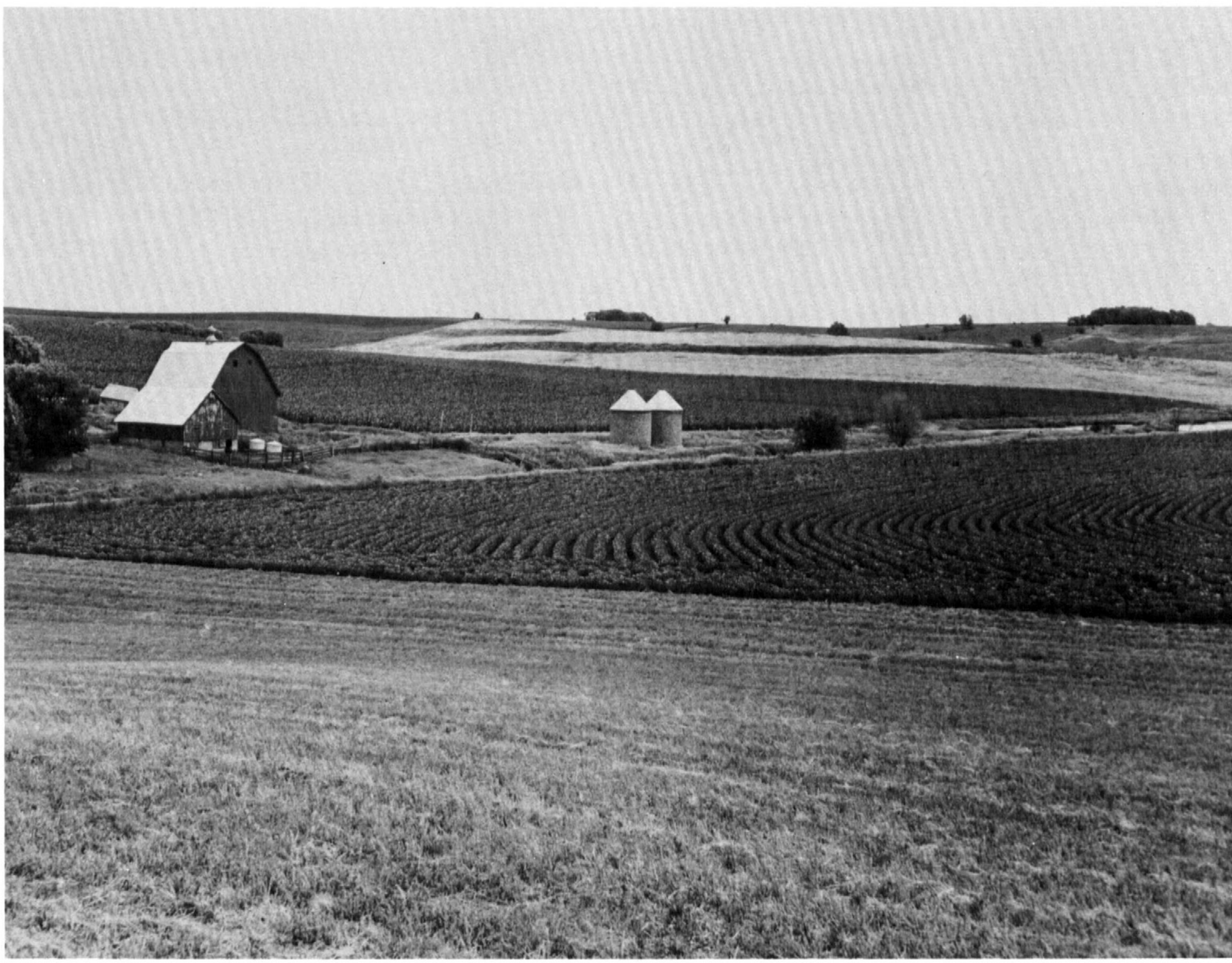
United States Department of Agriculture

Soil Conservation Service

In cooperation with Iowa Agriculture and Home Economics Experiment Station; Cooperative Extension Service, Iowa State University; Department of Soil Conservation, State of Iowa

Soil Survey of Audubon County, Iowa



HOW TO USE

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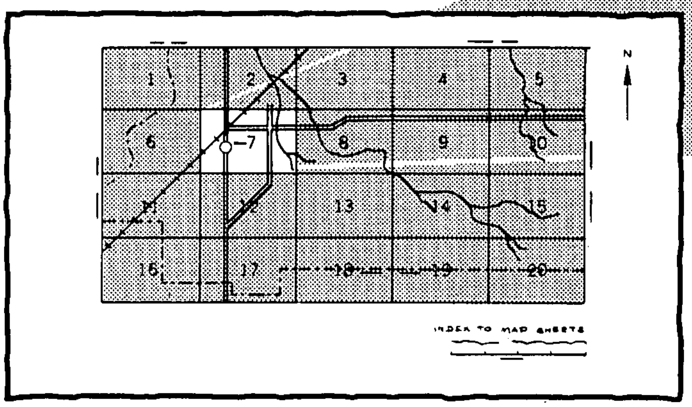

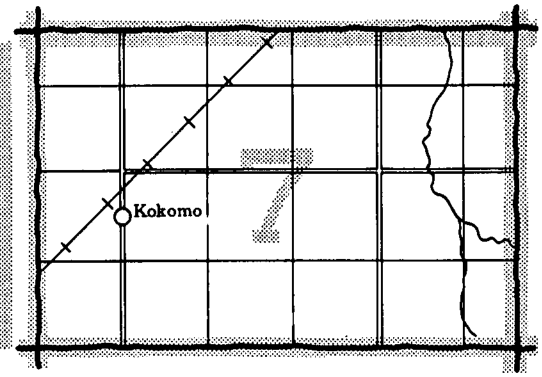

2. Note the number of the map sheet and turn to that sheet.

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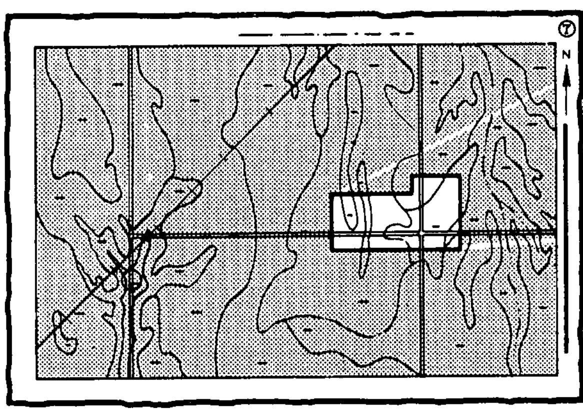
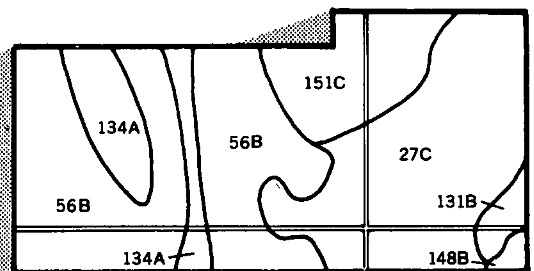
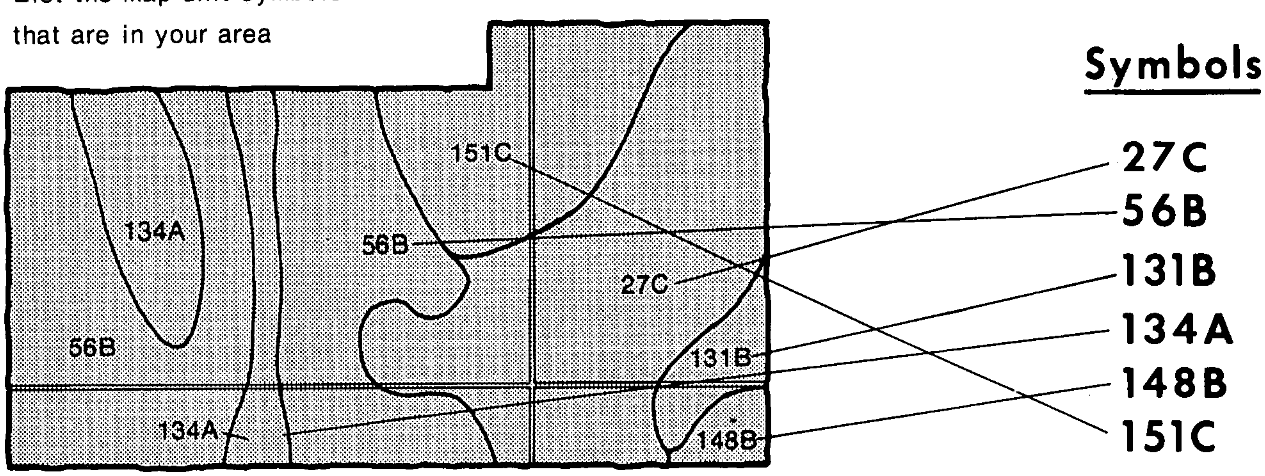


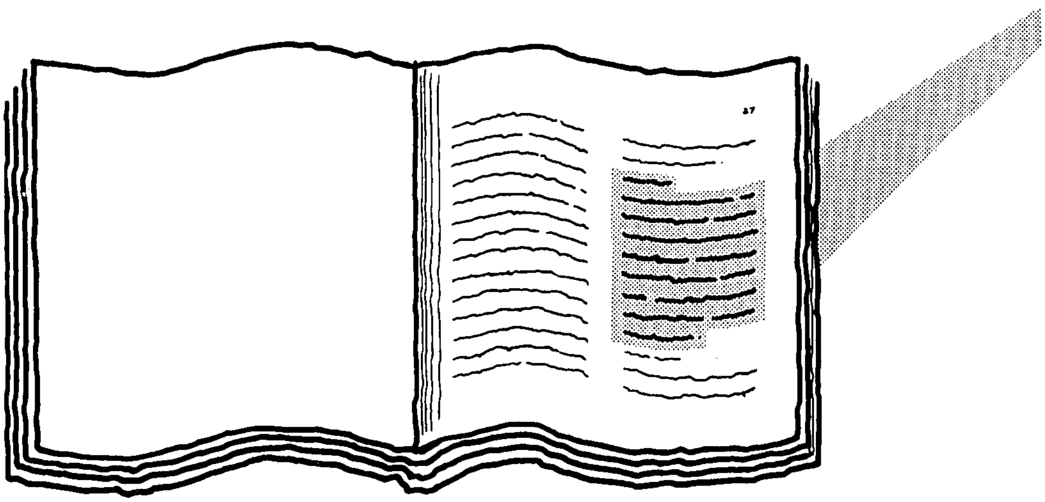


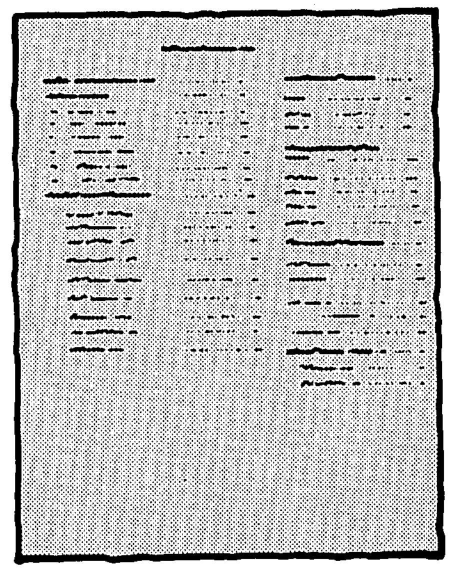
4. List the map unit symbols that are in your area



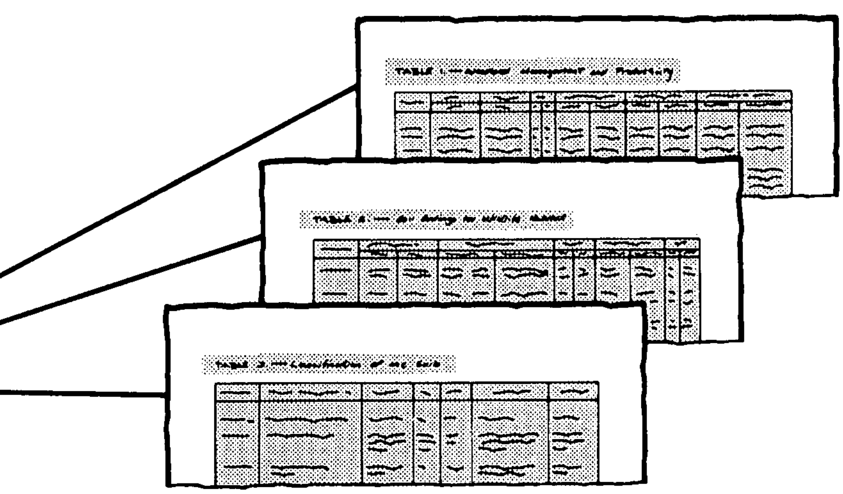
THIS SOIL SURVEY

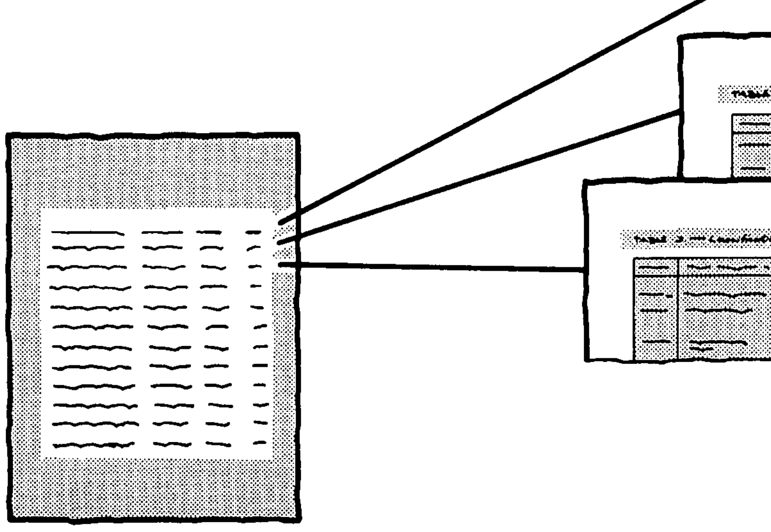
5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.





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





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

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

Major fieldwork for this soil survey was completed in 1976-81. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981.

This survey was made cooperatively by the Soil Conservation Service; the Iowa Agriculture and Home Economics Experiment Station; the Cooperative Extension Service, Iowa State University; and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Audubon County Soil Conservation District. Funds appropriated by Audubon County were used to defray part of the cost of the survey.

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

Cover: Terraces and contour stripcropping in an area of the Marshall-Shelby-Adair association on upland side slopes. These measures help to control erosion.

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Soil Series

Issued July 1984

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Summary of Tables

Preface

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

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

Soil Survey of
Audubon County, Iowa

By Mark J. Minger, Soil Conservation Service

Fieldwork by Mark J. Minger and David L. Reeves,
Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with
the Iowa Agriculture and Home Economics Experiment Station;
the Cooperative Extension Service, Iowa State University;
and the Department of Soil Conservation, State of Iowa

AUDUBON COUNTY is in west-central Iowa (fig. 1). It has a total area of about 286,720 acres, or 434 square miles. Audubon, the county seat, is about 70 miles west of Des Moines. It has a population of 2,841. The population of the county is about 8,560. It is mostly rural.

Most of the soils in Audubon County formed on a loess-mantled glacial till plain. The native vegetation on this plain was prairie grasses. The soils dominantly are gently sloping to moderately steep.

This survey updates the soil survey of Audubon County published in 1940 (*4*). It provides additional information and larger maps, which show the soils in greater detail.

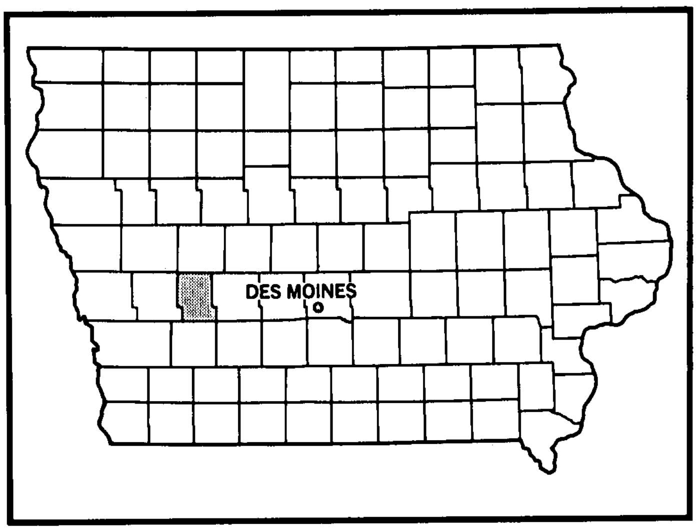

Figure 1.—Location of Audubon County in Iowa.

General Nature of the County

The following paragraphs briefly describe the history and development of the county and the transportation facilities; physiography, relief, and drainage; climate; natural resources; water supply; and farming.

History and Development

The area that is now Audubon County was acquired by the United States as a part of the Louisiana Purchase in 1803. In the early 1800's, it was inhabited by the Pottawattamie and Mesquakie Indian tribes, who would come to the area each summer to camp and hunt in the woodland groves. In 1846, the Mormons, who were traveling west, established three trails across the area. The southern trail later became a stagecoach route. In 1851, Nathaniel Hamlin and John Jenkins, the first settlers, occupied land in the southwest corner of the county.

The county was named after John James Audubon, the eminent naturalist. Originally a civil township in Cass County, it was organized as a separate county in 1855. The first county seat was established at Dayton in the same year. In 1866, the county seat was moved to Exira. In 1879, it was moved to Audubon (*3*).

In 1868, the railroads began replacing the stagecoach, and in 1878, a branch line was constructed along the East Nishnabotna River. In 1869, people of Danish descent began farming in the county. The area became the largest Danish settlement in the United States.

Transportation Facilities

Federal, state, and county highways throughout the county provide routes for automobile traffic and for the transportation of farm products. U.S. Highway No. 71 extends north and south through the central part of the county, and Iowa Highway No. 44 extends east and west across the central part. Hard surfaced county roads connect these highways to the smaller communities. Most other roads are surfaced with crushed limestone or gravel. Audubon has a municipal airport, which provides access to small private and commercial aircraft.

Physiography, Relief, and Drainage

Audubon County is mainly on dissected uplands that are drained by the southwestward flowing East and West Nishnabotna Rivers and their tributaries. The uplands consist of a loess-mantled glacial till plain, which is eroding and exposing paleosols and glacial till on the lower ridges and on the side slopes.

The northern half of the county is characterized by gently rolling and strongly sloping topography. Some areas in the northwest and northeast corners are moderately steep to very steep. Some scattered areas on uplands in the north-central part of the county are level or nearly level, but these areas are not extensive. The southern half of the county is characterized by gently sloping to moderately steep topography. It has scattered areas throughout that are steep or very steep. The most extensive steep area is in the west-central part of the county. The bottom land in the county, particularly that in the larger watersheds, is characterized by wide, nearly level flood plains. The rivers once meandered across the valleys. They are now commonly confined to straightened channels, which are entrenching into the valley floor.

The East Nishnabotna River flows in a north-south direction through the center of the county. Most of the drainageways within the county empty into the East Nishnabotna River or its tributaries. The drainageways in the western part of the county empty into the West Nishnabotna River. The East and West Nishnabotna Rivers empty into the Missouri River. In a small area in the extreme northeast corner of the county, the drainageways empty into Brushy Creek and into the South Racoon River, whose waters ultimately flow into the Mississippi River (*10*).

The highest surface elevation in Audubon County, about 1,540 feet above sea level, is in the west-central part of the county. The elevation also is more than 1,500 feet in several areas on a broad, stable divide extending northwest to southeast from the north-central part of the county to the east-central border. This divide is west of the divide between the Mississippi and Missouri Rivers, which is at a lower elevation. The lowest elevation, about 1,180 feet above sea level, is at a point where the East Nishnabotna River flows south out of the county.

Most of the upland soils are moderately well drained or well drained, except for the soils that formed in a paleosol. The poorly drained soils in upland drainageways and on bottom land generally have been artificially drained for crop production. A few scattered areas of very poorly drained soils are along the wider bottom land. Because these soils typically have a high content of clay, an artificial drainage system may not function well.

Climate

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

The climate in Audubon County is subhumid and continental. Winters are cold, and summers are warm. The growing season is long enough for the crops grown in the county to mature.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Audubon in the period 1951 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is about 22 degrees F, and the average daily minimum temperature is 12 degrees. The lowest temperature on record, which occurred at Audubon on February 17, 1958, is -29 degrees. In summer the average temperature is 73 degrees, and the average daily maximum temperature is 85 degrees. The highest recorded temperature, which occurred at Audubon on July 31, 1955, is 107 degrees.

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

The total annual precipitation is about 33 inches. Of this, 25 inches, or 75 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 20 inches. The heaviest 1-day rainfall during the period of record was 12.5 inches at Audubon on July 2, 1958. Thunderstorms occur on about 50 days each year, and most occur in summer.

The average seasonal snowfall is about 34 inches. The greatest snow depth at any one time during the period of record was 24 inches. On an average of 9 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 70 percent of the time possible in summer and 50 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 13 miles per hour, in summer.

Tornadoes and severe thunderstorms accompanied by hail and damaging winds are an occasional threat in Audubon County, particularly during the hot, humid periods in summer. Such storms are typically of short duration and result in crop or property damage in local, narrow belts.

Natural Resources

Soil is the most important natural resource in the county. It provides a growing medium for the grass grazed by livestock and for the marketable crops. Other natural resources are sand and gravel. The sand and gravel underlying the soils on flood plains, mainly in the southern part of the county, can be mined for commercial use. Most of the upland deposits have provided individual landowners an economical, noncommercial source of sand and gravel for use on the farm.

Water Supply

In most years and in most areas in Audubon County, the water supply is adequate for domestic use and for watering livestock. The underground geologic formations of the Dakota Sandstone and Mississippi Aquifer are the water-bearing sources for wells. These formations are quite deep, however, and yields are somewhat unpredictable. As a result, most rural and community wells are somewhat shallow and are in the lower part of upland drainageways or on flood plains. The sand and gravel at a depth of about 20 to 30 feet in these areas are sources for most of the water needed for residential and industrial uses and for livestock. The water supply from these sources often fluctuates, however, with the level of the water table, which is determined by the amount and frequency of rainfall. Also, the wells should be monitored periodically because contamination from ground water pollutants is a hazard..

A water table study was conducted by soil scientists on selected bottom land soils along the East Nishnabotna River during the progress of the soil survey. The purpose of this study was to obtain annual and long range patterns of water table fluctuations within poorly drained and very poorly drained bottom land soils. The results of this study may be useful in crop management, soil and water conservation, and land use planning. They are available at the office of the Audubon County Soil Conservation District.

Farming

About 281,500 acres in Audubon County, or about 98 percent of the total acreage, is farmland (*21*). The principal crops are corn, soybeans, hay, oats, and pasture. Raising hogs and feeding beef cattle are the principal livestock enterprises.

In recent years the farms in the county have been increasing in size and decreasing in number. The percentage of owner-operators has been increasing. In 1981, the county had 980 farms, which averaged 287 acres in size. Production on these farms has been increasing overall, mainly because of increased efficiency.

In 1980, about 132,000 acres was used for corn, 54,000 acres for soybeans, 22,300 acres for hay of all kinds, and 15,800 acres for oats. A minor acreage was used for sorghum and wheat. Farming is of prime importance to the total economy of Audubon County. It provides a livelihood for farmers as well as for those engaged in business, finance, and many related agribusiness activities.

Livestock production is becoming more specialized. More farmers are producing only one class of livestock. Recent trends show an increase in the number of confinement livestock systems, primarily in swine production. In 1980, about 310,000 hogs and 36,000 grain-fed cattle were marketed in the county. A small number of specialized farms raise dairy cows, sheep and lambs, or poultry.

Because of the rolling topography and the hazard of erosion on most of the soils in Audubon County, the farmers are continually guarding against excessive soil loss through conservation practices designed for their farms. The Audubon County Soil Conservation District was formed in 1943 to help overcome the effects of early farming methods. These methods resulted in soil loss and ultimately in the "Dust Bowl" of the 1930's. Because of the cooperation of individual landowners since the district was organized, conservation tillage, terraces, contour farming, grassed waterways, stabilization structures, and other measures are helping to conserve the soils in Audubon County.

