	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
63----------------- Humeston	C/D	Occasional	Very brief	Feb-Nov	0-1.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
66----------------- Nodaway	B	Frequent----	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Nov-Apr	>60	---	High-----	Moderate	Low.
68C----------------- Vigar	C	Rare---------	---	---	2.0-3.0	Apparent	Nov-Apr	>60	---	High-----	High-----	Moderate.
76----------------- Zook	C/D	Frequent----	Brief to long.	Feb-Nov	0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.

* 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
*Adair	Fine, montmorillonitic, mesic Aquic Argiudolls
Amana	Fine-silty, mixed, mesic Aquic Hapludolls
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Belinda	Fine, montmorillonitic, mesic Mollic Albaqualfs
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Edina	Fine, montmorillonitic, mesic Typic Argialbolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Gorin	Fine, montmorillonitic, mesic Aquic Hapludalfs
Humeston	Fine, montmorillonitic, mesic Argiaquic Argialbolls
Keswick	Fine, montmorillonitic, mesic Aquic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Pershing	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Putco	Fine, mixed (calcareous), mesic Typic Udorthents
*Rinda	Fine, montmorillonitic, mesic, sloping Mollic Ochraqualfs
Schuline	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
*Seymour	Fine, montmorillonitic, mesic Aquic Argiudolls
*Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Vanmeter	Fine, illitic, mesic Typic Eutrochrepts
Vigar	Fine-loamy, mixed, mesic Aquic Argiudolls
Winnegan	Fine, mixed, mesic Typic Hapludalfs
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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