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; and the kinds of crops and native plants growing on the soils. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

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

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

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

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

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

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

Map Unit Composition

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

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

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

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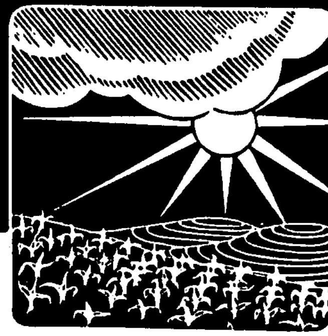

AGRONOMY
• Crops
• Soils
• Climate

Corn Suitability Ratings— An Index to Soil Productivity

Corn Suitability Rating (CSR) is an index procedure developed in Iowa to rate each different kind of soil for its potential row-crop productivity. Soil profile properties and weather conditions are the dominant factors that affect productivity. Slope characteristics are major factors that determine how land should be used. Slope gradient and slope length affect potential erosion rates, water infiltration, and ease and efficiency of machine operation.

CSRs provide a relative ranking of all soils mapped in the state of Iowa based on their potential to be utilized for row-crop production. The CSR is an index that can be used to rate one soil's potential yield production against another over a period of time.

The CSR considers average weather conditions as well as frequency of use of the soil for row-crop production. Ratings range from 100 for soils that have no physical limitations, occur on minimal slopes, and can be continuously row-cropped to as low as 5 for soils with severe limitations for row crops.

The CSR assumes: (a) adequate management, (b) natural weather conditions (no irrigation), (c) artificial drainage where required, (d) soils lower on the landscape are not affected by frequent floods, and (e) no land leveling or terracing. The CSR for a given field or farm can be modified by sandy spots, rock outcroppings, field boundaries, wet spots, and other special soil conditions.

Predicted yields are expected to change with time. CSRs are expected to remain relatively constant in relation to one another. CSRs can be used to quantify the productivity potential for individual fields, farms, or larger tracts of land.

Why "Corn" Suitability

Each year approximately 80 percent or more of Iowa's cropland is planted to corn and soybeans. More than 60 percent of the row crop is corn, which annually averages 13 to 14 million acres planted.

Since the introduction of hybrid corn seed on a wide scale in the 1930s, research has been conducted at Iowa State University to study the relationship among soil properties, weather, and corn yields. These investigations have been carried out throughout Iowa on major soils under varying weather conditions at outlying research centers, on farmers' fields, and on industry plots. A long-term and detailed data base is available concerning corn yields.

CSRs Versus Yields

Crop yields for a given kind of soil are expected to change from year to year. Factors that determine crop yields for a specific crop are soil properties, topography, weather, and management. The interaction of these variables in terms of yield is difficult to isolate. Yields are usually estimated for a specified level of management and normalized for a 5- or 10-year average.

New developments in technology and changes in weed, insect, and disease control may make any estimate of yield obsolete. Technological developments include new and improved crop varieties, changes in tillage methods, improvements in artificial drainage techniques, improved fertilization and liming techniques for optimum efficiency, new disease, weed, and insect control methods, and improved timely and efficient harvest practices. New diseases, insects, or weeds can result in lower yields. Consequently, yield estimates must be considered tentative, and revision will be necessary over time as new information becomes available.

Corn Suitability Ratings are based on soil properties, average weather, and the inherent potential of each kind of soil for corn production. CSRs are specified for average management and assume that new developments in technology and changes in the need for pest management practices will be relatively applicable to all soils.

Yield estimates are generally based on a high or an above average level of management. This level of management includes an implicit assumption that soil conserving activities on sloping lands are part of the management practices used to obtain high yields.

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A comparison of the CSR values and estimated corn yields for different slope and erosion phases of a Clarion loam are shown in table 1. Note the change in CSR and yield for a Clarion loam, 2 to 5 percent slopes, slightly eroded, and for a Clarion loam, 9 to 14 percent slopes, moderately eroded. The CSR changes from 82 to 55 while the estimated corn yield changes from 145 to 127.

This difference in CSR implies fewer inputs will be required to achieve an average yield of 145 bushels per acre on the 2 to 5 percent slope compared to inputs required to achieve 127 bushels per acre on the 9 to 14 percent slope gradient.

The additional inputs required on the steeper sloping soil may include agronomic and engineering practices such as some form of conservation tillage, a 4- or 5-year crop rotation that includes a grass or grass-legume crop with corn and soybeans, conservation structures, and above average addition of fertilizer and lime.

The change in value of the CSR by 27 points implies a need to conserve the soil on steeper slopes for maintenance of its long-term productivity. When CSR and yields are compared do not expect a linear one-to-one relationship among different slope classes and erosion phases for the same kind of soil.

Calculation of an Average CSR Value

Corn Suitability Ratings can be used with soil maps to calculate a weighted average CSR value for any size of land tract. A typical soil map of an 80-acre field located in the Clarion-Nicollet-Webster soil association area of North Central Iowa is shown in figure 1. Calculation of a weighted average CSR is illustrated in table 2. The weighted average CSR for the 80-acre field is 75.2.

Symbols on the soil map in addition to the soil mapping unit designation can be useful in evaluating a tract of land. Special soil symbols identify soil areas less than 2 acres that vary significantly from the soil mapping unit delineation in which they occur (figure 1). Many of these symbols indicate hazards or features that detract from

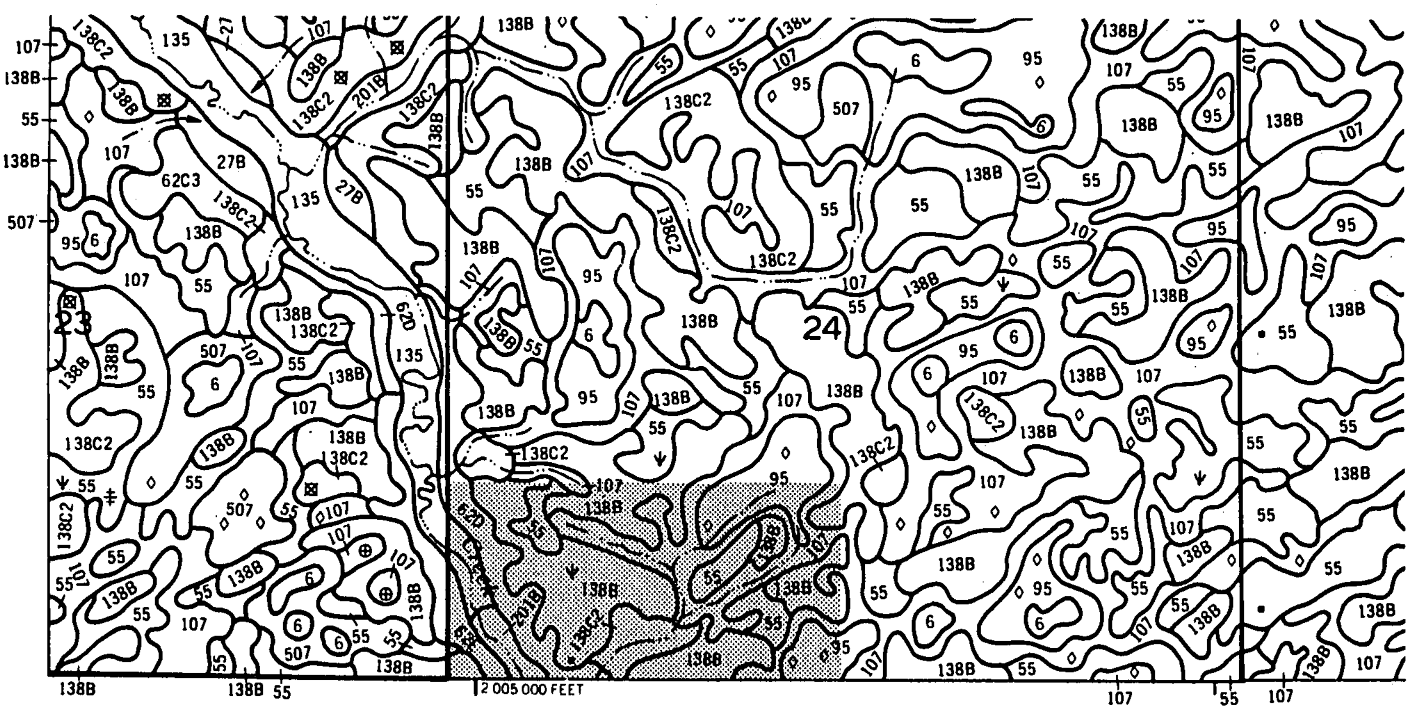


Figure 1. A soil map showing the soil inventory for an 80-acre field (shaded area).

Map symbol	Soil Phase
55	Nicollet loam, 1 to 3 percent slopes, no erosion
62D	Storden loam, 9 to 14 percent slopes, slight erosion
62E	Storden loam, 14 to 18 percent slopes, slight erosion
95	Harps clay loam, 0 to 2 percent slopes, no erosion
107	Webster clay loam, 0 to 2 percent slopes, no erosion
135	Coland clay loam, 0 to 2 percent slopes, no erosion
138B	Clarion loam, 2 to 5 percent slopes, slight erosion
138C2	Clarion loam, 5 to 9 percent slopes, moderate erosion
201B	Coland-Terril Complex, 1 to 5 percent slopes, slight erosion

Scale: 1 inch = 1320 feet

Slope Symbols

Blank	=	0 to 2% or 1 to 3%
B	=	2 to 5%
C	=	5 to 9%
D	=	9 to 14%
E	=	14 to 18%

Erosion Symbols

Blank	=	none or slight
2	=	moderate

Special Symbols

- —·· — waterway crossable with farm implements
- —··· — waterway not crossable with farm implements
- ↓ wet spot
- ◇ depression containing less than 2 acres of Okoboji soil
- • farmstead

Table 1. A comparison of CSRs and estimated corn yields for different slope and erosion phases of Clarion loam.

Soil map number	Percent slope gradient	Erosion class	CSR	Estimated yield bu/acre*
138B	2-5	slight	82	145
138C	5-9	slight	67	140
138C2	5-9	moderate	65	136
138D	9-14	slight	57	131
138D2	9-14	moderate	55	127

*Yield estimate for high level management, 5-year average.

the optimum use of the land and must be considered in evaluation of a tract. For example, the diamond-shaped symbol that occurs in soil delineation number 95 (figure 1) represents an area of Okoboji silty clay loam soil. The Okoboji soil often is saturated with water at or near the ground surface and has a CSR of 58.

Weighted average CSRs can be calculated for larger tracts or any combination of land tracts. Examples include whole farms, sections, townships, and county-by-county summaries. Figures 2 and 3 illustrate weighted CSRs that have been summarized on a county-by-county basis.

Uses of Corn Suitability Ratings

Corn Suitability Ratings can be used for several practical purposes. CSRs provide a method for placing a numerical rating on land. A numerical ratings provides a quantitative assessment of land compared to a qualitative rating. A primary use of CSRs is to quantify the productivity potential of a tract of land, field, or farm as described in figure 1 and table 2.

Other uses of CSRs are calculation of land values, comparison of farmland, aid in the equalization of tax assessment, and evaluation of farmland quality.

Table 2. Calculation of the weighted average CSR for an 80-acre field using the soil map shown in figure 1.

Soil map number	Soil type name	Acreage	CSR	Acreage × CSR
55	Nicollet loam	5.9	90	531.0
62D	Storden loam	6.4	45	288.0
62E	Storden loam	1.9	35	66.5
95	Harps clay loam	8.0	63	504.0
107	Webster clay loam	13.8	85	1173.0
135	Coland clay loam	2.0	80	160.0
138B	Clarion loam	36.1	82	2960.2
138C2	Clarion loam	3.9	65	253.5
201B	Coland-Terrill complex	2.0	40	80.0
		80.0		6016.2

$$\frac{6016.2}{80.0} = 75.2 = \text{weighted average CSR for field}$$

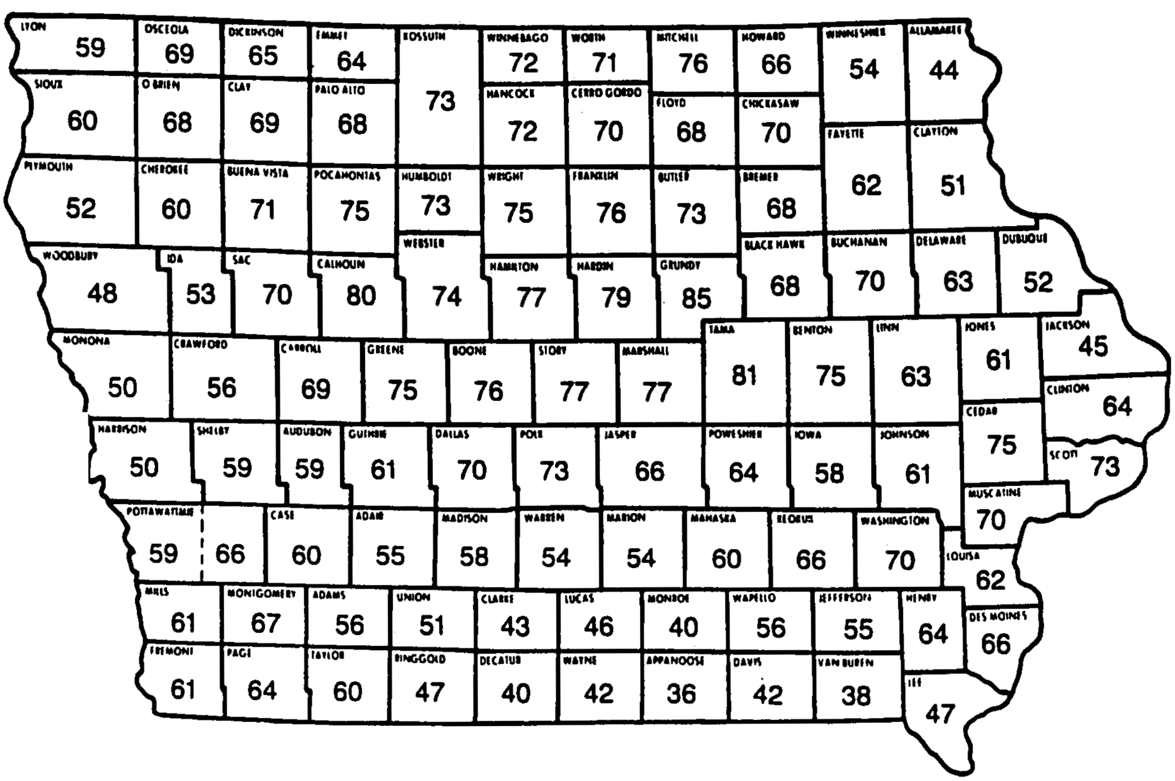


Figure 2. The average calculated corn suitability rating for each county based on 2 percent statistical sample data modified with weather correction factor where needed (Source: T. E. Fenton, Agronomy Department, ISU).

Calculation of Land Values

Appraisers, brokers, and farmers can use CSRs to calculate an index number for a tract of land based on its inherent productivity. To accomplish this, two pieces of information are required. First, an average CSR of a county, township, or other large land area is required. Figure 2 shows an example of the information needed. Second, the average price or sale value of the same land area is required. Using these two pieces of information, calculation of a current dollar value of each CSR point can be determined for the county, township, or other large land area. The next step is to take the dollar value of each CSR point and multiply this value times the average CSR of a specific tract of land or farm. This results in the dollar per acre value for the land tract or farm. An example of this procedure is illustrated in table 3 (see next page) using information from figure 1 and table 2.

This method assesses only the inherent productivity of the land. It does not include the value of buildings, location, water supplies, and other management features.

Table 4. Comparison of weighted average CSR and acreage for farms illustrated in figure 4.

Farm	Acres	Weighted average CSR
X	80	75.2
A	236	80.8
B	158	83.4
C	322	72.3
D	460	79.8

Comparison of Farmland

Calculation of the weighted average CSR for several farms or tracts of land within a defined soil association area provides a tool to compare the inherent productivity of one farm against another farm. Figure 4 shows a legal township containing 36 sections and the location of an 80-acre field designated as tract X. The average CSR of field X is 75.2 and can be compared to Farms A, B, C, and D, table 4. All the farms occur within the same major soil association area of Iowa and have some soil mapping units in common. These average CSR values can be used directly to compare the inherent productivity of each tract or farm with the other farms, regardless of size.

This method assesses only the inherent productivity. Factors such as buildings, location, water supplies, crop and noncrop acreages, and other management features must be subsequently evaluated.

Equalization of Tax Assessment

The Code of Iowa requires that farmland assessments be based on net earning capacity and productivity. The Code as legislated and made effective in 1977 states:

> The actual value of agricultural property shall be determined on the basis of productivity and net earning capacity of the property determined on the basis of its use for agricultural purposes capitalized at a

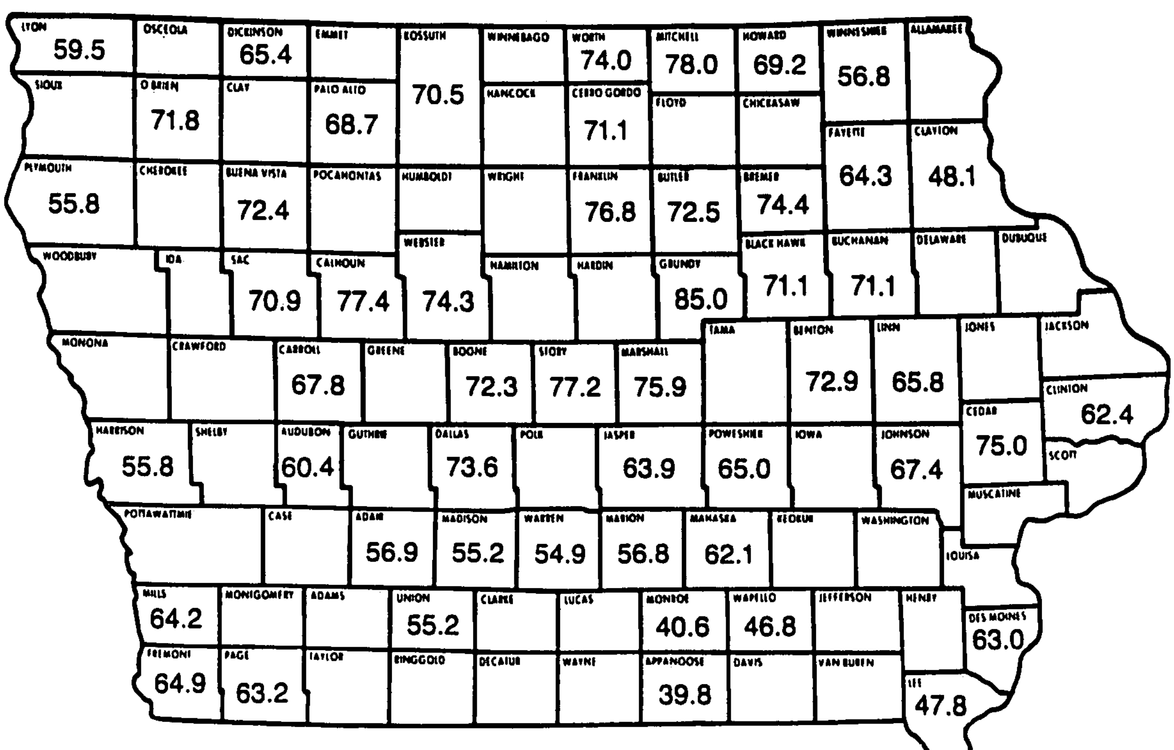


Figure 3. County average corn suitability rating calculated from acreages listed in published soil survey report and CSRs listed in the respective soil survey report supplement.

Table 3. Worksheet for calculating the land value for an 80-acre field based on inherent productivity.

1. Average CSR of a county or other large area:		(1) 70.0
2. Average sale price per acre of farmland for a county or other large area:		(2) $2200.00
3. Dollar value of each CSR point:	(2)/(1) $2200.00 / 70.0	= (3) $ 31.43
4. Value per acre of farmland for specific tract of land (e.g., use average CSR for 80-acre field shown in table 2). Weighted CSR per acre × dollar value	75.2 × (3) $31.43	= (4) $2363.54
5. Value of 80-acre field:	80 × (4) $ 2363.54	= (5) $ 189,083.20

> rate of seven percent and applied uniformly among counties and among classes of property. [Code of Iowa, Sec. 441.21.1e]

The major feature of the Code allows for the calculation of an average productivity on a county-by-county basis and the use of soil maps and CSRs for the equalization on an ownership tract basis. Concerning the use of soil map information the Code states:

> In counties or townships in which field work on a modern soil survey has been completed since January 1, 1949, the assessor and the Department of Revenue shall place emphasis upon the results of such survey in determining the productivity and earning capacity of such agricultural property. [Code of Iowa, Sec. 441.21.1f]

The present procedure used requires the use of soil maps and CSRs. The first step is made by the Iowa Department of Revenue (IDR). IDR considers the county as one large unit and calculates an average productivity value per acre for the county by the landlord net income method. As an example, a county has an average productivity value of $900 per acre. This value is based on a 5-year average of annual Iowa Crop and Livestock Reporting Service census data for cropland acreages, yields, estimated prices of farm products, and landlord expenses. Using a 7 percent capitalization rate the formula is:

$$(1)\quad \frac{\text{landlord net income per acre}}{\text{capitalization rate}}$$

= average productivity value per acre for county

$$(2)\quad \frac{\$63.00}{0.07} = \$900.00$$

On this basis each county in the state is assigned a productivity value.

The second step is made by the county assessor. The assessor uses the productivity value assigned by the Iowa Department of Revenue to calculate the total assessed value of taxable farmland in the county. For example, assume a county has 340,000 acres of taxable farmland and the average value of farmland is $900 per acre, the total assessed value is $306,000,000. The assessor then determines the total CSR points for the taxable farmland in the county by summing the CSR points for each ownership tract as illustrated in table 2. Next the assessor divides the total assessed value of taxable land by the total CSR points and determines the average dollar value per CSR point. Assume the total CSR points in the county are 23,800,000. This value divided into $306,000,000, the total assessed value, yields an average dollar value of $12.86 for each CSR point.

The assessor then multiplies the average CSR per ownership tract (some county assessors use 40-acre tracts or portions thereof based on ownership) times the value of each CSR point. In the example 80-acre field (table 2), the average CSR is 75.2. This average value times $12.86 yields an equalized assessed value of $967.07 per acre. The total assessed value of the 80-acre field is $77,365.60 (table 5).

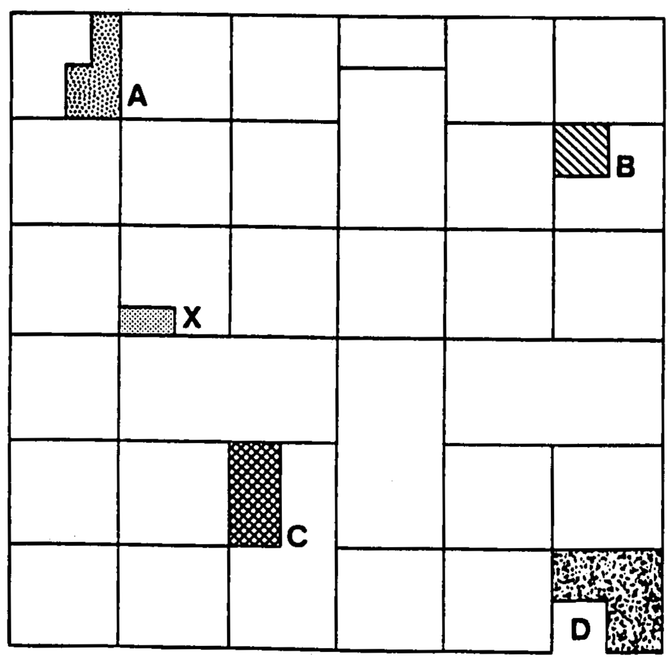


Figure 4. A rectangular township with 36 legal sections showing the location of farm X and comparable farms A, B, C, and D.

Table 5. Worksheet used by Iowa county assessors for equalization of assessed value of farmland based on inherent soil productivity.

1. Average value of an acre of farmland. (1) $900.00

2. Total taxable acres of farmland in county. (2) 340,000

3. Total value of taxable farmland.

$900 (1) × 340,000 (2) = (3) 306,000,000

4. Total CSR points in county. (4) 23,800,000

5. Value of each CSR point: (3) 306,000,000 / (4) 23,800,000 = (5) $ 12.86

6. Average CSR for example land tract (from table 2). (6) 75.2

7. Equalization per acre based on inherent productivity.

$12.86 (5) × 75.2 (6) = (7) $ 967.07

8. Equalization value of tract.

80.0 Acres × $967.07 (7) = (8) $ 77,365.60

This procedure allows county assessors to eliminate farm management skills of farmers in assessment of productivity of farmland. Instead, soil maps and CSRs provide the assessor with tools to evaluate soil properties and characteristics below the ground surface. This method provides for equalization of assessment on soil productivity, not how well or how poorly one is able to apply management skills.

Evaluation of Farmland Quality

Quality of farmland can be measured by several methods. One method commonly used is the USDA Land Capability Classification (LCC) system that rates each kind of soil at the map unit level in one of eight classes, I through VIII. The LCC system is a qualitative method that assesses soil limitations rather than soil productivity capacity. In Iowa the dominant soil limitation that separates soils into different classes of the LCC system is steepness of slope and erosion hazard.

The use of CSRs provides a method for quantification of the quality of farmland. The calculation of a weighted average CSR for each tract of land for a specified size or acreage allows comparison of land areas and provides a numerical value for each tract. Several Iowa counties have implemented a system to identify high quality farmland based on the numerical ratings determined by assignment and calculation of CSRs.

Availability of Corn Suitability Ratings

A Corn Suitability Rating value is assigned to each kind of soil that occurs in Iowa. Currently there are approximately 400 soil types (example: Clarion loam) and more than 1,600 soil map units (example: Clarion loam, 5 to 9 percent slopes, moderately eroded) identified in Iowa. Many of these map units occur over wide geographical areas under different rainfall and temperature patterns. For example, the Clarion loam soil is identified in all or part of 29 counties in north central Iowa ranging in latitude from southern Polk County to the Iowa-Minnesota state line and east to west from Worth County to Osceola County.

Because of the large geographic extent of many soil map units and the range of rainfall and temperature conditions in Iowa, CSRs are adjusted on a county-by-county basis. These localized CSR values are published in county soil survey report supplements. Since 1975, supplements have been released at the time of initial distribution of the county soil survey report. Currently, supplements are available for more than half of Iowa counties and supplements will be developed and published for the remaining Iowa counties as published soil survey reports become available.

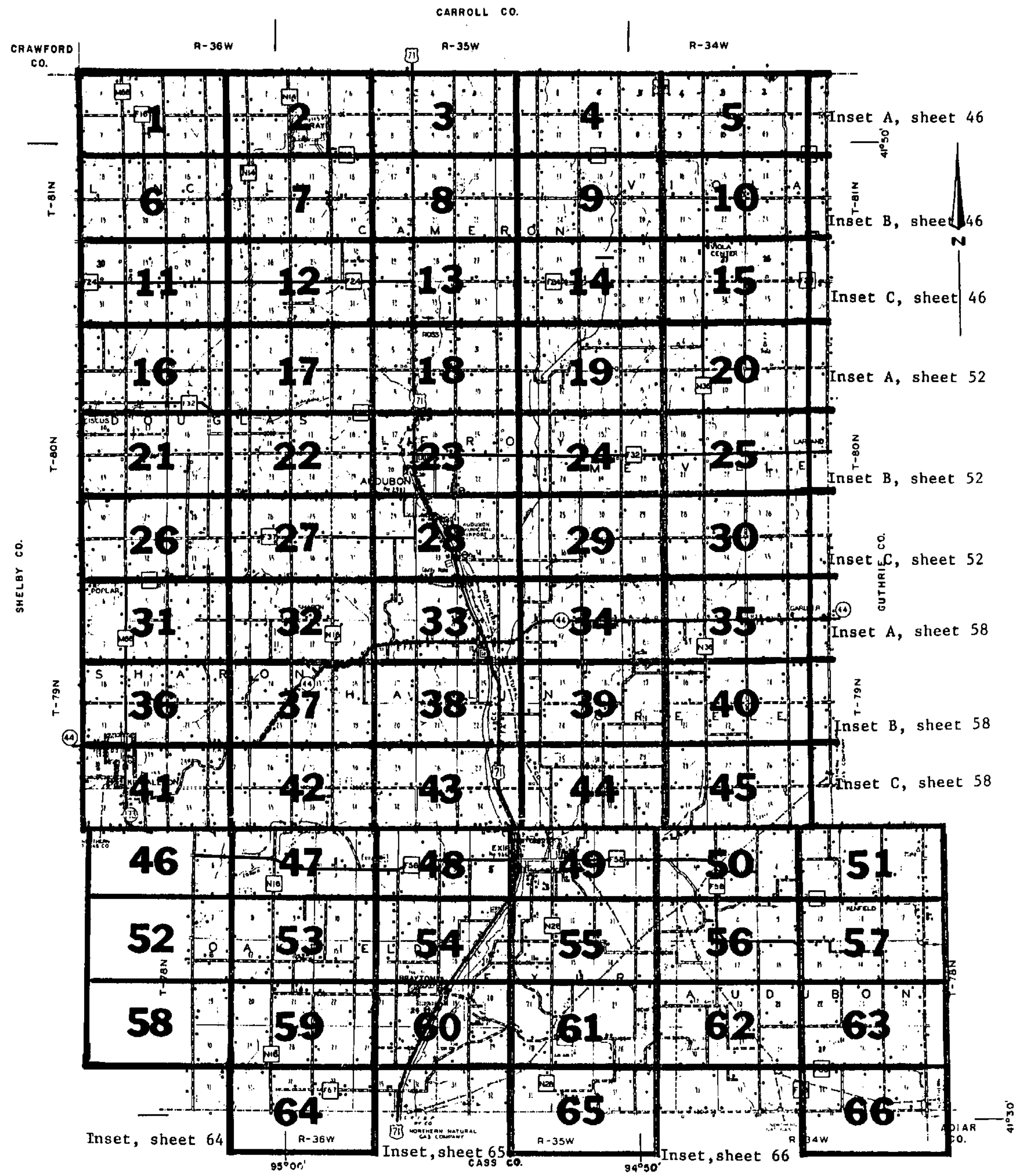
Copies of published soil survey reports and soil survey report supplements are available at the respective county extension office and soil conservation district office. Also, soil survey report supplements can be obtained from the Department of Agronomy, Iowa State University, Ames, Iowa 50011.

File: Agronomy 7

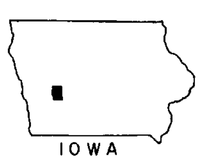
Cooperative Extension Service, Iowa State University of Science and Technology and the United States Department of Agriculture cooperating. Robert L. Crom, director, Ames, Iowa. Distributed in furtherance of the Acts of Congress of May 8 and June 30, 1914.

U. S. DEPARTMENT OF AGRICULTURE

SOIL CONSERVATION SERVICE



INDEX TO MAP SHEETS
AUDUBON CO.
SOIL CONSERVATION DISTRICT
IOWA



TOTAL ACREAGE APPROXIMATE 286,721.

SOURCE:
1976 GENERAL COUNTY HIGHWAY MAP
POLYCONIC PROJECTION
USDA SCS LINCOLN, NEBR 1978

1/168,960
SCALE 1 0 1 2 3 4 5 MILES

12-23-77
5,N-30,295

Audubon County Soil Survey Report Supplement

This supplement includes supplementary and updated information compiled for the Audubon County soil survey report dated July, 1984.

The supplementary portion contains corn suitability ratings (CSRs) which are not found in the report. Additional supplementary information includes an explanation of subsoil fertility terms, and a definition of erosion classes. The updated portion provides yield estimates for commonly grown crops.

Corn Suitability Ratings provide a relative ranking of all soils mapped in the State of Iowa based on their potential to be utilized for intensive row crop production. The CSR is an index that can be used to rate one soil's potential yield production against another over a period of time. The CSR index considers average weather conditions as well as frequency of use of the soil for row crop production. Ratings range from 100 for soils that have no physical limitations, occur on minimal slopes, and can be continuously row cropped to as low as 5 for soils with severe limitations for row crops. The highest CSR index in Audubon County is 91. The ratings listed in this supplement assume a) adequate management, b) natural weather conditions (no irrigation), c) artificial drainage where required, d) soils lower on the landscape are not affected by frequent floods, and e) no land leveling or terracing. The CSR for a given field can be modified by the occurrence of sandy spots, glacial till or gravel outcroppings, field boundaries, and so forth. Even though predicted average yields will change with time, the CSRs

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[1]Prepared by Gerald A. Miller, Extension Agronomist, and Thomas E. Fenton, Research Agronomist, Iowa State University; Ronald J. Kuehl, Assistant State Soil Scientist, and Mark J. Minger, Soil Scientist, Soil Conservation Service. CSR values were taken from information provided the Audubon County Assessor by the Iowa Cooperative Soil Survey Staff. Prepared October 1984.

Soil Map Symbol	Soil Mapping Unit Name	CSR	Corn Bu/Ac	Soybeans Bu/Ac	Oats Bu/Ac	Alfalfa-Grass T/Ac
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded	15	--	--	38	3.0
192D3	Adair clay loam, 9 to 14 percent slopes, severely eroded	5	--	--	--	2.1
212	Kennebec silt loam, 0 to 2 percent slopes	91	152	51	84	6.4
220	Nodaway silt loam, 0 to 2 percent slopes	85	145	49	80	6.0
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	10	66	22	33	2.0
248	Wabash silty clay loam, 0 to 1 percent slopes	60	107	36	59	3.2
268C	Knox silt loam, 5 to 9 percent slopes	61	128	43	70	5.4
268D	Knox silt loam, 9 to 14 percent slopes	50	121	41	67	5.1
268E	Knox silt loam, 14 to 18 percent slopes	40	105	35	58	4.4
268F	Knox silt loam, 18 to 25 percent slopes	20	--	--	--	2.0
273C	Olmitz loam, 5 to 9 percent slopes	57	132	44	73	5.5
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes	86	151	51	76	6.3
370B2	Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded	81	147	49	74	6.2
370C	Sharpsburg silty clay loam, 5 to 9 percent slopes	71	146	49	73	6.1
370C2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	66	142	48	71	6.0
370D2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	56	133	45	67	5.6
430	Ackmore silt loam, 0 to 2 percent slopes	83	141	47	78	4.2
509	Marshall silty clay loam, benches, 0 to 2 percent slopes	90	153	51	84	6.4
509B	Marhsall silty clay loam, benches, 2 to 5 percent slopes	85	150	50	83	6.3
509C2	Marshall silty clay loam, benches, 5 to 9 percent slopes, moderately eroded	68	141	47	78	5.9
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	15	76	25	38	3.0
980G	Gullied land-Judson complex, 2 to 40 percent slopes	5	--	--	--	--
5010	Pits, sand and gravel	Not rated				
5040	Orthents, loamy	Not rated				

are expected to remain relatively constant in relation to one another. The CSR can be useful to farmers, land buyers, and assessors and others as an aid in determining suitable land use and land value. The CSRs assigned for individual tracts of land by the Audubon County Assessor may differ from those listed in the accompanying table. These differences can be due to adjustments for waterways, land use for woodland and forest reserves, and combination of some soil mapping units during correlation of the final report.

Subsoil nutrient levels. Inherent subsoil fertility levels in terms of potential plant available phosphorus and potassium are described for each soil map unit in Audubon County (pp. 15-46). The qualitative ratings of available phosphorus and potassium assigned to each soil mapping unit are for the following depths in the soil profile: phosphorus, 24 to 36 inches, and potassium, 6 to 12 inches.

Soil tests of the plow layer are used to determine the most profitable rates of fertilizers for various crops. Nutrient levels in the subsurface layers do influence crop yields, particularly in drier seasons when the nutrients in the dry tilled layer become temporarily unavailable to plants. The availability of nutrients in the tilled layer and subsoil influences the relative uptake from the two zones in the soil profile. Fertilizer recommendations based on soil tests of the tilled layer may be adjusted by the average nutrient levels in the subsoil of each soil series. The fertilizer recommendations made by the Iowa State University Soil Testing Laboratory are adjusted for subsoil nutrient levels. The potential plant available subsoil phosphorus and potassium classes are described as follows:

Subsoil phosphorus (P). The base for the subsoil phosphorus level in soil test recommendations from the Iowa State University Soil Testing Laboratory are:

Soil Test Class	Soil Test Value, lbs/A
Very Low (VL)	Less than 15
Low (L)	15 to 25
Medium (M)	26 to 45
High (H)	Greater than 45

Subsoil potassium (K). The base for subsoil potassium level in soil test recommendations from the Iowa State University Soil Testing Laboratory are:

Soil Test Class	Soil Test Value, lbs/A
Very Low minus (VL-)	Less than 40
Very Low plus (VL+)	40 to 79
Low (L)	80 to 125
Medium (M)	126 to 200
High (H)	201 to 300
Very High (VH)	Greater than 300

Soil Mapping Unit Erosion Classes. The soil mapping unit name includes the soil type name, the slope gradient in percent, and the erosion class. For example, 9C2 is the soil mapping unit symbol for Marshall silty clay loam, 5 to 9 percent slopes, moderately eroded. The soil type, Marshall silty clay loam, is identified by the number 9. The slope gradient, 5 to 9 percent slopes, is identified by the letter C, and the erosion class, moderately eroded, is identified by the number 2. The erosion class of a soil mapping unit is classified by soil scientists based on the thickness of the A horizon and/or the amount of mixing of subsoil material in the tilled layer of cultivated soils.

A description of the erosion classes used in the Audubon County Soil Survey Report are outlined in the following table:

Erosion Symbol	Erosion Class Name	Description
+	Overwash	Recent deposition. 8 to 18 inches of light-colored material deposited on an existing A horizon.
(no symbol indicated. Blank)	None or slightly eroded	The tilled layer consists of A horizon material. Soils on 0 to 1%, 0 to 2%, and 1 to 3% slopes usually have an A horizon thickness of 10 inches or greater. Soils on 2 to 5% or steeper slopes usually have 7 to 12 inches of A horizon material. Little or no mixing of the subsoil material occurs in the tilled layer.
2	Moderately eroded	Dark colored A horizon material is 3 to 7 inches thick. Some mixing of subsoil material is present in the tilled layer.
3	Severely eroded	Dark colored A horizon material is less than 3 inches thick. A major portion of the tilled layer consists of subsoil material.

Yield estimates. The yield estimates listed in this supplement are provided to update corn, soybeans, oats, and grass-legume hay yields listed on Table 6 (pp. 104-106) of the report. These updated yields are estimated for high level management and are normalized for a five-year average. The yields listed in Table 6 for smooth bromegrass, Kentucky bluegrass and bromegrass-alfalfa are satisfactory estimates.

High level management includes the adaption of best available technology for crop production to include agronomic, engineering, and economic practices. For example, best available technology for corn production includes tillage and engineering practices that maintain soil erosion rates at or below tolerance limits. Also, best available technology includes use of artificial drainage on those soils requiring the removal of excess water for optimum plant root growth and development and protection from periodic flooding for those soils adjacent to drainageways, streams, and rivers. Other management practices may include cultivar selection, planting dates, optimum population, row-spacing, optimum fertilization and liming rates, weed and insect control, and timely and efficient harvest practiceds. All yield estimates are for dryland (non-irrigated) conditions.

Five-year average estimates are used to smooth the effects of weather variations on a year-to-year basis.

Yield estimates for soybeans, oats, and alfalfa-grass hay are calculated from a percentage of the estimated corn yields. Kind of parent material is considered in the calculation of soybean yield estimates. Natural soil drainage class is considered in the calculation of alfalfa-grass hay yield estimates. The alfalfa-grass hay yields assume 80 percent or more alfalfa in the stand with either orchardgrass or bromegrass.

Soil Map Symbol	Soil Mapping Unit Name	CSR	Corn Bu/Ac	Soybeans Bu/Ac	Oats Bu/Ac	Alfalfa-Grass T/Ac
1C3	Ida silt loam, 5 to 9 percent slopes, severely eroded	50	111	37	61	4.7
7B	Wiota silty clay loam, 1 to 4 percent slopes	85	150	50	83	6.3
8B	Judson silty clay loam, 2 to 5 percent slopes	84	149	50	82	6.3
8C	Judson silty clay loam, 5 to 9 percent slopes	69	144	48	79	6.0
9	Marshall silty clay loam, 0 to 2 percent slopes	90	153	51	84	6.4
9B	Marshall silty clay loam, 2 to 5 percent slopes	85	150	50	83	6.3
9B2	Marshall silty clay loam, 2 to 5 percent slopes, moderately eroded	83	146	49	80	6.1
9C	Marshall silty clay loam, 5 to 9 percent slopes	70	145	49	80	6.1
9C2	Marshall silty clay loam, 5 to 9 percent slopes, moderately eroded	68	141	47	78	5.9
9D2	Marshall silty clay loam, 9 to 14 percent slopes, moderately eroded	58	132	44	73	5.5
9E2	Marshall silty clay loam, 14 to 20 percent slopes, moderately eroded	48	115	39	63	4.8
9E3	Marshall silty clay loam, 14 to 20 percent slopes, severely eroded	45	106	36	58	4.4
11B	Judson-Colo-Ackmore complex, 2 to 5 percent slopes	68	130	44	72	3.9
24C3	Shelby clay loam, 5 to 9 percent slopes, severely eroded	55	116	39	58	4.9
24D2	Shelby clay loam, 9 to 14 percent slopes, moderately eroded	48	115	39	57	4.8
24D3	Shelby clay loam, 9 to 14 percent slopes, severely eroded	45	107	36	53	4.5
24E3	Shelby clay loam, 14 to 18 percent slopes, severely eroded	35	—	—	—	3.8
24F3	Shelby clay loam, 18 to 25 percent slopes, severely eroded	15	—	—	—	2.5
54	Zook silty clay loam, 0 to 2 percent slopes	70	126	42	69	3.8
71D	Dickman-Marshall complex, 9 to 14 percent slopes	40	98	33	54	4.1
93D2	Shelby-Adair comlex, 9 to 14 percent slopes, moderately eroded	25	94	31	52	3.8
93D3	Shelby-Adair complex, 9 to 14 percent slopes, severely eroded	20	—	—	—	3.0
93E2	Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded	10	—	—	—	2.3
93E3	Shelby-Adair complex, 14 to 18 percent slopes, severely eroded	5	—	—	—	1.4
99C2	Exira silty clay loam, 5 to 9 percent slopes, moderately eroded	66	138	46	76	5.8
99D2	Exira silty clay loam, 9 to 14 percent slopes, moderately eroded	57	132	44	73	5.5
99D3	Exira silty clay loam, 9 to 14 percent slopes, severely eroded	54	123	41	68	5.2
99E2	Exira silty clay loam, 14 to 18 percent slopes, moderately eroded	47	112	38	62	4.7
133	Colo silty clay loam, 0 to 2 percent slopes	80	136	46	75	4.1
179E	Gara loam, 14 to 18 percent slopes	35	—	—	—	2.8
179F	Gara loam, 18 to 25 percent slopes	15	—	—	—	2.5
179G	Gara loam, 25 to 40 percent slopes	5	—	—	—	—
192C2	Adair clay loam, 5 to 9 percent slopes, moderately eroded	30	82	27	41	3.3

General Soil Map Units

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

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

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Marshall-Exira association

Nearly level to moderately steep, well drained, silty soils formed in loess; on uplands

This association is on the most stable upland ridges, side slopes, and drainageways in the county. It generally is on the divide between the East Nishnabotna River and the West Nishnabotna River and on the broad divide between the Missouri River and Mississippi River watersheds. Slopes range from 0 to 20 percent.

This association makes up about 48 percent of the county. It is about 60 percent Marshall soils, 25 percent Exira soils, and 15 percent soils of minor extent (fig. 2).

Marshall soils are nearly level to moderately steep. They typically are at the higher elevations and are upslope from the Exira soils. Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown silty clay loam about 11 inches thick. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam.

Exira soils are moderately sloping to moderately steep. Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 41 inches thick. It is friable. The upper part is brown silty clay loam; the next part is brown, variegated silt loam; and the lower part is light brownish gray and yellowish brown, variegated silt loam. The substratum to a depth of about 60 inches is light brownish gray and brown silt loam. The variegated soil colors are not indicative of present drainage conditions.

Minor in this association are Adair, Clarinda, Ida, Lamoni, and Shelby soils and the soils in the Judson-Colo-Ackmore complex. The gently sloping soils in the Judson-Colo-Ackmore complex are in upland drainageways. Adair soils are moderately sloping or strongly sloping, moderately well drained or somewhat poorly drained, and slowly permeable. Clarinda soils are strongly sloping, poorly drained, and very slowly permeable. The moderately sloping Ida soils are on ridges. They formed in calcareous loess. Lamoni soils are strongly sloping, somewhat poorly drained, and slowly permeable. The moderately sloping to moderately steep, moderately well drained Shelby soils generally are on the lower side slopes.

Most areas in this association are used for row crops. Some of the steeper areas are used for small grain and hay. Most of the soils are well suited or moderately well suited to row crops. The moderately steep soils are best suited to hay or permanent pasture. The main concerns of management are controlling water erosion and maintaining or improving tilth and fertility (fig. 3). Because Adair and Lamoni soils are slowly permeable and Clarinda soils are very slowly permeable, some areas of the surrounding Marshall and Exira soils may be seepy.

2. Marshall-Shelby-Adair association

Gently sloping to steep, well drained to somewhat poorly drained, silty and loamy soils formed in loess and glacial till; on uplands

This association is in the many areas in the county where deep loess mantles the ridges and upper side slopes and glacial till and a paleosol are exposed on the lower side slopes. Slopes range from 2 to 25 percent.

This association makes up about 41 percent of the county. It is about 42 percent Marshall soils, 20 percent Shelby soils, 18 percent Adair soils, and 20 percent soils of minor extent (fig. 4).

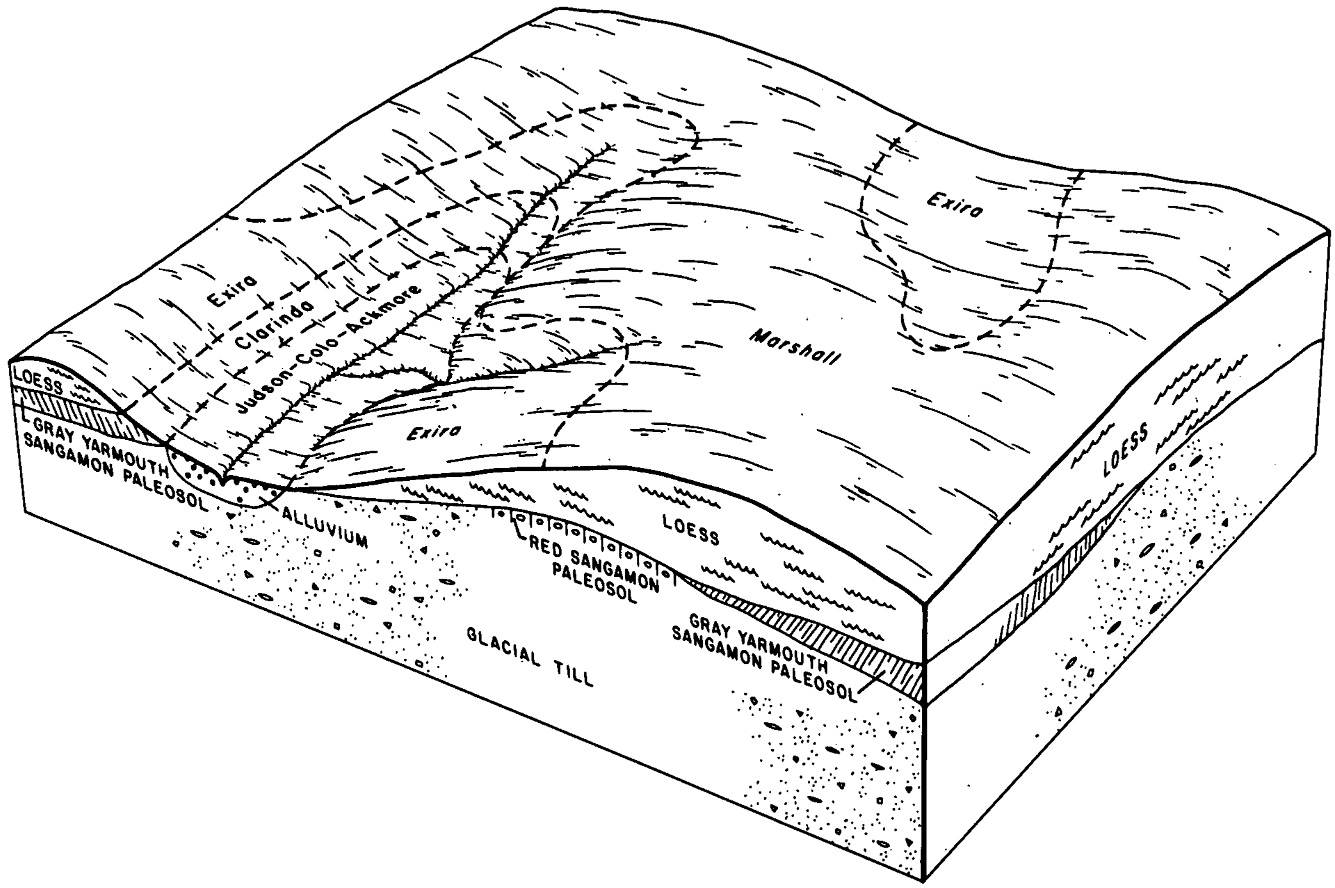

Figure 2.—Pattern of soils and parent material in the Marshall-Exira association.

Marshall soils are well drained and are gently sloping to moderately steep. They formed in loess. Shelby soils are moderately well drained and are moderately sloping to steep. They formed in glacial till. Adair soils are moderately well drained or somewhat poorly drained and are moderately sloping to moderately steep. They formed in a reddish paleosol that formed in glacial till.

Typically, the surface layer of the Marshall soils is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 40 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam.

Typically, the surface layer of the Shelby soils is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 38 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam.

Typically, the surface layer of the Adair soils is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown and brown subsoil material. The upper part of the subsoil is dark yellowish brown and brown, friable clay loam. The lower part to a depth of about 60 inches is brown, reddish brown, and strong brown, mottled, very firm clay and clay loam.

Minor in this association are Clarinda, Exira, and Olmitz soils and the soils in the Judson-Colo-Ackmore complex. Clarinda soils are strongly sloping, poorly drained, and very slowly permeable. Exira soils are moderately sloping to moderately steep. Their subsoil and substratum are dominantly mottled silt loam. The moderately sloping Olmitz soils are on foot slopes. The

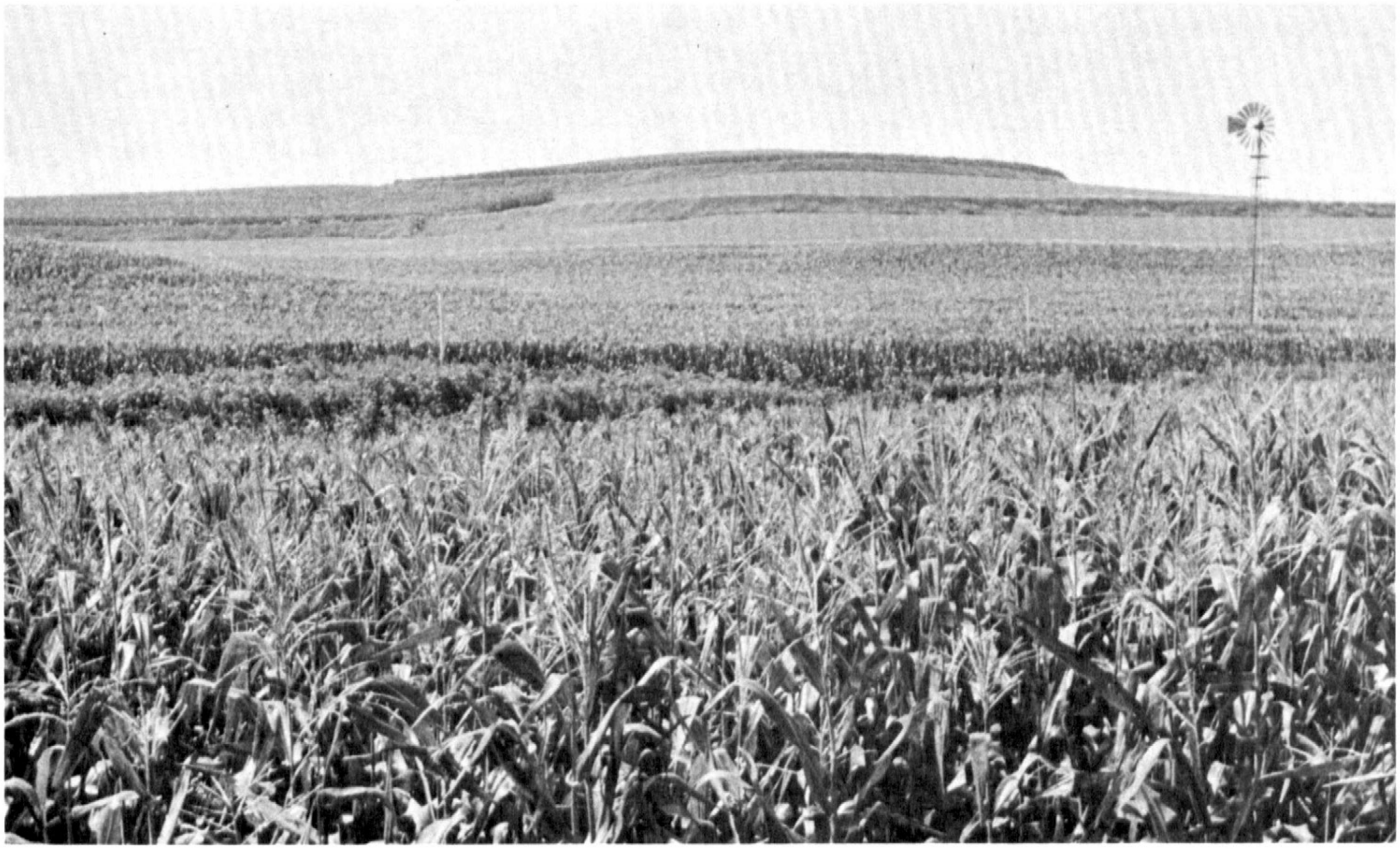

Figure 3.—A combination of terraces and contour farming in an area of the Marshall-Exira association. These measures help to control erosion on upland side slopes and thus help to prevent siltation in the adjacent drainageways.

gently sloping soils in the Judson-Colo-Ackmore complex are in upland drainageways.

Most areas in this association are used for row crops. Some of the steeper areas are used for hay and pasture (fig. 5). The gently sloping to strongly sloping Marshall soils and the moderately sloping and strongly sloping Shelby soils are generally well suited or moderately well suited to row crops. The moderately sloping Adair soils are moderately well suited to row crops, and the strongly sloping ones are poorly suited or generally unsuited. The moderately steep or steep soils are better suited to hay or permanent pasture than to row crops. The main concerns of management are controlling water erosion, maintaining or improving tilth and fertility, and draining seepy areas. Because Adair soils are slowly permeable and Clarinda soils are very slowly permeable, some areas of the surrounding Marshall and Exira soils may be seepy.

3. Marshall-Gara-Shelby association

Gently sloping to very steep, well drained and moderately well drained, silty and loamy soils formed in loess and glacial till; on uplands

This association is on the steepest slopes and in the most dissected parts of the county. Slopes range from 2 to 40 percent.

This association makes up about 9 percent of the county. It is about 30 percent Marshall soils, 20 percent Gara soils, 15 percent Shelby soils, and 35 percent soils of minor extent.

Marshall soils are well drained and are gently sloping to moderately steep. They formed in loess. Gara soils are moderately well drained and are moderately steep to very steep. They formed in glacial till. Shelby soils are moderately well drained and are moderately sloping to steep. They formed in glacial till.

Typically, the surface layer of the Marshall soils is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The

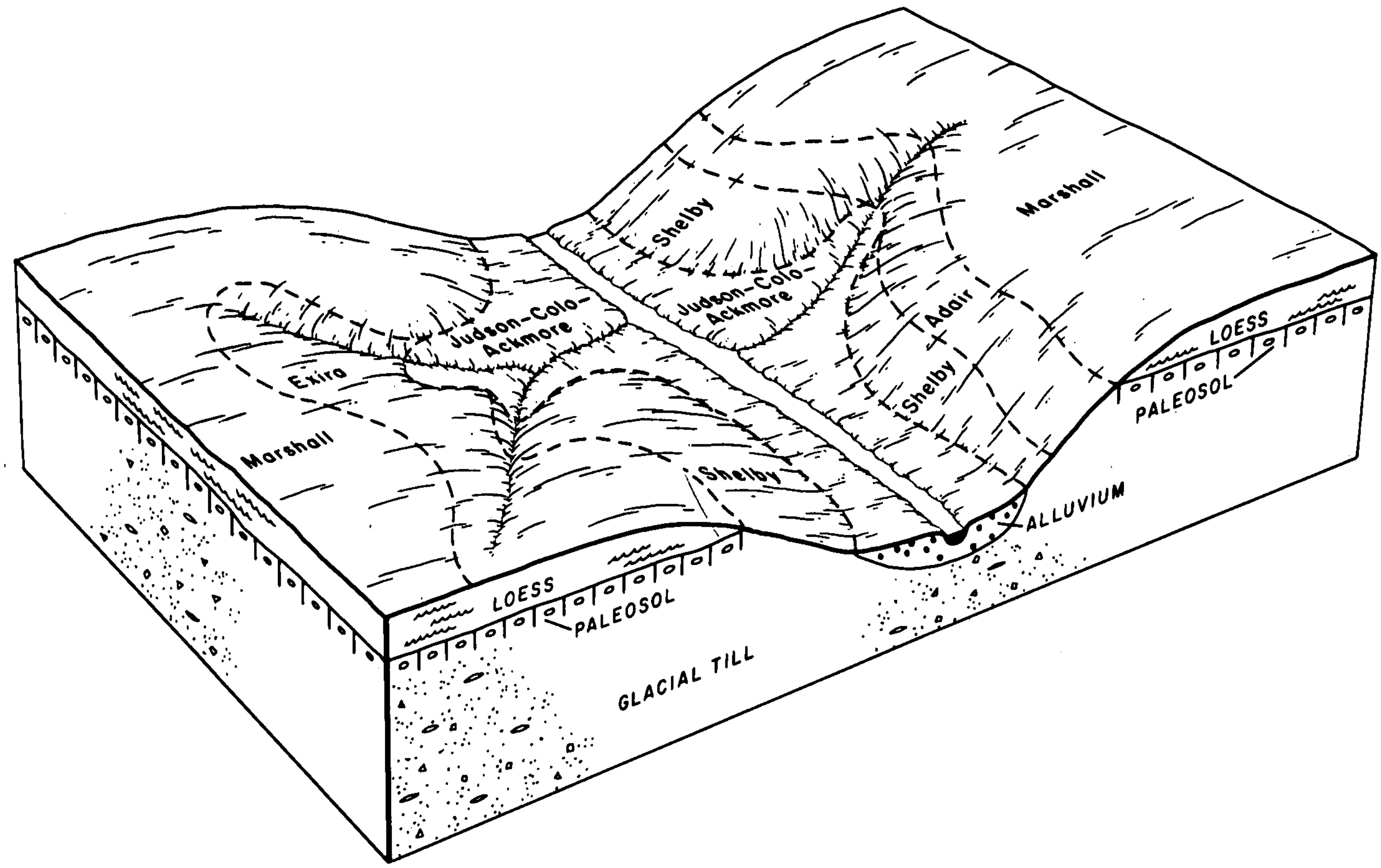

Figure 4.—Pattern of soils and parent material in the Marshall-Shelby-Adair association.

substratum to a depth of about 60 inches is grayish brown, mottled silt loam.

Typically, the surface layer of the Gara soils is very dark gray loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown and yellowish brown, firm, mottled clay loam. The substratum to a depth of about 60 inches is yellowish brown and gray, mottled clay loam.

Typically, the surface layer of the Shelby soils is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 38 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam.

Minor in this association are Adair, Knox, and Olmitz soils, the Judson-Colo-Ackmore complex, and the Gullied land-Judson complex. Adair soils are moderately sloping to moderately steep and are moderately well drained or somewhat poorly drained. They formed in a paleosol. Knox soils are well drained and are moderately sloping to steep. Their surface layer is silt loam. The moderately sloping Olmitz soils are on foot slopes below the Gara and Shelby soils. The gently sloping soils in the Judson-Colo-Ackmore complex are in upland drainageways. The gently sloping to very steep Gullied land-Judson complex is in upland drainageways.

The less sloping areas of the Marshall and Shelby soils in this association generally are used for row crops. The steeper areas of these soils are used mainly for hay and pasture. Gara soils generally support mixed hardwood timber and permanent pasture plants. The gently sloping to strongly sloping soils generally are moderately well suited to row crops. The main concerns of management are controlling water erosion and maintaining or improving tilth and fertility.

4. Sharpsburg-Shelby-Marshall association

Gently sloping to steep, well drained and moderately well drained, silty and loamy soils formed in loess and glacial till; on uplands

This association is in a small area that extends from the east-central part of the county to the southeast corner. Slopes range from 2 to 25 percent.

This association makes up about 1 percent of the county. It is about 40 percent Sharpsburg soils, 25 percent Shelby soils, 12 percent Marshall soils, and 23 percent soils of minor extent (fig. 6).

Sharpsburg soils are moderately well drained and are gently sloping to strongly sloping. They formed in loess. Shelby soils are moderately well drained and are moderately sloping to steep. They formed in glacial till. Marshall soils are well drained and are moderately sloping to moderately steep. They formed in loess. They are mainly in the northern part of the association.

Typically, the surface layer of the Sharpsburg soils is very dark brown silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 34 inches thick. The upper part is dark brown, the next part is brown, and the lower part is mottled grayish brown, brown, and yellowish brown. The substratum to a depth of about 60 inches is mottled light brownish gray, brown, and yellowish brown silty clay loam.

Typically, the surface layer of the Shelby soils is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 38 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown

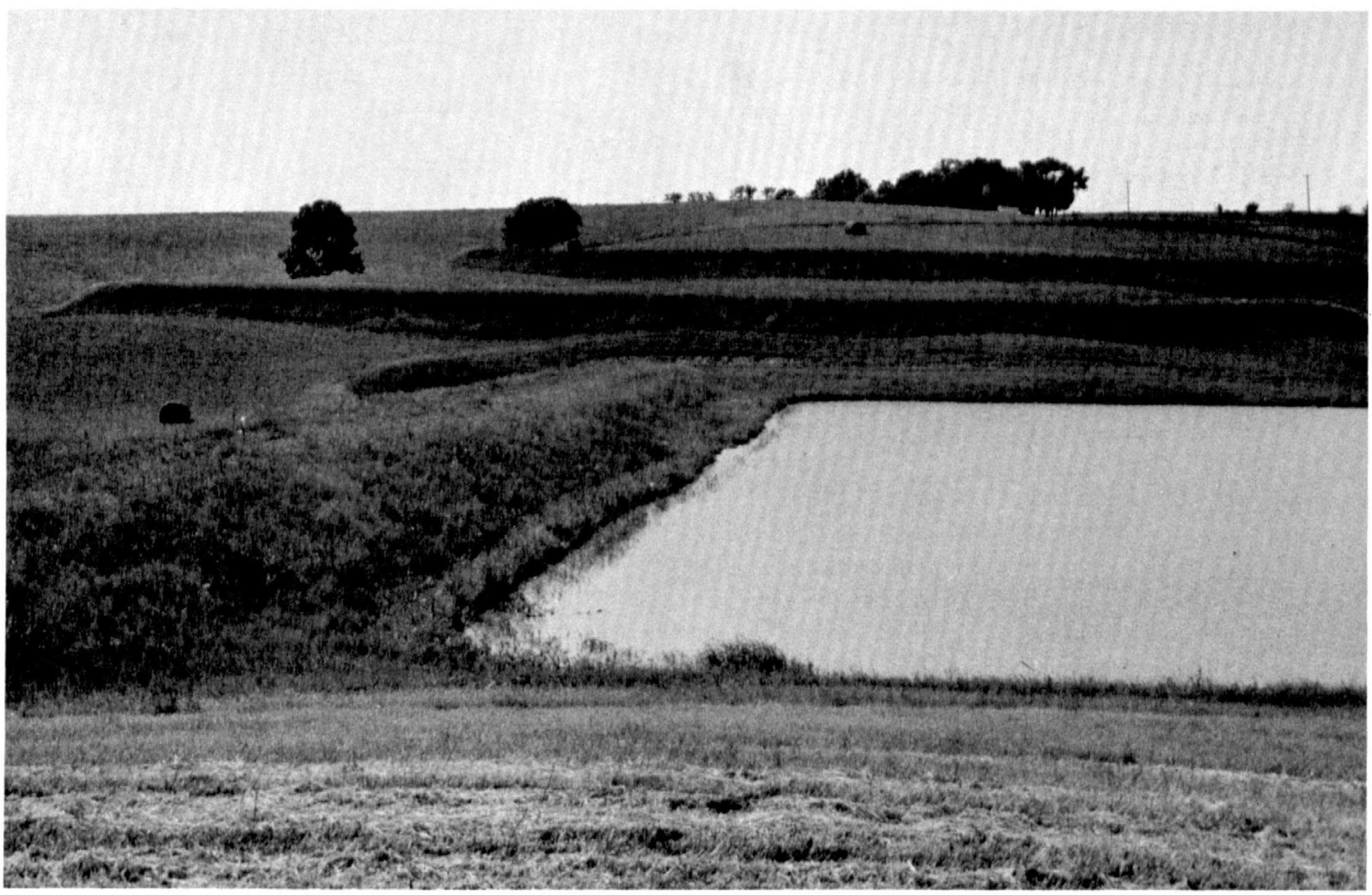

Figure 5.—An area of the Marshall-Shelby-Adair association used for alfalfa hay. The alfalfa, the terraces, and the farm pond help to control erosion in the strongly sloping areas.

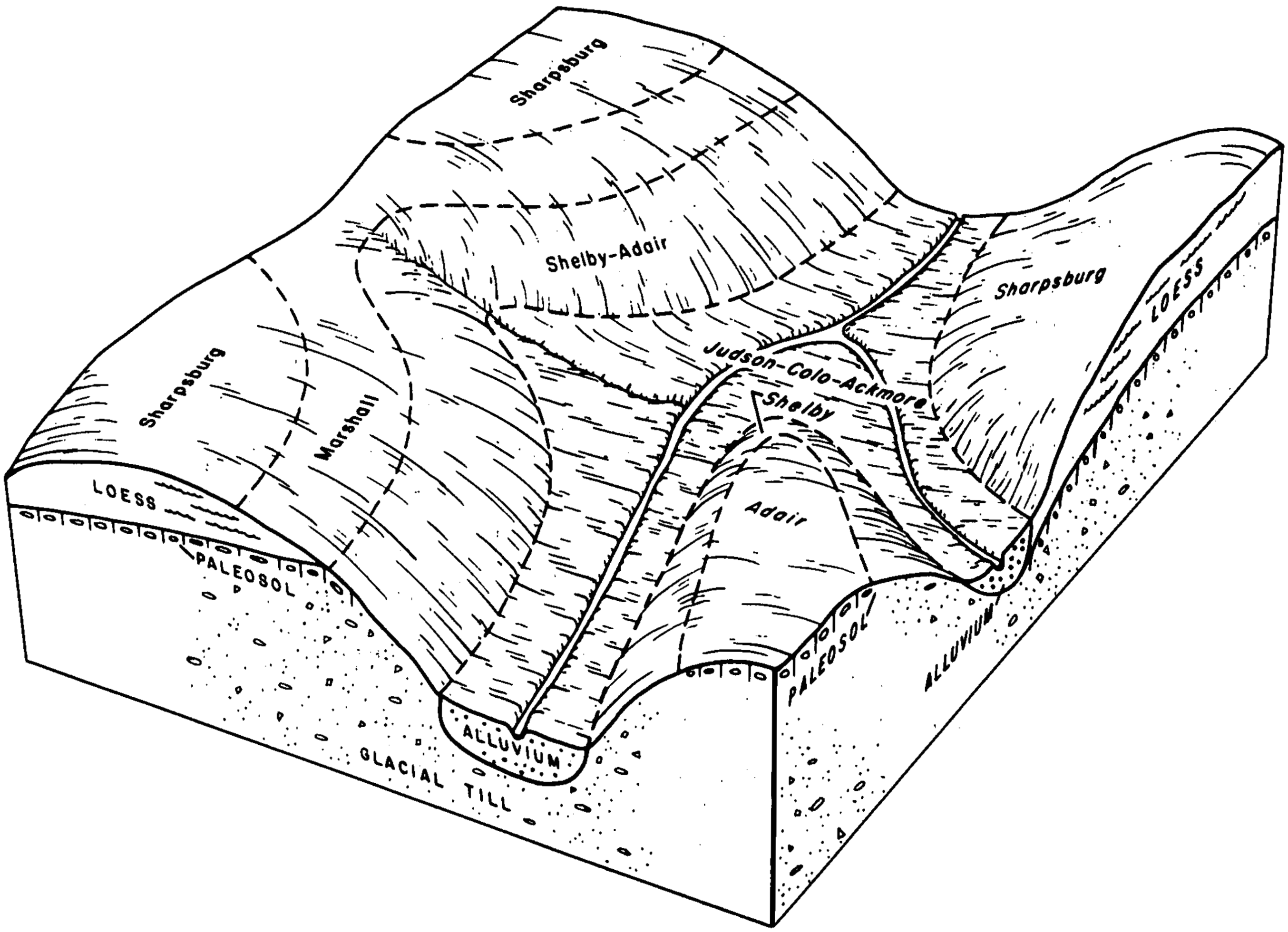

Figure 6.—Pattern of soils and parent material in the Sharpsburg-Shelby-Marshall association.

streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam.

Typically, the surface layer of the Marshall soils is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 40 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam.

Minor in this association are Adair and Exira soils and the soils in the Judson-Colo-Ackmore complex. Adair soils are moderately sloping to moderately steep, moderately well drained or somewhat poorly drained, and slowly permeable. Exira soils are moderately sloping to moderately steep. Their subsoil and substratum are dominantly mottled silt loam. The gently sloping soils in the Judson-Colo-Ackmore complex are in upland drainageways.

Most areas in this association are used for row crops. Some of the steeper areas are used for hay and pasture. The gently sloping to strongly sloping soils are well suited or moderately well suited to row crops. The moderately steep and steep soils are best suited to hay or permanent pasture. The main concerns of management are controlling water erosion, maintaining or improving tilth and fertility, and draining seepy areas. Because the Adair soils are slowly permeable, some areas of the surrounding loess soils may be seepy.

Figure 7.—Nearly level Colo and Zook soils on bottom land in the Davids Creek watershed in an area of the Colo-Ackmore-Zook association.

5. Colo-Ackmore-Zook association

Nearly level, poorly drained, silty soils formed in alluvium; on bottom land

This association is on bottom land along the major and minor streams in the county (fig. 7). It is subject to flooding. Slopes generally range from 0 to 2 percent.

This association makes up about 1 percent of the county. It is about 32 percent Colo soils, 24 percent Ackmore soils, 20 percent Zook soils, and 24 percent soils of minor extent (fig. 8).

Colo soils are on the bottom land that commonly is near the mouth of upland drainageways and minor streams. Ackmore soils are in scattered areas on bottom land and to some extent on alluvial fans near the mouth of upland drainageways and minor streams. They formed in stratified, silty recent alluvium overlying a buried silty soil that formed in alluvium. Zook soils are in irregularly shaped areas on the bottom land that commonly is nearer to the base of uplands than to the main stream channel.

Typically, the surface layer of the Colo soils is black silty clay loam about 11 inches thick. The subsurface layer is silty clay loam about 24 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The next 14 inches is very dark gray, mottled silty clay loam. The substratum to a depth of about 60 inches is silty clay loam. It is very dark gray in the upper part and dark gray in the lower part.

Typically, the surface layer of the Ackmore soils is very dark gray silt loam about 9 inches thick. The substratum is stratified very dark gray, dark gray, gray, and grayish brown silt loam about 16 inches thick. The next layer to a depth of about 60 inches is black silty clay loam. It is a buried soil.

Typically, the surface layer of the Zook soils is black silty clay loam about 8 inches thick. The subsurface layer is about 25 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, firm silty clay about 13 inches thick. The substratum to a depth of about 60 inches is dark gray silty clay loam.

Minor in this association are Judson, Kennebec, Marshall, Nodaway, Wabash, and Wiota soils. Judson and Marshall soils are well drained, are gently sloping and moderately sloping, and are adjacent to uplands.

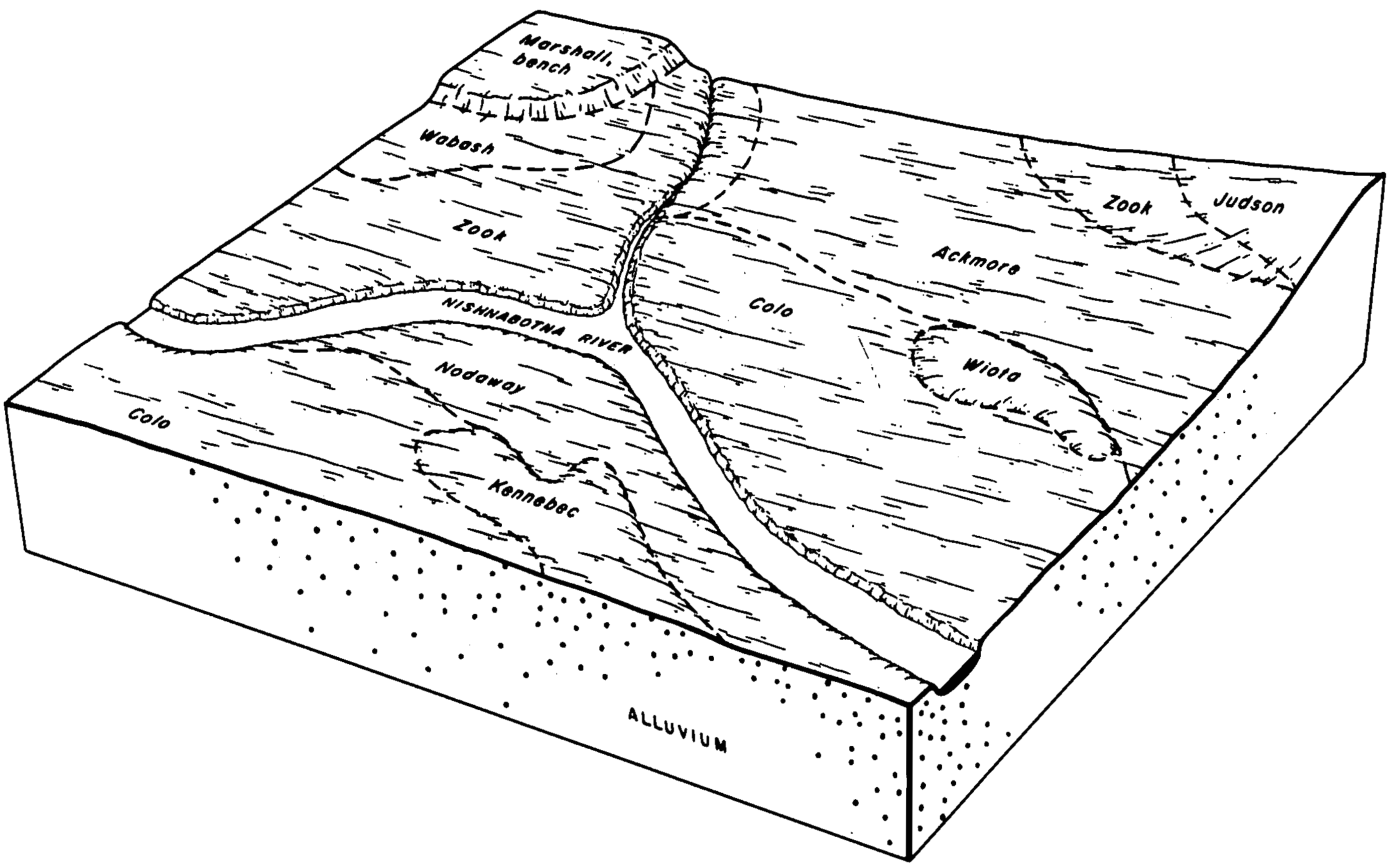

Figure 8.—Pattern of soils and parent material in the Colo-Ackmore-Zook association.

Kennebec and Nodaway soils are moderately well drained and commonly are adjacent to or near the main stream channel. Wabash soils are very poorly drained, are slightly depressional or level, and are very slowly permeable. Wiota soils are well drained, are very gently sloping, and are on low stream terraces.

Nearly all the areas in this association are used for row crops. Only small areas in old meandering stream channels remain in permanent pasture or woodland. The main concerns of management are soil drainage and flooding. Because the rivers and streams in the county are so deeply entrenched, however, flooding is not a serious hazard, except when precipitation is heavy or runoff from adjacent upland side slopes is excessive. Streambank erosion is common.

Detailed Soil Map Units

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

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

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

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

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, 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, Marshall silty clay loam, 5 to 9 percent slopes, moderately eroded, is one of several phases in the Marshall 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 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. Judson-Colo-Ackmore complex, 2 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.

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

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

1C3—Ida silt loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, well drained soil is on low, narrow interfluves and convex side slopes in the uplands. Areas are long and narrow or round and range from 2 to 10 acres in size.

Typically, the surface layer is brown silt loam about 7 inches thick. The substratum to a depth of about 60 inches is yellowish brown silt loam. It has light brownish gray and yellowish brown mottles. Calcium carbonate nodules generally are throughout the profile. In most areas they are on the surface.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair soils and the poorly drained Clarinda soils. These soils make up about 6 percent of the map unit.

Permeability is moderate in the Ida soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The soil typically is mildly alkaline throughout. The substratum generally has a very low supply of available phosphorus and potassium. Tilth generally is fair in the surface layer.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss and conserve moisture. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The high content of calcium carbonate restricts the availability of phosphorus and potassium to plants. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay generally is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

7B—Wiota silty clay loam, 1 to 4 percent slopes. This very gently sloping, well drained soil is on slightly convex, low stream terraces, commonly only a few feet above the flood plain. It is subject to rare flooding. Areas typically are elliptical and range from 2 to 10 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. The subsurface layer is silty clay loam about 11 inches thick. It is very dark grayish brown in the upper part and very dark grayish brown and brown in the lower part. The subsoil is brown, friable silty clay loam about 27 inches thick. It is mottled in the lower part. The substratum to a depth of about 60 inches is brown, mottled silty clay loam.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer typically is slightly acid, and the subsurface layer and the upper part of the subsoil are slightly acid or medium acid. The subsoil generally has a very low supply of available phosphorus and a low supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss and conserve moisture. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. Because it occurs as small areas, the soil is commonly managed along with the surrounding soils on bottom land. Flood-protection measures may be beneficial in some areas.

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

The capability subclass is IIe.

8B—Judson silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on slightly concave or plane foot slopes in the uplands, on alluvial fans, and in upland drainageways. Areas are irregular in shape and range from 2 to more than 50 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 20 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil to a depth of about 60 inches is dark brown and brown, friable silty clay loam.

Included with this soil in mapping are small areas where slopes are short and are more than 5 percent, small areas of the poorly drained Colo soils, and small areas of springs. These areas are scattered throughout the foot slopes. Also included are areas of soils having a sandy surface layer that typically is low in content of organic matter. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Judson soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. This layer typically is neutral, and the subsurface layer and the upper part of the subsoil are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. The soil is subject to siltation during periods when it receives runoff from the soils upslope. In areas where the water concentrates, the runoff may cause gullying. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. Grassed waterways help to prevent gully erosion. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

8C—Judson silty clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on slightly concave or plane foot slopes, below the more strongly sloping uplands. Slopes typically are short. Areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 20 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil to a depth of about 60 inches is dark brown and brown, friable silty clay loam.

Included with this soil in mapping are small areas where slopes are short and are more than 9 percent and small areas of springs that are seasonally wet. These areas generally are scattered throughout the foot slopes. Also included are areas of soils having a sandy surface layer that is low in content of organic matter. Included areas make up about 6 percent of the map unit.

Permeability is moderate in the Judson soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer typically is neutral, and the subsurface layer and the upper part of the subsoil are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. The soil is subject to siltation during periods when it receives runoff from the soils upslope. In areas where the water concentrates, the runoff may cause gullying. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. Grassed waterways help to prevent gully erosion. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

9—Marshall silty clay loam, 0 to 2 percent slopes. This nearly level, well drained soil is on broad upland divides. Areas are irregular in shape and range from 2 to 50 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 11 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In places the depth to mottles is less than 30 inches.

Included with this soil in mapping are slightly depressional areas that remain wet for short periods after rainfall and impound water during periods of heavy rainfall. These areas generally are on the most stable parts of the landscape. They make up less than 5 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The surface layer and the upper part of the subsoil generally are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, wind erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface and by winter cover crops. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration, particularly in the slightly depressional areas.

A cover of pasture plants or hay is effective in controlling wind erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth and reduces the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability class is I.

9B—Marshall silty clay loam, 2 to 5 percent slopes. This gently sloping, well drained soil is on ridges in the uplands. Slopes generally are long. Areas are irregular in shape and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick (fig. 9). The subsurface layer is silty clay loam about 11 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In some places the surface layer is thinner and lighter colored. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small scattered areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, and somewhat poorly drained Lamoni soils. Also included are scattered areas of wind-deposited sand that typically have a low content of organic matter and scattered areas where slopes are short and are more than 5 percent. Included areas make up about 10 percent of the map unit.

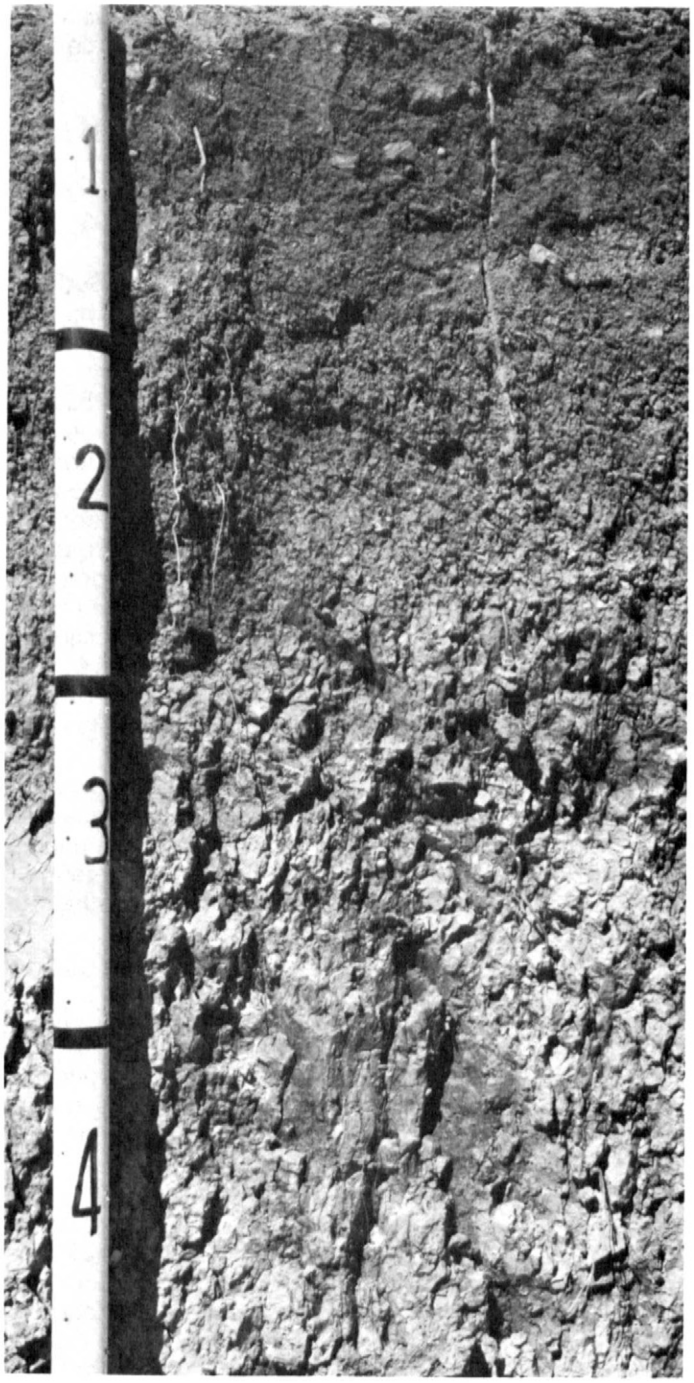

Figure 9.—Profile of Marshall silty clay loam, 2 to 5 percent slopes. This soil has a dark surface layer. Depth is marked in feet.

Permeability is moderate in the Marshall soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 or 4 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

9B2—Marshall silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, well drained soil is on ridges and side slopes in the uplands. Slopes generally are long or grade into long adjacent slopes. Areas are irregular in shape and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 46 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In some places the surface layer is thinner. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, somewhat poorly drained Lamoni, and moderately well drained Shelby soils. Also included are scattered areas of wind-deposited sand that typically have a low content of organic matter and small scattered areas of the calcareous Ida soils. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

9C—Marshall silty clay loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on convex side slopes and in slightly concave and plane coves in upland drainageways. Areas are irregular in shape and range from 2 to 50 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 5 inches thick. It is very dark grayish brown in the upper part and dark brown in the lower part. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In some places the surface layer is thinner. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, somewhat poorly drained Lamoni, and moderately well drained Shelby soils. Also included are small scattered areas of wind-deposited sand that typically have a low content of organic matter and scattered areas where slopes are short and are more than 9 percent. Included areas make up about 8 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

9C2—Marshall silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex ridges and side slopes in the uplands. Slopes generally are long. Areas are irregular in shape and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 40 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In some places the surface layer is thinner. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, somewhat poorly drained Lamoni, and moderately well drained Shelby soils. Also included are small scattered areas of the calcareous Ida soils and scattered areas where slopes are short and are more than 9 percent. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces.

Less water infiltrates this soil than the uneroded Marshall soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

9D2—Marshall silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex side slopes that border upland drainageways and to some extent on narrow ridges downslope from the less sloping Marshall soils. Areas are irregular in shape and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In some places the surface layer is thinner. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small areas of wind-deposited sand that typically have a low content of organic matter, small areas of the calcareous Ida soils, and small areas where slopes are short and are more than 14 percent. Also included are scattered areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, somewhat poorly drained Lamoni, and moderately well drained Shelby soils. Included areas make up about 10 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the uneroded Marshall soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

9E2—Marshall silty clay loam, 14 to 20 percent slopes, moderately eroded. This moderately steep, well drained soil is on convex or plane upland side slopes. Many areas are narrow and occupy the entire side of a slope. Others are at the slightly concave or smooth head of upland drainageways. Areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 35 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In some places the surface layer is thinner. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small areas of the calcareous Ida soils, small areas of wind-deposited sand that typically have a low content of organic matter, and small areas where slopes are short and are more than 20 percent. Also included are small scattered areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, somewhat poorly drained Lamoni, and moderately well drained Shelby soils. Included areas make up about 8 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Less water infiltrates this soil than the less sloping, uneroded Marshall soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

This soil is best suited to pasture or hay. A cover of pasture plants or hay generally is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

9E3—Marshall silty clay loam, 14 to 20 percent slopes, severely eroded. This moderately steep, well drained soil is on convex or plane upland side slopes. Many areas are narrow and occupy the entire side of a slope. Others are at the slightly concave or smooth head of upland drainageways. Areas are irregular in shape and range from 2 to 15 acres in size.

Typically, the surface layer is mixed dark brown and brown silty clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 35 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silt loam. In places the depth to mottles is less than 30 inches.

Included with this soil in mapping are small areas of the calcareous Ida soils, small areas of wind-deposited sand that typically have a low content of organic matter, and small areas where slopes are short and are more than 20 percent. Also included are small scattered areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, somewhat poorly drained Lamoni, and moderately well drained Shelby soils. Included areas make up about 8 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is poor in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a very severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to control erosion, but crops that require tillage should be grown only to reestablish hay or pasture. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Less water infiltrates this soil than the less sloping, less eroded Marshall soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

This soil is best suited to pasture or hay. A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soil is too wet causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

11B—Judson-Colo-Ackmore complex, 2 to 5 percent slopes. These gently sloping soils are in upland drainageways, on the adjacent foot slopes, and to some extent on alluvial fans. The well drained Judson soil typically is on the slightly concave or plane foot slopes below the more strongly sloping upland soils and occurs as narrow bands on each side of the drainageways. The poorly drained Ackmore and Colo soils typically are in the center of the drainageways. They are occasionally flooded. Areas are irregular in shape and range from 5 to more than 100 acres in size. They are about 33 percent Judson soil, 30 percent Colo soil, and 25 percent Ackmore soil. The three soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the Judson soil has a surface layer of very dark brown silty clay loam about 9 inches thick. The subsurface layer is silty clay loam about 20 inches thick. The upper part is very dark brown, and the lower part is very dark grayish brown. The subsoil to a depth of about 60 inches is dark brown and brown, friable silty clay loam.

Typically, the Colo soil has a surface layer of black silty clay loam about 11 inches thick. The subsurface layer is silty clay loam about 24 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The next 14 inches is very dark gray, mottled silty clay loam. The substratum to a depth of about 60 inches is silty clay loam. The upper part is very dark gray, and the lower part is dark gray.

Typically, the Ackmore soil has a surface layer of very dark gray silt loam about 9 inches thick. The substratum is stratified very dark gray, dark gray, gray, and grayish brown silt loam about 16 inches thick. It has some thin strata of silty clay loam throughout. The next layer to a depth of about 60 inches is black silty clay loam. It is friable in the upper part and firm in the lower part. It is a buried soil. In some areas the depth to the buried soil is less than 20 inches but generally is not less than 18 inches. In other areas the surface layer is silty clay loam. In places the buried soil has a higher content of clay and is more slowly permeable.

Included with these soils in mapping are small areas where slopes are short and are more than 5 percent. These slopes generally are in areas of the Judson soil. Also included are areas of the moderately well drained Olmitz and poorly drained Zook soils and small areas of springs. The nearly level Zook soils generally are on the lower parts of upland drainageways, and Olmitz soils are on alluvial fans. Included areas make up about 12 percent of the map unit.

The Judson soil is moderately permeable. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. This layer typically is neutral, and the subsurface layer and the upper part of the subsoil are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

The Colo soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The organic matter content is about 5 to 7 percent in the surface layer. This layer typically is medium acid, and the subsurface layer is slightly acid. The lower part of the subsurface layer and the transitional layer generally have a medium supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains.

The Ackmore soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 2 to 4 percent in the surface layer. This layer typically is medium acid, and the substratum is slightly acid. The substratum and the buried soil generally have a low supply of available phosphorus and a very low supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. These soils are well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. They receive runoff from the soils upslope. As a result, they are subject to gully erosion in areas where water concentrates and to siltation in areas where eroded soil accumulates. Also, the wetness caused by seepage is a limitation. The Colo and Ackmore soils may be wet because of the flooding, particularly in areas on the lower parts of upland drainageways and on alluvial fans and foot slopes. A drainage system is needed to reduce the wetness and provide proper aeration to the plant root system. A tile drainage system generally functions well if the tile is suitably spaced and adequate outlets are available. The tile drains should be those that are designed to intercept the laterally moving water from the adjacent upland side slopes. Terracing the adjacent upland side slopes and farming them on the contour help to control the runoff on these soils. Returning crop residue to the soils, regularly adding other organic material, or establishing a suitable cover of grasses helps to control erosion and siltation and increases the rate of water infiltration. Grassed waterways help to prevent gully erosion. Also, they help to prevent crop damage by controlling siltation.

A cover of pasture plants or hay is effective in controlling the runoff from the adjacent upland side slopes. Overgrazing or grazing when the soils are too wet, however, causes surface compaction, excessive runoff, and the formation of gullies. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soils in good condition.

The capability subclass is IIw.

24C3—Shelby clay loam, 5 to 9 percent slopes, severely eroded. This moderately sloping, moderately well drained soil is on toe slopes and narrow ridges in the uplands. Slopes typically are short. Areas are round or oblong and range from 2 to 10 acres in size.

Typically, the surface layer is dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 35 inches thick. The upper part is yellowish brown, friable clay loam mixed with dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places the surface layer is loam or silty clay loam. In some areas carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface. In places the surface layer is less eroded.

Included with this soil in mapping are areas of the moderately well drained or somewhat poorly drained, slowly permeable Adair soils and the poorly drained, very slowly permeable Clarinda soils. Also included are scattered areas of sand that are droughty and have a low content of organic matter. Included areas make up about 5 percent of the map unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 1 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a very severe hazard. Row crops can be grown in some years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the less eroded Shelby soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay generally is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

24D2—Shelby clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on convex, uneven side slopes and toe slopes in the uplands. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 25 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown subsoil material. The subsoil is about 42 inches thick. The upper part is yellowish brown, friable clay loam mixed with some very dark grayish brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, firm clay loam. In some places the surface layer is thinner. In other places it is loam or silty clay loam. In some areas carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface.

Included with this soil in mapping are some small areas of the moderately well drained or somewhat poorly drained, slowly permeable Adair soils and the poorly drained, very slowly permeable Clarinda soils. These soils generally are on the upper part of the slopes. Also included are scattered areas of sand that are droughty and have a low content of organic matter and scattered areas where slopes are short and are more than 14 percent. Included areas make up about 10 percent of the map unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be topsoiled and revegetated as soon as possible. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

24D3—Shelby clay loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, moderately well drained soil is on convex, uneven side slopes and toe slopes in the uplands. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 15 acres in size.

Typically, the surface layer is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 40 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, firm clay loam. It is mottled with strong brown and light brownish gray below a depth of 20 inches. The substratum to a depth of about 60 inches is yellowish brown, mottled, firm clay loam. In places carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface. In some areas the surface layer is silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained, slowly permeable Adair soils and the poorly drained, very slowly permeable Clarinda soils. These soils generally are on the upper part of the slopes. Also included are scattered areas of sand that are droughty and have a low content of organic matter and scattered areas where slopes are short and are more than 14 percent. Included areas make up about 10 percent of the map unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. It is better suited to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a very severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be topsoiled and revegetated as soon as possible. Less water infiltrates this soil than the less eroded Shelby soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

24E3—Shelby clay loam, 14 to 18 percent slopes, severely eroded. This moderately steep, moderately well drained soil is on narrow, convex side slopes and in plane or slightly concave coves of upland drainageways. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 20 acres in size.

Typically, the surface layer is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 38 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In some areas the surface layer is less eroded. In other areas carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface. In places the surface layer is silty clay loam.

Included with this soil in mapping are some small areas of the moderately well drained or somewhat poorly drained, slowly permeable Adair soils and the poorly drained, very slowly permeable Clarinda soils. These soils generally are on the upper part of the slopes. Also included are small areas where slopes are short and are more than 18 percent. These areas generally are in the coves of upland drainageways on the strongly dissected parts of the landscape. Included areas make up about 5 percent of the map unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is poor in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. This soil generally is not suited to corn, soybeans, and small grain because further erosion is a very severe hazard. Crops that require tillage should be grown only to reestablish hay or pasture. Most areas are not suited to contour farming and terraces because slopes are moderately steep and irregular. Because of the severe erosion, the clayey texture, and the slope, revegetation of exposed or excavated areas is very difficult. Less water infiltrates this soil than the less eroded Shelby soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

This soil is best suited to pasture or hay. A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soil is too wet causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition. If grasses or legumes are grown for hay, a good plant cover can be maintained by timely cutting, periodic overseeding of areas where the plant cover is thin, and restricted use of harvesting equipment.

The capability subclass is VIe.

24F3—Shelby clay loam, 18 to 25 percent slopes, severely eroded. This steep, moderately well drained soil is on slightly convex or plane side slopes in the uplands. Slopes typically are short. Areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is mixed dark brown, brown, and yellowish brown clay loam about 5 inches thick. It is mostly subsoil material. The subsoil is about 36 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In some areas carbonates are within a depth of 40 inches, and in the highly eroded, strongly dissected areas, they are on the surface. In places the surface layer is thinner and lighter colored.

Included with this soil in mapping are some small areas of the poorly drained, very slowly permeable Clarinda soils. These soils generally are on the upper part of the slopes. They make up less than 5 percent of the map unit.

Permeability is moderately slow in the Shelby soil. Surface runoff is very rapid. Available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is poor in the surface layer.

Most areas are pastured. A few support hardwoods. This soil generally is not suited to corn, soybeans, or small grain and is poorly suited to grasses or legumes for hay because of the slope and erosion. If cultivated crops are grown, further erosion is a very severe hazard and tilling and harvesting can be difficult. In most areas the soil generally is not suited to contour farming and terraces because slopes are steep and irregular. Because of the clayey texture and the steep slopes, revegetation of exposed or excavated areas is very difficult. If grasses or legumes are grown for hay, a good plant cover can be maintained by timely cutting, periodic overseeding of areas where the plant cover is thin, and restricted use of harvesting equipment. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

This soil is best suited to pasture, which may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soil is too wet causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is VIe.

54—Zook silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains and to a lesser extent on the lower part of upland drainageways. It is occasionally flooded. Areas are irregular in shape, are somewhat parallel to the stream channel, and range from 2 to more than 100 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is about 25 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, firm silty clay about 13 inches thick. The substratum to a depth of about 60 inches is dark gray silty clay loam. In places the soil is stratified to a depth of 24 inches.

Included with this soil in mapping are small areas of the very poorly drained Wabash soils. These soils are in level or slightly depressional areas. They make up about 10 percent of the map unit.

The Zook soil is slowly permeable. It has a seasonal high water table. Surface runoff is slow or very slow. Available water capacity is high. The content of organic matter is about 5 to 7 percent in the surface layer. The surface soil and subsoil typically are medium acid throughout. The lower part of the subsurface layer and the subsoil generally have a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The wetness caused by flooding and the seasonal high water table is the main limitation. It can delay cultivating and harvesting. A drainage system is needed to reduce the wetness, to provide proper aeration to the plant root system, and to maintain good tilth. A tile drainage system generally functions well if the tile is suitably spaced and adequate outlets are available. Surface drains help to remove surface water. Flood-protection measures are beneficial in most areas. Returning crop residue to the soil or regularly adding other organic material and delaying tillage when the soil is too wet increase the rate of water infiltration, help to prevent surface crusting, and maintain good tilth.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability subclass is IIw.

71D—Dickman-Marshall complex, 9 to 14 percent slopes. These strongly sloping, well drained soils are on convex side slopes in the uplands. Areas are irregular in shape and range from 2 to 15 acres in size. They are about 58 percent Dickman soil and 38 percent Marshall soil. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Dickman soil is very dark brown sandy loam about 6 inches thick. The subsurface layer is very dark brown and very dark grayish brown sandy loam about 10 inches thick. The subsoil is loamy sand about 32 inches thick. The upper part is brown and very friable, and the lower part is dark yellowish brown and loose. The substratum to a depth of about 60 inches is yellowish brown fine sand. In places the surface layer is loamy fine sand.

Typically, the surface layer of the Marshall soil is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 37 inches thick. It is brown and friable. The upper part is silty clay loam, and the lower part is mottled silty clay loam and silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled silty clay loam. In some places the lower part of the subsoil is silt loam. In other places the surface layer is thinner. In some areas the depth to mottles is less than 30 inches.

Included with these soils in mapping are small scattered areas of the moderately well drained or somewhat poorly drained, slowly permeable Adair soils, the poorly drained, very slowly permeable Clarinda soils, and the moderately well drained, moderately slowly permeable Shelby soils. These soils make up about 4 percent of the map unit.

Permeability is moderately rapid in the upper part of the Dickman soil and rapid in the lower part. Surface runoff is medium. Available water capacity is low, and the soil is droughty during periods of below normal rainfall. The content of organic matter is 2 to 3 percent in the surface layer. This layer typically is strongly acid, and the upper part of the subsoil is medium acid. The subsoil generally has a low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is good in the surface layer.

Permeability is moderate in the Marshall soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. These soils are poorly suited to corn, soybeans, and small grain and to grasses and legumes for hay because of a severe hazard of erosion and droughtiness. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. A cover of crop residue conserves moisture by reducing evaporation. Most areas are not well suited to terraces because of the sandy subsoil and substratum in the Dickman soil. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion and a sandy loam texture is a concern if fertilizers and herbicides are applied.

These soils are best suited to pasture, which generally is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. If pastured areas of the Dickman soil are overgrazed or grazed when too dry, the plant cover may be thin, yields and regrowth of grasses or legumes may be poor, the susceptibility to erosion is increased, and tilth is poor. Overgrazing or grazing when the Marshall soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soils in good condition.

The capability subclass is IVe.

93D2—Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded. These strongly sloping soils are on upland side slopes. The moderately well drained Shelby soil is on the convex or plane, mid and lower side slopes. The moderately well drained or somewhat poorly drained Adair soil is on the narrow, convex, upper side slopes. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 30 acres in size. They are about 55 percent Shelby soil and 40 percent Adair soil. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Shelby soil is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown subsoil material. The subsoil is about 42 inches thick. The upper part is yellowish brown, friable clay loam mixed with some very dark grayish brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface.

Typically, the surface layer of the Adair soil is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown and brown subsoil material. The upper part of the subsoil is dark yellowish brown and brown, friable clay loam. The lower part to a depth of about 60 inches is brown, reddish brown, and strong brown, mottled, very firm clay loam. In places the surface layer is thinner.

Included with these soils in mapping are small areas of the poorly drained Clarinda and somewhat poorly drained Lamoni soils on the upper part of the slopes and areas where slopes are short and are more than 14 percent, generally in the coves of upland drainageways. Also included are scattered areas of sand that are droughty and have a low content of organic matter. Included areas make up about 5 percent of the map unit.

The Shelby soil is moderately slowly permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. This layer typically is slightly acid, and the upper part of the subsoil is medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated along with areas of the more productive adjacent soils. The Shelby and Adair soils are poorly suited to corn, soybeans, and small grain. They are best suited to grasses and legumes for hay or pasture. Row crops can be grown in some years if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. Although these soils are not well suited to level terraces, graded terraces that have properly designed tile outlets can help to control erosion. If terraces are constructed, an adequate plant cover should be maintained following construction. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. Because the Adair soil is slowly permeable, some areas may be seepy. Installing an interceptor tile drainage system, however, helps to eliminate the seepy areas. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soils are too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

93D3—Shelby-Adair complex, 9 to 14 percent slopes, severely eroded. These strongly sloping soils are on upland side slopes. The moderately well drained Shelby soil is on the convex or plane, mid and lower side slopes. The moderately well drained or somewhat poorly drained Adair soil is on the narrow, convex, upper side slopes. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 25 acres in size. They are about 55 percent Shelby soil and 40 percent Adair soil. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Shelby soil is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 40 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface.

Typically, the surface layer of the Adair soil is mixed very dark brown, brown, and dark yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The upper part of the subsoil is dark yellowish brown and brown, friable clay loam. The lower part to a depth of about 60 inches is brown, reddish brown, and strong brown, very firm, mottled clay loam.

Included with these soils in mapping are small areas of the poorly drained Clarinda and somewhat poorly drained Lamoni soils on the upper part of the slopes and areas where slopes are short and are more than 14 percent, generally in the coves of upland drainageways. Also included are small scattered areas of sand that are droughty and have a low content of organic matter. Included areas make up about 5 percent of the map unit.

The Shelby soil is moderately slowly permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 percent of the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. This layer typically is slightly acid, and the upper part of the subsoil is medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is poor in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. These soils generally are not suited to corn, soybeans, or small grain. If cultivated crops are grown, further erosion is a very severe hazard. Although these soils are not well suited to level terraces, graded terraces that have properly installed tile outlets can help to control erosion. If terraces are constructed, an adequate plant cover should be maintained following construction. Less water infiltrates these soils than the less eroded Shelby and Adair soils. Regularly adding organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. Because the Adair soil is slowly permeable, some areas may be seepy. Installing an interceptor tile drainage system, however, helps to eliminate the seepy areas. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

These soils are best suited to pasture or hay. A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soils are too wet causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soils in good condition.

The capability subclass is VIe.

93E2—Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded. These moderately steep soils are on upland side slopes. The moderately well drained Shelby soil is on the convex or plane, mid and lower side slopes. The moderately well drained or somewhat poorly drained Adair soil is on the narrow, convex or plane, upper side slopes. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 25 acres in size. They are about 60 percent Shelby soil and 35 percent Adair soil. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Shelby soil is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of yellowish brown subsoil material. The subsoil is about 39 inches thick. The upper part is yellowish brown, friable clay loam mixed with some very dark grayish brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. It has concretions throughout. In some places the surface layer is thinner. In other places carbonates are within a depth of 40 inches, and on the highly eroded, strongly dissected parts of the landscape, they are on the surface.

Typically, the surface layer of the Adair soil is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown and brown subsoil material. The subsoil is about 47 inches thick. It is dark yellowish brown and brown, friable clay loam in the upper part and brown, reddish brown, and strong brown, very firm, mottled clay loam in the lower part. The substratum to a depth of about 60 inches is strong brown, very firm, mottled clay loam. In places the surface layer is thinner.

Included with these soils in mapping are some small areas of the poorly drained, very slowly permeable Clarinda soils on the upper part of the slopes and areas where slopes are short and are more than 18 percent, generally in the coves of upland drainageways. Included areas make up about 5 percent of the map unit.

The Shelby soil is moderately slowly permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. This layer typically is slightly acid, and the upper part of the subsoil is medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. These soils generally are not suited to corn, soybeans, or small grain because of a severe hazard of further erosion and the slope. Crops that require tillage should be grown only to reestablish hay or pasture. Because of the slope, the hazard of erosion, and the difficulty in establishing a plant cover, these soils generally are not suitable for terraces. Because the Adair soil is slowly permeable, some areas may be seepy. Installing an interceptor tile drainage system, however, helps to eliminate the seepy areas. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

These soils are best suited to pasture or hay. A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soils are too wet causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soils in good condition.

The capability subclass is VIe.

93E3—Shelby-Adair complex, 14 to 18 percent slopes, severely eroded. These moderately steep soils are on upland side slopes. The moderately well drained Shelby soil is on the convex or plane, mid and lower side slopes. The moderately well drained or somewhat poorly drained Adair soil is on the narrow, convex or plane, upper side slopes. Slopes typically are short. Areas are irregular in shape or long and narrow and range from 2 to 20 acres in size. They are about 60 percent Shelby soil and 35 percent Adair soil. The two soils occur as areas so intermingled or so small that mapping them separately is not practical.

Typically, the surface layer of the Shelby soil is mixed dark brown, brown, and yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 35 inches thick. The upper part is yellowish brown, friable clay loam mixed with some dark brown and brown streaks and pockets. The lower part is yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places the depth to carbonates is less than 40 inches.

Typically, the surface layer of the Adair soil is mixed very dark brown, brown, and dark yellowish brown clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 47 inches thick. The upper part is dark yellowish brown and brown, friable clay loam, and the lower part is brown, reddish brown, and strong brown, very firm, mottled clay loam. The substratum to a depth of about 60 inches is strong brown, very firm, mottled clay loam.

Included with these soils in mapping are some small areas of the poorly drained, very slowly permeable Clarinda soils on the upper part of the slopes and areas where slopes are short and are more than 18 percent, generally in the coves of upland drainageways. Also included are scattered areas of sand that tend to be droughty and typically have a low content of organic matter. Included areas make up about 5 percent of the map unit.

The Shelby soil is moderately slowly permeable. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid. The subsoil generally has a low supply of available phosphorus and a high supply of available potassium. Tilth generally is poor in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. This layer typically is slightly acid, and the upper part of the subsoil is medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is poor in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. These soils generally are not suited to corn, soybeans, or small grain or to grasses and legumes for hay because of a very severe hazard of further erosion and the slope. Crops that require tillage should be grown only to reestablish pasture. Because of the slope, the hazard of erosion, and the difficulty in establishing a plant cover, these soils generally are not suited to terraces. Because the Adair soil is slowly permeable, some areas may be seepy. Installing an interceptor tile drainage system, however, helps to eliminate the seepy areas. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

These soils are best suited to permanent pasture, which may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soils are too wet causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soils in good condition.

The capability subclass is VIIe.

99C2—Exira silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on slightly convex and plane side slopes in the uplands and to a lesser extent in slightly concave coves at the head of upland drainageways. Slopes generally are long. Areas are irregular in shape and range from 2 to 60 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 41 inches thick. The upper part is brown, friable silty clay loam; the next part is brown, variegated, friable silt loam; and the lower part is light brownish gray and yellowish brown, variegated, friable silt loam. The substratum to a depth of about 60 inches is light brownish gray and brown, variegated silt loam. In places the surface layer is thinner.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, and somewhat poorly drained Lamoni soils and the moderately slowly permeable Shelby soils. Also included are small scattered areas of wind-deposited sand that typically have a low content of organic matter and scattered areas of the calcareous Ida soils. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Exira soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

99D2—Exira silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, well drained soil is on convex and plane side slopes in the uplands and to a lesser extent in slightly concave coves at the head of upland drainageways. Areas are irregular in shape and range from 2 to 70 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 39 inches thick. The upper part is brown, friable silty clay loam; the next part is brown, variegated, friable silt loam; and the lower part is light brownish gray and yellowish brown, variegated, friable silt loam. The substratum to a depth of about 60 inches is light brownish gray and brown, variegated silt loam. In places the surface layer is thinner.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, and somewhat poorly drained Lamoni soils and the moderately slowly permeable Shelby soils. Also included are small scattered areas of wind-deposited sand that typically have a low content of organic matter, scattered areas of the calcareous Ida soils, and scattered areas where slopes are short and are more than 14 percent. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Exira soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

99D3—Exira silty clay loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, well drained soil is on convex and plane side slopes in the uplands and to a lesser extent in slightly concave coves at the head of upland drainageways. Areas are irregular in shape and range from 2 to 30 acres in size.

Typically, the surface layer is mixed dark brown and brown silty clay loam about 6 inches thick. It is mostly subsoil material. The subsoil is about 39 inches thick. The upper part is brown, friable silty clay loam; the next part is variegated light brownish gray and grayish brown, friable silt loam; and the lower part is light brownish gray and yellowish brown, variegated, friable silt loam. The substratum to a depth of about 60 inches is light brownish gray and brown, variegated silt loam. In places the depth to mottles is more than 30 inches.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, and somewhat poorly drained Lamoni soils and the moderately slowly permeable Shelby soils. Also included are small scattered areas of wind-deposited sand that typically have a low content of organic matter, scattered areas of the calcareous Ida soils, and scattered areas where slopes are short and are more than 14 percent. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Exira soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. It is best suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a very severe hazard. Row crops can be grown in some years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the less eroded Exira soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is generally effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

99E2—Exira silty clay loam, 14 to 18 percent slopes, moderately eroded. This moderately steep, well drained soil is on convex side slopes in the uplands and to a lesser extent in slightly concave coves at the head of upland drainageways. Areas are narrow and irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is about 34 inches thick. The upper part is brown, friable silty clay loam; the next part is light brownish gray and grayish brown, variegated, friable silt loam; and the lower part is light brownish gray and yellowish brown, variegated, friable silt loam. The substratum to a depth of about 60 inches is light brownish gray and brown, variegated silt loam. In places the surface layer is thinner.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair, poorly drained Clarinda, and somewhat poorly drained Lamoni soils and the moderately slowly permeable Shelby soils. Also included are small scattered areas where slopes are short and are more than 18 percent, generally in the coves of upland drainageways; scattered areas of wind-deposited sand that typically have a low content of organic matter; and scattered areas of the calcareous Ida soils. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Exira soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated along with the more productive adjacent soils. This soil is poorly suited to corn, soybeans, and small grain. It is best suited to grasses and legumes for hay and pasture. If cultivated crops are grown, further erosion is a severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the less sloping Exira soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

133—Colo silty clay loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains, alluvial fans, and the lower part of upland drainageways. It is occasionally flooded. Areas are irregular in shape, are somewhat parallel to the stream channel, and range from 2 to more than 100 acres in size.

Typically, the surface layer is black silty clay loam about 11 inches thick. The subsurface layer is silty clay loam about 24 inches thick. It is black in the upper part and very dark gray and mottled in the lower part. The next 14 inches is very dark gray, mottled, friable silty clay loam. The substratum to a depth of about 60 inches is silty clay loam. The upper part is very dark gray, and the lower part is dark gray. In some places the surface layer is stratified silt loam. In other places the soil contains more clay.

This soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 5 to 7 percent in the surface layer. This layer typically is medium acid, and the subsurface layer is slightly acid. The lower part of the subsurface layer and the transitional layer generally have a medium supply of available phosphorus and potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The wetness caused by the flooding and the seasonal high water table is the main management concern. A drainage system is needed to reduce the wetness and provide proper aeration to the plant root system. A tile drainage system generally functions well if the tile is suitably spaced and adequate outlets are available. Flood-protection measures are beneficial in most areas. Returning crop residue to the soil or regularly adding other organic material and delaying tillage when the soil is wet improve fertility, help to prevent surface crusting, and increase the rate of water infiltration.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability subclass is IIw.

179E—Gara loam, 14 to 18 percent slopes. This moderately steep, moderately well drained soil is on convex or plane side slopes in the uplands. Areas are irregular in shape or long and narrow and range from 2 to 20 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 3 inches thick. The subsoil is about 39 inches thick. The upper part is brown, friable loam, and the lower part is dark yellowish brown and yellowish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown and gray, mottled clay loam. In some places the surface layer is thinner. In other places the depth to calcium carbonates is less than 60 inches.

Included with this soil in mapping are some small areas of the moderately well drained or somewhat poorly drained Adair soils, generally on the upper part of the slopes. These soils contain more clay than the Gara soil. They make up about 4 percent of the map unit.

Permeability is moderately slow in the Gara soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface soil typically is slightly acid to very strongly acid, and the upper part of the subsoil is very strongly acid. The subsoil generally has a low or very low supply of available phosphorus and a very low supply of available potassium. Tilth generally is fair in the surface layer.

Some areas have been cleared and are cultivated. This soil generally is not suited to corn, soybeans, or small grain. If cultivated crops are grown, erosion is a severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is not suited to contour farming and terraces because slopes are moderately steep and irregular. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

Most areas support a mixture of pasture plants and hardwoods. A cover of pasture plants generally is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Because the soil erodes easily, adequate ground cover is needed to prevent excessive soil loss.

The capability subclass is VIe.

179F—Gara loam, 18 to 25 percent slopes. This steep, moderately well drained soil is on convex or plane side slopes in the uplands and in slightly concave or plane coves in upland drainageways. Areas are irregular in shape or long and narrow and range from 2 to 20 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 2 inches thick. The subsoil is about 35 inches thick. The upper part is brown, friable loam. The lower part is dark yellowish brown and yellowish brown, firm clay loam. It has grayish brown and strong brown mottles. The substratum to a depth of about 60 inches is yellowish brown and gray, mottled clay loam. In some places the surface layer is thinner. In other places the depth to calcium carbonates is less than 60 inches.

Included with this soil in mapping are small areas of the poorly drained Clarinda soils, generally on the upper part of the slopes. These soils contain more clay than the Gara soil. They make up about 4 percent of the map unit.

Permeability is moderately slow in the Gara soil. Surface runoff is very rapid. Available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The surface soil typically is slightly acid to very strongly acid, and the upper part of the subsoil is very strongly acid. The subsoil generally has a low or very low supply of available phosphorus and a very low supply of available potassium. Tilth generally is poor in the surface layer.

This soil generally is not suited to corn, soybeans, or small grain or to grasses and legumes for hay because the hazard of erosion is severe and because the slope restricts the use of farm machinery.

Most areas support a mixture of pasture plants and hardwoods. A cover of pasture plants generally is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Adequate ground cover is needed to prevent excessive soil loss. The slope restricts the use of equipment.

The capability subclass is VIe.

179G—Gara loam, 25 to 40 percent slopes. This very steep, moderately well drained soil is on slightly convex or plane side slopes in the uplands and in slightly concave or plane coves in upland drainageways. Slopes typically are short. Areas are irregular in shape and range from 2 to 16 acres in size.

Typically, the surface layer is very dark gray loam about 6 inches thick. The subsurface layer is dark grayish brown loam about 2 inches thick. The subsoil is about 32 inches thick. The upper part is brown, friable loam. The lower part is dark yellowish brown and yellowish brown, firm clay loam. It has grayish brown and strong brown mottles. The substratum to a depth of about 60 inches is yellowish brown and gray, mottled clay loam. In places the surface layer is thinner. In most areas the depth to calcium carbonates is less than 60 inches.

Included with this soil in mapping are small scattered areas where large stones that have eroded from glacial till are on the surface. Included areas make up about 4 percent of the map unit.

Permeability is moderately slow in the Gara soil. Surface runoff is very rapid. Available water capacity is high. The content of organic matter is less than 1 percent in the surface layer. The surface soil typically is slightly acid to very strongly acid, and the upper part of the subsoil is very strongly acid. The subsoil generally has a low or very low supply of available phosphorus and a very low supply of available potassium. Tilth generally is poor in the surface layer.

This soil generally is not suited to corn, soybeans, or small grain or to grasses and legumes for hay because the hazard of erosion is severe and because the slope restricts the use of farm machinery.

Most areas either support a mixture of pasture plants and hardwoods or have a permanent cover of grasses. This soil is best suited to a permanent grass cover, which helps to control erosion. A cover of pasture plants may be effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition. If the livestock damage the protective plant cover and the soil surface, renovating and reseeding as soon as possible help to prevent excessive soil loss.

This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Adequate ground cover is needed to prevent excessive soil loss. The slope restricts the use of equipment.

The capability subclass is VIIe.

192C2—Adair clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained or somewhat poorly drained soil is on long, convex side slopes and narrow ridges in the uplands. Areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown subsoil material. The upper part of the subsoil is dark yellowish brown and brown, friable clay loam. The lower part to a depth of about 60 inches is brown, reddish brown, and strong brown, mottled, very firm clay and clay loam. In most areas a stone line is at the base of the surface layer or in the upper part of the subsoil. In areas on south- and east-facing slopes adjacent to streams and on the lower parts of the landscape, the subsoil is clay and is thicker. In places the surface layer is thinner.

Included with this soil in mapping are some small areas of the moderately well drained, moderately slowly permeable Shelby soils, generally on the lower part of the slopes. Also included are small areas of well drained, calcareous soils that generally are thin deposits of loess. Included areas make up less than 5 percent of the map unit.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. This soil is not well suited to terraces because of the high content of clay, the slow permeability, and the difficulty in establishing a permanent plant cover on the terrace slopes. The incorporation of this soil into the terraces constructed on adjacent soils should be avoided or minimized. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content or organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

192D2—Adair clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained or somewhat poorly drained soil is on short, convex side slopes and narrow ridges in the uplands. Areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is very dark grayish brown clay loam about 8 inches thick. It is mixed with streaks and pockets of dark yellowish brown and brown subsoil material. The upper part of the subsoil is dark yellowish brown and brown, friable clay loam. The lower part to a depth of about 60 inches is brown, reddish brown, and strong brown, mottled, very firm clay and clay loam. In some areas on south- and east-facing slopes adjacent to streams and on the lower parts of the landscape, the subsoil is clay and is thicker. In places the surface layer is thinner.

Included with this soil in mapping are small scattered areas where slopes are short and are more than 14 percent and scattered areas of the moderately slowly permeable Shelby soils. Included areas make up about 2 percent of the map unit.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is poorly suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in some years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. This soil is not well suited to terraces because of the high content of clay, the slow permeability, and the difficulty in establishing a permanent plant cover on the terrace slopes. The incorporation of this soil into the terraces constructed on adjacent soils should be avoided or minimized. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

192D3—Adair clay loam, 9 to 14 percent slopes, severely eroded. This strongly sloping, moderately well drained or somewhat poorly drained soil is on short, convex side slopes and narrow ridges in the uplands. Areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is mixed dark brown, yellowish brown, and brown clay loam about 6 inches thick. It is mostly subsoil material. The upper part of the subsoil is dark yellowish brown and brown, friable clay loam. The lower part to a depth of about 60 inches is brown, reddish brown, and strong brown, mottled, very firm clay and clay loam.

Included with this soil in mapping are areas of the moderately slowly permeable Shelby soils, generally on the lower, steepest part of the slopes. These soils make up less than 5 percent of the map unit.

The Adair soil is slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 0.5 to 1.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are slightly acid or medium acid. The subsoil generally has a very low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is poor in the surface layer. This layer tends to crust or puddle after hard rains because it is mostly subsoil material.

Most areas are cultivated. This soil generally is not suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a very severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. This soil is not well suited to terraces because of the high content of clay, the slow permeability, and the difficulty in establishing a permanent plant cover on the terrace slopes. The incorporation of this soil into the terraces constructed on adjacent soils should be avoided or minimized. Less water infiltrates this soil than the less eroded Adair soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration. The reduced content of organic matter that results from severe erosion is a major concern if fertilizers and herbicides are applied.

This soil is best suited to pasture or hay. A cover of pasture plants or hay may be effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soil is too wet causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is VIe.

212—Kennebec silt loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on flood plains, commonly near the stream channel. It is occasionally flooded. Areas are irregular in shape, are somewhat parallel to the stream channel, and range from 2 to 55 acres in size.

Typically, the surface layer is very dark brown silt loam about 9 inches thick. The subsurface layer is silt loam about 23 inches thick. It is black in the upper part and very dark gray in the lower part. The next 8 inches is very dark gray silt loam. The substratum to a depth of about 60 inches is very dark gray silt loam. In places it has strata of fine and very fine sand.

Included with this soil in mapping are small areas of the poorly drained Colo soils in similar positions on the landscape. These soils make up less than 5 percent of the map unit.

The Kennebec soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 4 to 6 percent in the surface layer. The surface soil typically is slightly acid. The transitional layer and the substratum generally have a low supply of available phosphorus and a very low supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, the wetness caused by the flooding and the seasonal high water table is a management concern. Most of the periods of flooding are brief and occur before row crops are planted. Returning crop residue to the soil or regularly adding other organic material and delaying tillage when the soil is wet improve fertility and help to maintain good tilth.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability class is I.

220—Nodaway silt loam, 0 to 2 percent slopes. This nearly level, moderately well drained soil is on flood plains, commonly adjacent to the stream channels that have recently received sediments. In areas where the stream channels have been straightened, it is along the old meander belts (fig. 10). It is frequently flooded. Areas are irregular in shape, are somewhat parallel to the stream channels, and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark gray silt loam about 8 inches thick. The substratum to a depth of about 60 inches is stratified, multicolored silt loam.

Included with this soil in mapping are some small areas of water-deposited sand, generally in old stream meanders. Included areas make up less than 5 percent of the map unit.

The Nodaway soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface layer and the upper part of the substratum typically are neutral or slightly acid. The substratum generally has a low supply of available phosphorus and a low or very low supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and

Figure 10.—An area of Nodaway silt loam, 0 to 2 percent slopes, in an old stream meander. Marshall silty clay loam, benches, 5 to 9 percent slopes, moderately eroded, is in the higher areas.

legumes for hay or pasture. If cultivated crops are grown, the wetness caused by the flooding and the seasonal high water table is a management concern. Most of the periods of flooding are brief or very brief and occur before row crops are planted. Flood-protection measures are beneficial in most areas. Surface drains help to remove surface water, particularly in the old meander channels. Returning crop residue to the soil or regularly adding other organic material and delaying tillage when the soil is too wet improve fertility and help to maintain good tilth.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability subclass is IIw.

222D2—Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, poorly drained soil is on convex side slopes and to some extent on toe slopes in the uplands. Slopes typically are short. Areas are long and narrow and range from 2 to 10 acres in size.

Typically, the surface layer is very dark gray silty clay loam about 8 inches thick. It is mixed with streaks and pockets of dark gray subsoil material. The upper part of the subsoil is dark gray, mottled, firm and very firm silty clay. The lower part to a depth of about 60 inches is gray, mottled, very firm silty clay. In some places the surface layer is thicker and darker. In other places it is thinner.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamoni and moderately well drained Shelby soils. These soils typically are downslope from the Clarinda soil. Also included are small scattered areas of sand that typically have a low content of organic matter. Included areas make up about 8 percent of the map unit.

The Clarinda soil is very slowly permeable. It has a seasonal high water table. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. This layer typically is medium acid, and the upper part of the subsoil is medium acid or slightly acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas have been cultivated in the past but now support a permanent cover of grasses because cultivating is difficult and productivity is low. This soil is poorly suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a severe hazard. A continuous plant cover helps to prevent excessive soil loss. The soil is poorly suited to terraces. A tile drainage system generally does not function properly because of the high content of clay. Installing interceptor drainage tile in the upslope soils, however, can reduce the wetness in seepy areas of this soil. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay generally is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding with a minimum of soil disturbance. Overgrazing or grazing when the soil is too wet causes surface compaction and excessive runoff. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

248—Wabash silty clay loam, 0 to 1 percent slopes. This level, very poorly drained soil is in slack water areas on flood plains, commonly a considerable distance from the stream channel. It is occasionally flooded. The floodwater generally stands long enough for the clay in it to settle. Areas are irregular in shape and range from 3 to 90 acres in size.

Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is black silty clay loam about 10 inches thick. The subsoil to a depth of about 60 inches is firm and very firm silty clay. The upper part is black, the next part is very dark gray and dark gray, and the lower part is olive gray and mottled.

This soil is very slowly permeable. It has a seasonal high water table. Surface runoff is very slow, and water stands for long periods in areas where surface drainage is not adequate. Available water capacity is moderate. The content of organic matter is about 4 to 6 percent in the surface layer. The surface layer and the upper part of the subsurface layer typically are medium acid, and the lower part of the subsurface layer and the upper part of the subsoil are slightly acid. The subsoil generally has a high supply of available phosphorus and a medium supply of available potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains.

Most areas are cultivated. If artificially drained, this soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If crops are grown, however, flooding, the seasonal high water table, and water standing on the surface for long periods are management concerns. A drainage system is needed to reduce the wetness and provide proper aeration to the plant root system. A tile drainage system, however, generally does not function properly because of the very slowly permeable, clayey subsoil. Surface drains help to remove surface water. Flood-protection measures are beneficial in most areas. Returning crop residue to the soil or regularly adding other organic material and delaying tillage when the soil is too wet increase the rate of water infiltration, help to prevent surface crusting, and maintain tilth.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability subclass is IIIw.

268C—Knox silt loam, 5 to 9 percent slopes. This moderately sloping, well drained soil is on narrow ridges in the uplands. Areas are long and irregular in shape and range from 2 to 40 acres in size.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is about 38 inches thick. It is friable. The upper part is brown silt loam; the next part is yellowish brown silty clay loam that has brown coatings; and the lower part is dark yellowish brown, mottled silty clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled silty clay loam. In some places the slope is more than 9 percent. In other places the surface layer is thinner and lighter colored.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface soil and the upper part of the subsoil typically are neutral. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium. Tilth generally is good in the surface layer.

Some areas have been cleared of hardwoods and are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

Most areas support a mixture of pasture plants and hardwoods (fig. 11). A cover of pasture plants generally is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Adequate ground cover is needed to prevent excessive soil loss.

The capability subclass is IIIe.

268D—Knox silt loam, 9 to 14 percent slopes. This strongly sloping, well drained soil is on narrow, convex side slopes and to some extent on narrow ridges. Areas are long and irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is very dark brown silt loam about 6 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is about 36 inches thick. It is friable. The upper part is brown silt loam; the next part is yellowish brown silty clay loam that has brown coatings; and the lower part is dark yellowish brown silty clay loam. The substratum to a depth of about 60 inches is yellowish brown silty clay loam. In places the surface layer is thinner and lighter colored.

Included with this soil in mapping are small scattered areas of the moderately well drained or somewhat poorly drained, slowly permeable Adair soils and scattered areas of wind-deposited sand that typically have a low content of organic matter. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Knox soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface soil and the upper part of the subsoil typically are neutral. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium. Tilth generally is good in the surface layer.

Some areas have been cleared of hardwoods and are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

Most areas support a mixture of pasture plants and hardwoods. A cover of pasture plants generally is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Adequate ground cover is needed to prevent excessive soil loss.

The capability subclass is IIIe.

268E—Knox silt loam, 14 to 18 percent slopes. This moderately steep, well drained soil is on convex or plane upland side slopes and in slightly concave or plane coves at the head of upland drainageways. Areas are irregular in shape and range from 2 to 10 acres in size.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 4 inches thick. The subsoil is about 35 inches thick. It is friable. The upper part is brown silt loam; the next part is yellowish brown silty clay loam that has brown coatings; and the lower part is dark yellowish brown silty clay loam. The substratum to a depth of about 60 inches is yellowish brown silty clay loam.

Included with this soil in mapping are scattered areas of wind-deposited sand that typically have a low content of organic matter. These areas make up about 5 percent of the map unit.

Figure 11.—Bluegrass and hardwoods on Knox silt loam, 5 to 9 percent slopes.

Permeability is moderate in the Knox soil. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1 to 2 percent in the surface layer. The surface soil and the upper part of the subsoil typically are neutral. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium. Tilth generally is fair in the surface layer.

Some areas have been cleared of hardwoods and are cultivated. This soil is poorly suited to corn, soybeans, and small grain. If cultivated crops are grown, erosion is a severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The low content of organic matter is a concern if fertilizers and herbicides are applied.

Most areas support a mixture of pasture plants and hardwoods. A cover of pasture plants generally is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is well suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Adequate ground cover is needed to prevent excessive soil loss.

The capability subclass is IVe.

268F—Knox silt loam, 18 to 25 percent slopes. This steep, well drained soil is on convex or plane upland side slopes and in slightly concave or plane coves at the head of upland drainageways. Areas are irregular in shape and range from 2 to 30 acres in size.

Typically, the surface layer is very dark brown and very dark grayish brown silt loam about 4 inches thick. The subsurface layer is dark grayish brown silt loam about 2 inches thick. The subsoil is about 32 inches thick. It is friable. The upper part is brown silt loam; the next part is yellowish brown silty clay loam that has brown coatings; and the lower part is dark yellowish brown silty clay loam. The substratum to a depth of about 60 inches is yellowish brown silty clay loam.

Included with this soil in mapping are small scattered areas of wind-deposited sand that typically have a low content of organic matter. Also included are small areas of the moderately well drained, moderately slowly permeable Shelby soils, typically on the lower part of the slopes. Included areas make up about 5 percent of the map unit.

Permeability is moderate in the Knox soil. Surface runoff is very rapid. Available water capacity is high. The content of organic matter is about 1 percent in the surface layer. The surface soil and the upper part of the subsoil typically are neutral. The subsoil generally has a medium supply of available phosphorus and a low supply of available potassium. Tilth generally is fair in the surface layer.

This soil generally is not suited to corn, soybeans, or small grain or to grasses and legumes for hay because the hazard of erosion is severe and because the slope restricts the use of farm machinery.

Most areas support a mixture of pasture plants and hardwoods. A cover of pasture plants generally is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and excessive runoff and reduces the extent of the protective plant cover. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suited to trees. Tree seeds, cuttings, and seedlings survive and grow well if competing vegetation is controlled by site preparation, by prescribed burning, or by spraying, cutting, or girdling. Adequate ground cover is needed to prevent excessive soil loss. The slope restricts the use of equipment.

The capability subclass is VIe.

273C—Olmitz loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on alluvial fans at or near the mouth of upland drainageways and on slightly concave or plane foot slopes. Slopes typically are short. Areas are irregular in shape and range from 2 to 20 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is clay loam about 22 inches thick. The upper part is black, the next part is very dark brown, and the lower part is very dark grayish brown. The subsoil to a depth of about 60 inches is friable clay loam. It is dark brown in the upper part and brown and mottled in the lower part. In places the soil is loam throughout.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. This layer and the upper part of the subsurface layer typically are neutral, and the lower part of the subsurface layer typically is slightly acid. The subsoil generally has a very low supply of available phosphorus and potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. The soil is subject to siltation during periods when it receives runoff from the soils upslope. In areas where the water concentrates, the runoff may cause gullying. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss, and grassed waterways help to prevent gully erosion. In most areas the soil is suited to contour farming and terraces. Because the soil erodes easily, however, areas excavated for terraces should be revegetated as soon as possible. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to prevent surface crusting, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

370B—Sharpsburg silty clay loam, 2 to 5 percent slopes. This gently sloping, moderately well drained soil is on ridges in the uplands. Areas are irregular in shape and range from 2 to 40 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 5 inches thick. The subsoil is friable silty clay loam about 34 inches thick. The upper part is dark brown; the next part is brown; and the lower part is mottled grayish brown,

brown, and yellowish brown. The substratum to a depth of about 60 inches is mottled light brownish gray, brown, and yellowish brown silty clay loam. In places the soil is nearly level.

Permeability is moderately slow in the upper part of the soil and moderate in the lower part. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and a medium supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion and prevent surface crusting, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

370B2—Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded. This gently sloping, moderately well drained soil is on ridges in the uplands. Areas are irregular in shape or long and narrow and range from 2 to 45 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of dark brown subsoil material. The subsoil is friable silty clay loam about 38 inches thick. The upper part is dark brown; the next part is brown; and the lower part is mottled grayish brown, brown, and yellowish brown. The substratum to a depth of about 60 inches is mottled light brownish gray, brown, and yellowish brown silty clay loam.

Included with this soil in mapping are small scattered areas of wind-deposited sand that typically have a low content of organic matter. These areas make up about 4 percent of the map unit.

Permeability is moderately slow in the upper part of the Sharpsburg soil and moderate in the lower part. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and a medium supply of available potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

370C—Sharpsburg silty clay loam, 5 to 9 percent slopes. This moderately sloping, moderately well drained soil is on ridges and side slopes in the uplands. Areas are irregular in shape and range from 2 to 50 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 3 inches thick. The subsoil is friable silty clay loam about 37 inches thick. The upper part is dark brown; the next part is brown; and the lower part is mottled grayish brown, brown, and yellowish brown. The substratum to a depth of about 60 inches is mottled light brownish gray, brown, and yellowish brown silty clay loam. In places the surface layer is thinner.

Included with this soil in mapping are small scattered areas of Shelby soils, generally on the steepest part of the slopes. These soils are moderately slowly permeable throughout. Also included are scattered areas of wind-deposited sand that typically have a low content of organic matter. Included areas make up about 4 percent of the map unit.

Permeability is moderately slow in the upper part of the Sharpsburg soil and moderate in the lower part. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and a medium supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

370C2—Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping, moderately well drained soil is on ridges and side slopes in the uplands. Areas are irregular in shape or long and narrow and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of dark brown subsoil material. The subsoil is friable silty clay loam about 37 inches thick. The upper part is dark brown; the next part is brown; and the lower part is mottled grayish brown, brown, and yellowish brown. The substratum to a depth of about 60 inches is mottled light brownish gray, brown, and yellowish brown silty clay loam.

Included with this soil in mapping are small areas of the moderately well drained or somewhat poorly drained Adair and poorly drained Clarinda soils and small areas of Shelby soils, which are moderately slowly permeable throughout. All of these included soils generally are on the steepest, most eroded part of the slopes. Also included are small scattered areas of wind-deposited sand that typically have a low content of organic matter. Included areas make up about 5 percent of the map unit.

Permeability is moderately slow in the upper part of the Sharpsburg soil and moderate in the lower part. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and a medium supply of available potassium. Tilth generally is good, but the surface layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the uneroded Sharpsburg soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

370D2—Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, moderately well drained soil is on ridges and side slopes in the uplands and to some extent in slightly concave or plane coves at the head of upland drainageways. Areas are irregular in shape or long and narrow and range from 2 to 10 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of dark brown subsoil material. The subsoil is friable silty clay loam about 35 inches thick. The upper part is dark brown; the next part is brown; and the lower part is mottled grayish brown, brown, and yellowish brown. The substratum to a depth of about 60 inches is mottled light brownish gray, brown, and yellowish brown silty clay loam.

Included with this soil in mapping are small areas of Shelby soils and small areas where the slope is moderately steep. These areas typically are on the lower part of the slopes. Shelby soils are moderately slowly permeable throughout. Also included are small scattered areas of wind-deposited sand that typically have a low content of organic matter. Included areas make up about 4 percent of the map unit.

Permeability is moderately slow in the upper part of the Sharpsburg soil and moderate in the lower part. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and a medium supply of available potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains because it contains subsoil material.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. Row crops can be grown in most years, however, if erosion is controlled. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the uneroded Sharpsburg soils. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

430—Ackmore silt loam, 0 to 2 percent slopes. This nearly level, poorly drained soil is on flood plains, alluvial fans, and the lower parts of upland drainageways. It is occasionally flooded and during some periods receives runoff from the adjacent upland side slopes. Areas range from 2 to more than 100 acres in size. They are irregular in shape. Some of those on the flood plains are somewhat parallel to the stream channel.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The substratum is stratified very dark gray, dark gray, gray, and grayish brown silt loam about 16 inches thick. It has some thin strata of silty clay loam throughout. The next layer to a depth of about 60 inches is black silty clay loam. It is a buried soil. It is friable in the upper part and firm in the lower part. In some areas, most commonly the slack water areas on flood plains, the buried soil is silty clay. In other areas it is within a depth of 20 inches. In places the surface layer is silty clay loam.

This soil is moderately permeable. It has a seasonal high water table. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 2 to 4 percent in the surface layer. This layer typically is medium acid, and the substratum is slightly acid. The substratum and the buried soil generally have a low supply of available phosphorus and a very low supply of available potassium. Tilth generally is good in the surface layer.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. The wetness caused by flooding and the seasonal high water table interferes with cultivating and harvesting. A drainage system is needed to reduce the wetness, provide proper aeration to the plant root system, and maintain good tilth. A tile drainage system generally functions well if adequate outlets are available and if the tile is suitably spaced and removes the excess water perched on top of the buried soil. Surface drains help to remove surface water, particularly in areas that receive runoff from the adjacent upland side slopes. Flood-protection measures are beneficial in most areas. Returning crop residue to the soil or regularly adding other organic material and delaying tillage when the soil is too wet increase the rate of water infiltration and maintain good tilth.

If this soil is used for pasture, overgrazing or grazing during wet periods causes surface compaction and poor tilth. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability subclass is IIw.

509—Marshall silty clay loam, benches, 0 to 2 percent slopes. This nearly level, well drained soil is on broad, loess-covered benches near streams. Areas are irregular in shape and range from 2 to more than 100 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 9 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 11 inches thick. The subsoil is brown, friable silty clay loam about 30 inches thick. It has grayish brown, brown, reddish brown, and strong brown mottles in the lower part. The substratum to a depth of about 60 inches is mottled light brownish gray and yellowish brown silty clay loam. The soil is underlain by alluvial sand and gravel.

Included with this soil in mapping are some small, scattered, slightly depressional areas. These areas are wetter than areas of the Marshall soil and impound water during periods of heavy rainfall. They make up less than 5 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is slow. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. The surface soil and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, wind erosion is a hazard. It can be controlled, however, by a conservation tillage system that leaves crop residue on the surface and by winter cover crops. Returning crop residue to the soil or regularly adding other organic material improves fertility and increases the rate of water infiltration, particularly in the slightly depressional areas.

A cover of pasture plants or hay is effective in controlling wind erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction and poor tilth and reduces the rate of water infiltration. Proper stocking rates, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

The capability class is I.

509B—Marshall silty clay loam, benches, 2 to 5 percent slopes. This gently sloping, well drained soil is on convex summits and side slopes on broad, loess-covered benches near streams. Areas are irregular in shape and range from 2 to 30 acres in size.

Typically, the surface layer is very dark brown silty clay loam about 8 inches thick. The subsurface layer is very dark grayish brown silty clay loam about 10 inches thick. The subsoil is brown, friable silty clay loam about 30 inches thick. It has grayish brown, brown, reddish brown, and strong brown mottles in the lower part. The substratum to a depth of about 60 inches is mottled light brownish gray and yellowish brown silty clay loam. The soil is underlain by alluvial sand and gravel. In places the surface layer is thinner.

Included with this soil in mapping are some small areas of wind-deposited sand that typically have a low content of organic matter. Also included are some small, scattered areas where slopes are short and are more than 5 percent. Included areas make up less than 5 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3 to 4 percent in the surface layer. The surface soil and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good.

Most areas are cultivated. This soil is well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, erosion is a hazard. A conservation tillage system that leaves crop residue on the surface and winter cover crops help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration.

A cover of pasture plants or hay is effective in controlling erosion. Overgrazing or grazing when the soil is too wet, however, causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIe.

509C2—Marshall silty clay loam, benches, 5 to 9 percent slopes, moderately eroded. This moderately sloping, well drained soil is on convex side slopes on loess-covered benches near streams. It is commonly downslope from the nearly level and gently sloping Marshall soils on benches. Areas are long and narrow and range from 2 to 20 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 8 inches thick. It is mixed with streaks and pockets of brown subsoil material. The subsoil is brown, friable silty clay loam about 36 inches thick. It has grayish brown, brown, reddish brown, and strong brown mottles in the lower part. The substratum to a depth of about 60 inches is mottled light brownish gray and yellowish brown silty clay loam. The soil is underlain by alluvial sand and gravel. In some places the surface layer is thinner. In other places the depth to mottles is less than 30 inches.

Included with this soil in mapping are areas of wind-deposited sand that typically have a low content of organic matter. Also included are scattered areas where slopes are short and are more than 9 percent. Included areas make up less than 5 percent of the map unit.

Permeability is moderate in the Marshall soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 2 to 3 percent in the surface layer. The surface layer and the upper part of the subsoil typically are medium acid. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is good.

Most areas are cultivated. This soil is moderately well suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. If cultivated crops are grown, further erosion is a severe hazard. A conservation tillage system that leaves crop residue on the surface, winter cover crops, and grassed waterways help to prevent excessive soil loss. In most areas the soil is suited to contour farming and terraces. Less water infiltrates this soil than the uneroded Marshall soils on benches. Returning crop residue to the soil or regularly adding other organic material improves fertility, helps to control erosion, and increases the rate of water infiltration. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IIIe.

822D2—Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded. This strongly sloping, somewhat poorly drained soil is on convex side slopes in the uplands. Slopes typically are short. Areas are long and narrow and range from 2 to 10 acres in size.

Typically, the surface layer is very dark grayish brown silty clay loam about 9 inches thick. The subsoil is about 39 inches thick. The upper part is dark grayish brown, mottled, very firm clay; the next part is grayish brown, mottled, very firm clay; and the lower part is grayish brown and strong brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is yellowish brown, mottled clay loam. In places the surface layer is thicker and darker.

This soil is slowly permeable or very slowly permeable. It typically has a perched water table during periods of seasonal rainfall. Surface runoff is rapid. Available water capacity is high. The content of organic matter is about 1.5 to 2.5 percent in the surface layer. The surface layer and the upper part of the subsoil typically are neutral. The subsoil generally has a low supply of available phosphorus and potassium. Tilth generally is fair in the surface layer. This layer tends to crust or puddle after hard rains.

Most areas are cultivated. A few support a permanent cover of grasses because cultivating is difficult and productivity is low. This soil is poorly suited to corn, soybeans, and small grain. If cultivated crops are grown, further erosion is a severe hazard. A continuous plant cover helps to prevent excessive soil loss. This soil is poorly suited to terraces. A tile drainage system generally does not function properly because of the high content of clay. Installing interceptor tile in the upslope soils, however, can reduce the wetness in seepy areas of this soil. The reduced content of organic matter that results from erosion is a concern if fertilizers and herbicides are applied.

A cover of pasture plants or hay generally is effective in controlling erosion. Permanent pastures can be improved by renovating and reseeding. Overgrazing or grazing when the soil is too wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking rates, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

The capability subclass is IVe.

980G—Gullied land-Judson complex, 2 to 40 percent slopes. This map unit occurs as areas of gently sloping to very steep, deeply entrenched, eroding Gullied land intermingled with areas of a gently sloping and moderately sloping, well drained Judson soil (fig. 12). The unprotected Gullied land is occasionally flooded for brief periods. Areas are long and narrow and range from 5 to 55 acres in size. They are about 80 percent Gullied land and 15 percent Judson soil. The Gullied land and the Judson soil occur as areas so intermingled or so small and narrow that mapping them separately is not practical.

The Gullied land formed as a result of severe water erosion in upland drainageways. Typically, it is actively eroding and is progressively extending further into the head of the drainageways. The gullies typically have very steep embankments, are 10 to 20 feet deep, and are 20 to 200 feet wide.

Typically, the surface soil of the Judson soil is silty clay loam about 33 inches thick. It is very dark brown in the upper part and very dark grayish brown in the lower part. The subsoil to a depth of about 60 inches is dark brown and brown, friable silty clay loam.

Included with the Gullied land and the Judson soil in mapping are areas of the poorly drained Ackmore and Colo soils on the most stable part of the slopes. Included areas make up about 5 percent of the map unit.

The properties of the Gullied land vary because of the accelerated erosion, the mass movement of soil particles, and the relative instability of the soil material.

Permeability is moderate in the Judson soil. Surface runoff is medium. Available water capacity is high. The content of organic matter is about 3.5 to 4.5 percent in the surface layer. This layer typically is neutral, and the subsurface layer and the upper part of the subsoil are medium acid. The subsoil generally has a low supply of available phosphorus and potassium.

Most areas support grasses or a mixture of grasses and water-tolerant trees. They are not suitable for cultivation. In narrow areas of the Judson soil adjacent to the gullies, operating farm machinery is hazardous because of embankment erosion.

This map unit is best suited to openland or woodland wildlife habitat. Livestock should be excluded from the gullied embankments because their traffic results in further damage. Planted or naturally established vegetation, such as water-tolerant trees and shrubs, not only provides feeding and nesting areas for wildlife but also may be effective in controlling further embankment erosion. In some areas the gully embankments have been stabilized by a cover of grasses. Leaving these areas undisturbed helps to prevent further erosion.

The capability subclass is VIIe.

5010—Pits, sand and gravel. These open sand pits and gravel pits are on flood plains and uplands. They commonly are surrounded by piles of spoil. About 5 to 100 feet of material has been removed from the pits, primarily for use in construction. Some of the pits are being mined. Others have been abandoned. Some contain water a few to many feet deep. The pits are irregular in shape and range from 2 to more than 100 acres in size.

The spoil surrounding the pits varies in texture but generally is sandy and contains various amounts of gravel. On uplands it is eolian material or glacial till or a mixture of the two. On flood plains it is alluvium. In some pits, particularly those on the flood plains, a thick overburden has been removed and the underlying sand

Figure 12.—An area of Gullied land-Judson complex, 2 to 40 percent slopes. The strongly sloping to steep Knox and Gara soils are on the higher parts of the landscape.

and gravel are exposed. Most of the pits have vertical sides that support little or no vegetation. Some areas have been partly reshaped, however, and support some grasses or trees. The spoil typically is neutral to medium acid.

All or part of the areas that are no longer mined for sand and gravel can be reclaimed for alternate uses. These areas are well suited to wildlife habitat, and some of the ponds could support fish. Because of the vertical sides and the varying depth of the water, however, the pits could be dangerous as sites for recreational development and wildlife habitat. Onsite investigation is needed to determine the hazards involved and the best use of the spoil areas.

No capability class or subclass is assigned.

5040—Orthents, loamy. These nearly level to very steep, well drained to poorly drained, mechanically disturbed soils are on uplands and flood plains. Most areas have been either cut or filled for road construction sites, borrow areas, or building site developments. In some areas the original soil has been removed to a depth of as much as 20 feet. The texture of these soils varies but generally is loamy. Areas are irregular in shape and range from 2 to 50 acres in size.

Typically, the upper 60 inches is calcareous, yellowish brown, friable or firm loam. Pebbles and larger stones are common on the surface and throughout the profile. In some areas the surface layer is silty clay loam or silt loam. It is clay loam or clay in some areas where the paleosol has been disturbed. In some places the surface color is gray or olive gray. In other places, a thin layer of topsoil has been redistributed over the area and the surface color ranges from very dark gray to dark brown or brown.

Included with these soils in mapping are a few areas that were once dumps or landfills. These areas have been covered with a thin layer of soil material. They make up less than 5 percent of the map unit.

Permeability varies, depending on the texture and density of the soils. Surface runoff ranges from slow to very rapid. Available water capacity is moderate or high. The content of organic matter is very low unless topsoil has been redistributed over the area. Reaction typically is neutral to moderately alkaline. In most areas these soils have a very low supply of available phosphorus and potassium.

Most areas support a permanent cover of grasses or weeds. Some areas, particularly along roads, are cultivated along with the adjoining cropland. These soils are best suited to small grain and to grasses and legumes for hay or pasture. They are poorly suited to cultivation. They generally are not suited to row crops unless the topsoil has been redistributed over the area and the slopes are not excessive. Because the organic matter content typically is very low, preparing a good seedbed is difficult and crops are seriously affected by drought. In cultivated areas a conservation tillage system that leaves crop residue on the surface helps to prevent excessive soil loss. Also, other measures that stabilize the soils are needed. Drought-tolerant grasses and erosion control generally are beneficial in these areas. Some form of vegetation can be established in most areas.

No capability class or subclass is assigned.

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 providing 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 cropland, pasture, woodland, or other land, but it is not urban and built-up land or water areas. It either is used for food or fiber or is available for these uses. The soil qualities, growing season, and moisture supply are those needed for a well managed soil economically to produce a sustained high yield of crops. Prime farmland produces the highest yields with minimal inputs of energy and economic resources, and farming it results in the least damage to the environment.

Prime farmland usually 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 local offices of the Soil Conservation Service.

About 112,825 acres in Audubon County, or nearly 39 percent of the total acreage, meets the requirements for prime farmland. This land is throughout the county, mainly in associations 1, 2, 4, and 5, which are described in the section "General Soil Map Units." Association 5 is almost entirely prime farmland. About 100,000 acres of the prime farmland is used for crops, mainly corn and soybeans. The crops grown on this land account for an estimated two-thirds of the local farm income each year.

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

The map units that are considered prime farmland in Audubon County 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 in the section "Detailed Soil Map Units."

Some soils that have a seasonal high water table and soils that are frequently flooded qualify for prime farmland only in areas where these limitations have been overcome by a drainage system or flood control. The need for these measures is indicated in parentheses after the name of these soils 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 avoid soil-related failures in land uses.

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

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

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

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where 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

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

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

More than 281,000 acres in Audubon County is farmland (*21*). The main row crops are corn and soybeans, and alfalfa or alfalfa-grass is the major hay crop. The acreage used for row crops has increased in recent years as a result of changes in farming practices and markets. Other land uses have remained about the same. Crop production and conservation of soil resources could be increased by extending known technology to all of the cropland in the county. This soil survey, which gives the basic characteristics of each kind of soil, can greatly aid in the application of such technology.

The main management concerns in Audubon County are controlling water erosion and wind erosion, draining naturally wet soils and seepy areas, and maintaining and improving soil fertility and tilth. The paragraphs that follow describe the management concerns affecting the use of the soils in the county for crops and pasture.

Soil erosion by water is the major problem in gently sloping to steep areas of cropland and pasture. It is a problem on about 70 percent of the acreage in Audubon County. Conservation measures that control erosion are needed on Adair, Clarinda, Dickman, Exira, Gara, Ida, Judson, Kennebec, Knox, Lamoni, Marshall, Olmitz, Sharpsburg, Shelby, and Wiota soils.

Loss of the surface layer through erosion reduces the productivity of soils and results in sedimentation in streams. Productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into a plow layer. Loss of the surface layer is especially damaging on soils having a subsoil that is low in fertility, such as Shelby soils, and on soils having a clayey subsoil, such as Adair and Clarinda soils. Preparing a good seedbed and tilling are difficult on eroded soils because the original friable surface layer has been removed or thinned and because the more strongly structured subsoil is often hard and cloddy after rainfall and if tilled when wet. Runoff from soils commonly becomes a damaging pollutant and can cause serious sedimentation problems in streams, drainageways, and road ditches. Control of erosion helps to maintain the productivity of

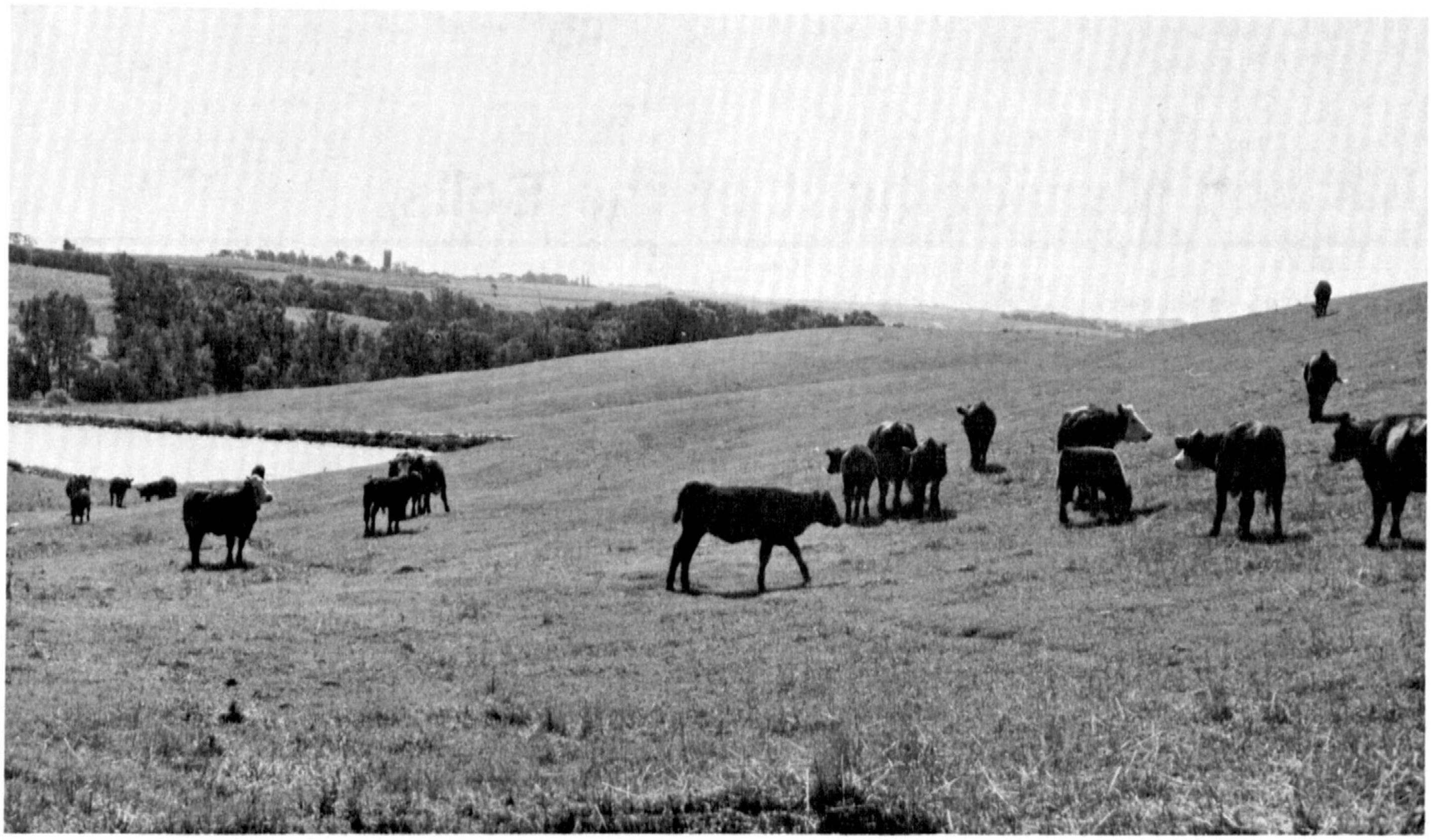

Figure 13.—Improved pasture in an area of the Marshall-Shelby-Adair association. The cover of grasses and the pond help to control erosion.

the soils and improves the quality of water for municipal use, for recreation, and for fish and wildlife by minimizing the pollution of streams.

Erosion-control practices provide a protective cover, which reduces the rate of runoff and increases the rate of water infiltration. Among the measures that help to control erosion are cover crops, contour stripcropping, contour farming, terraces and diversions, grassed waterways, windbreaks, and conservation tillage. A combination of several measures generally is most effective.

A cropping system that keeps a plant cover on the surface for extended periods can reduce soil losses to an amount that will not decrease the productive capacity of the soils. On livestock farms, where part of the acreage is hayland or pasture, including legumes and grasses in the cropping sequence not only provides nitrogen and improves tilth for the following crops but also provides a nearly continuous plant cover (fig. 13).

Conservation tillage is effective in controlling erosion, especially on the more sloping soils. Following are examples of the major kinds of conservation tillage systems that leave crop residue on the surface. No-tillage, or slot or zero tillage, is a system in which the seedbed is prepared and the seed planted in one operation. The surface is disturbed only in the immediate area of the planted seed row. A protective cover of crop residue is left on at least 90 percent of the surface. Site-plant, strip-till, or till-plant also is a system in which the seedbed is prepared and the seed planted in one operation. Tillage is limited to a strip not wider than one-third of the row. A protective cover of crop residue is left on two-thirds of the surface. Chisel-disk or rotary tillage is a system in which the soil is loosened throughout the field and part of the crop residue is incorporated into the soil. Preparing a seedbed and planting may be one or separate operations. Conservation tillage is effective only if the amount of crop residue left on the surface after planting is enough to control erosion.

Terraces and diversions reduce the length of slopes and thus the runoff rate and the risk of erosion. They are most practical on well drained or moderately well drained, gently sloping or moderately sloping soils that have smooth slopes. Other soils are less suitable because the slopes are irregular or are too steep. Level, grassed backslope terraces commonly are used in areas of the Exira and Marshall soils. On the soils that have a higher content of clay and are more slowly permeable, such as Gara, Sharpsburg, and Shelby soils, graded tile inlet terraces commonly are used. This type of terrace helps to prevent the accumulation of runoff in areas above the terrace. If terraces are constructed in loess soils, such as Exira, Marshall, or Sharpsburg soils, the incorporation of the adjacent, less permeable Adair, Clarinda, or Lamoni soils should be avoided or minimized. Because the less permeable soils have a high content of clay, terrace design and construction and revegetation of the terrace slope can be difficult and seepy areas can occur. In areas of Shelby and other soils having a subsoil that formed entirely or partly in glacial till, topsoil should be stockpiled during terrace construction and the exposed subsoil covered after construction. Diversion terraces commonly are installed upslope from the Judson or Olmitz soils on foot slopes and in drainageways. They reduce the amount of runoff from the upland soils onto these soils.

Contour farming and contour stripcropping are effective erosion-control practices in Audubon County. They are most effective in areas where slopes are smooth and uniform, such as areas of the Exira, Marshall, and Sharpsburg soils.

Wind erosion is a hazard in areas of Dickman sandy loam in the Dickman-Marshall complex and in the smaller scattered areas of wind-deposited sand throughout the county. It can damage these soils in a few hours if winds are strong and the soils are dry and have no plant cover or surface mulch. Row crops on these soils and on the adjacent soils can also be damaged by the windblown sand. Many of the nearly level loess soils in the uplands, such as Marshall, and the nearly level soils on bottom land, such as Colo, Kennebec, and Zook, can also be damaged by wind erosion. This erosion generally occurs in areas where these soils have been cropped to soybeans, which provide little residue, and then are tilled in the fall. Maintaining a plant cover or surface mulch or keeping the surface rough through proper tillage minimizes the damage caused by wind erosion. Windbreaks also help to control wind erosion.

Gully control structures, grassed waterways, and farm ponds are used to control erosion in watercourses. Farm ponds also provide a supply of water for livestock and for recreation.

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

Drainage is a major management concern on about 26 percent of the soils in Audubon County. An artificial drainage system generally is needed on the Ackmore, Colo, Wabash, and Zook soils on flood plains and on the Ackmore, Colo, and Zook soils in upland drainageways. Artificially draining poorly drained or very poorly drained soils generally increases productivity and expands the choice of crops that can be grown. The drains should be more closely spaced in the moderately slowly permeable soils than in the more rapidly permeable soils. In many areas, however, especially in areas of the nearly level to slightly depressional alluvial soils, suitable outlets for a tile drainage system are not available. Because of the high content of clay in the subsoil of the Wabash soils, a tile drainage system may not function properly. Open surface drainage ditches may be the only alternative for draining these soils. The slow or very slow permeability in Adair, Clarinda, Lamoni, and other soils that formed in a paleosol on uplands commonly results in seepy areas within the surrounding soils. Installing lateral interceptor tile drains upslope from the slowly permeable or very slowly permeable soils helps to intercept and drain the excess moisture at the point where loess and glacial till are in contact.

Soil fertility is affected by the supply of available phosphorus and potassium in the subsoil, by reaction, and by the content of organic matter in the surface layer. The fertility level varies widely in the soils of Audubon County. In most of the soils, the supply of available phosphorus and potassium is low or very low and reaction is neutral to medium acid. The Dickman, Gara, and Knox soils, however, may be strongly acid or very strongly acid, and the Ida soils typically are mildly alkaline throughout. On acid soils, applications of ground limestone are needed to promote good plant growth. Because of the high content of calcium carbonate in the Ida soils, the phosphorus and potassium commonly are unavailable to plants. On these soils special application rates are needed to overcome the problem. On all soils the kinds and amounts of lime and fertilizer needed should be determined by the results of soil tests, the needs of the crop, and the expected level of yields. Soil tests generally provide the most beneficial information. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime that should be applied.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth generally have a high content of organic matter and are granular and porous. In most of the uneroded upland soils that formed under prairie grasses, the content of organic matter is about 3.0 to 4.5 percent. In the eroded upland soils that formed under prairie grasses, it is less than 1 percent to 3 percent, depending on the degree of erosion that has taken place. In the Gara and Knox soils, which formed under mixed prairie grasses and deciduous trees, the content of organic matter is naturally low in the surface layer, generally ranging from 3 to less than 1 percent. Most of the soils on bottom land have the highest content of organic matter. The content is about 4 to 7 percent in the bottom land soils that have a surface layer of silty clay loam. It is lower in the stratified soils that have a surface layer of silt loam, such as Ackmore and Nodaway soils. Regular additions of crop residue, manure, and other organic material improve soil structure and tilth and help to prevent the formation of a surface crust.

Fall plowing generally is not considered a good practice on the soils in this county because it increases the susceptibility to water erosion and wind erosion. Many of the soils that are fall plowed are nearly as dense and hard at the time of planting as they were before they were plowed. The soils are best protected by minimum tillage or winter cover crops.

The soils that formed in glacial till, such as Adair, Gara, and Shelby, commonly have an accumulation of large stones on the surface (fig. 14). These stones eroded from the till. They can interfere with tilling and harvesting unless they are removed.

Most of the permanent pastures in the county support bluegrass, but some support a grass-legume mixture, such as alfalfa and bromegrass. Some renovated pastures support birdsfoot trefoil or crownvetch. Most of the bluegrass pastures are not used as cropland because the soils are too steep for cultivation. Measures that prevent overgrazing are needed, especially on steep slopes, to prevent surface compaction and gully erosion. Maximum production of grasses and legumes can be achieved if the pasture is properly managed. Applications of fertilizer, weed and brush control, rotation and deferred grazing, proper stocking rates, and adequate livestock watering facilities help to keep the pasture in good condition.

Many of the field crops suited to the soils and climate in Audubon County are not commonly grown. These include sorghum and milo, used mainly for silage; wheat; barley; various species of grasses for pasture; various native grasses, such as bluestem, switchgrass, and indiangrass, which produce grass seed; sweet corn; nursery stock; early vegetables; and certain orchard fruits.

The latest information and suggestions about crops and farming practices can be obtained from local offices of the Cooperative Extension Service and the Soil Conservation Service.

Figure 14.—Exposed large stones and pebbles on soils formed in glacial till. The putty knife is about 8 inches long.

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

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

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

Class I soils have few limitations that restrict their use.

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

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

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

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

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

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

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

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

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

The acreage of soils in each capability class and subclass is shown in table 7. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

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, reduce energy requirements, and provide food and cover for wildlife (fig. 15).

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 insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 8 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 8 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Figure 15.—Windbreak of honeysuckle and evergreen trees on Marshall silty clay loam, 5 to 9 percent slopes.

Recreation

According to the 1980 Audubon County Conservation District Inventory, about 465 acres in the county is used for recreation. Most of this acreage is in the largest county recreation area at Littlefield Park. This facility provides camping areas, picnic areas, boat ramps, fishing access, and a public beach area (fig. 16). The watershed structure in this area helps to control flooding in the surrounding areas.

The soils of the survey area are rated in table 9 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 9, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

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

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

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

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The

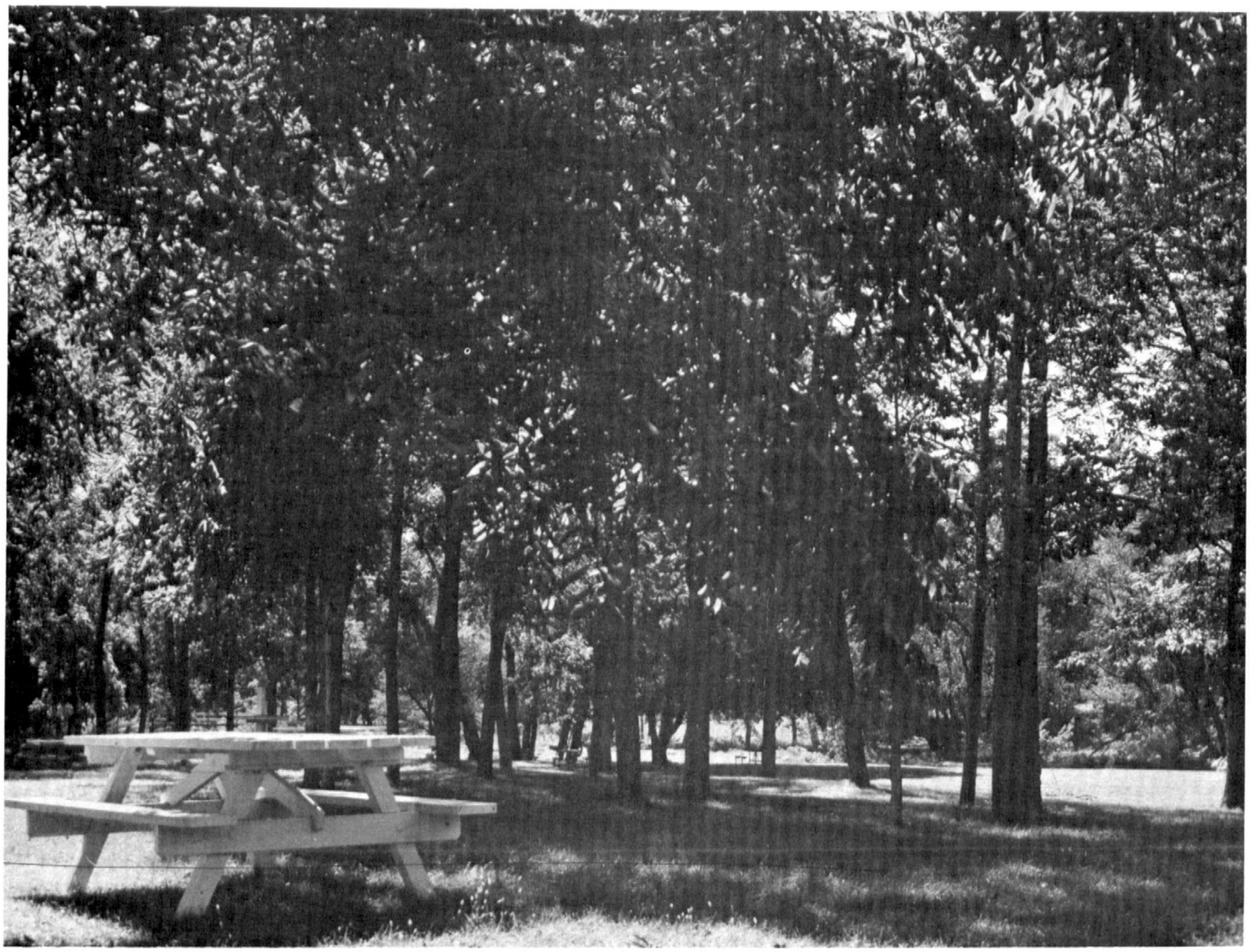

Figure 16.—Recreational development on nearly level soils in an area of the Colo-Ackmore-Zook association on bottom land.

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 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

Audubon County supports a variety of wildlife species even though intensive cropping continues to reduce the extent of the habitat available to wildlife. The open farmland is inhabited by ring-necked pheasant, cottontail, and bobwhite quail. Numerous farm ponds and watershed structures support a diversity of migrating waterfowl, including mallards, Canada geese, and some shore birds. Numerous creeks provide habitat for muskrat and beaver. The scattered woodland tracts, which are mainly throughout the southern part of the county, provide habitat for white-tailed deer, fox squirrel, red fox, raccoon, and a few coyotes and jackrabbits. These areas also attract various songbirds and woodland birds, such as bluejays, nuthatches, chickadees, thrushes, woodpeckers, grosbeaks, and warblers.

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

In table 10, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

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

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

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

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

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, beggarweed, 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 hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, hawthorn, dogwood, hickory, blackberry, and elderberry. 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, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, 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 wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

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

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

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

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

Engineering

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

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

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

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

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

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

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

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

Building Site Development

Table 11 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

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

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

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

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

Sanitary Facilities

Table 12 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 12 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, 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 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, flooding, large stones, and content of organic matter.

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

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

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

The ratings in table 12 are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

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

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

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

Construction Materials

Table 13 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a *probable* or *improbable* source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

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

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

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

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

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 13, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

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

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source.

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, 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 or stones, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

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

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

Water Management

Table 14 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

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

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to 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 or organic matter. 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 layers that affect the rate of water movement, permeability, depth to a high water table or depth of standing water if the soil is subject to ponding, slope, susceptibility to flooding, subsidence of organic layers, and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as a high content of calcium carbonate. 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. The performance of a system is affected by the depth of the root zone and soil reaction.

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

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

Soil Properties

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

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

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

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

Engineering Index Properties

Table 15 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

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

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "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, SP-SM.

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

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

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

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

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

Physical and Chemical Properties

Table 16 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

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

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

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

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

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

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

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

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

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

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

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

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

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops.

They are extremely erodible, and vegetation is difficult to establish.

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

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

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

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

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

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

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

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 16, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

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

Soil and Water Features

Table 17 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

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

The four hydrologic soil groups are:

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

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

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

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

In table 17, some soils are assigned to two hydrologic groups. 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 and 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, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs, on the average, no more than once in 2 years; and *frequent* that it occurs, on the average, more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

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

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

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 17 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 17. 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.

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

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

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

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

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*25*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. Table 18 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

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

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

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Hapludolls (*Hapl*, meaning minimal horizonation, plus *udoll*, the suborder of the Mollisols that have 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 Hapludolls.

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

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

Soil Series and Their Morphology

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

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the *Soil Survey Manual* (*24*). Many of the technical terms used in the descriptions are defined in *Soil Taxonomy* (*25*). 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."

Ackmore Series

The Ackmore series consists of poorly drained, moderately permeable soils on flood plains and alluvial fans and in upland drainageways. These soils formed in stratified recent alluvium over a buried soil that formed in alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 5 percent.

Ackmore soils commonly are adjacent to Colo, Judson, Kennebec, Nodaway, and Zook soils. None of the adjacent soils have a buried soil. All of the adjacent soils, except for Nodaway, have a mollic epipedon and are not stratified in color. Colo, Kennebec, Nodaway, and

Zook soils are in positions on the landscape similar to those of the Ackmore soils. Colo, Judson, and Zook soils have a silty clay loam surface layer. Nodaway soils are moderately well drained.

Typical pedon of Ackmore silt loam, 0 to 2 percent slopes, in a cultivated field; 1,210 feet north and 950 feet east of the center of sec. 19, T. 81 N., R. 34 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

C—9 to 25 inches; stratified very dark gray (10YR 3/1), dark gray (10YR 4/1), gray (10YR 5/1), and grayish brown (10YR 5/2) silt loam that has some thin strata of silty clay loam and a few very thin light gray (10YR 7/2) strata; very dark gray (10YR 3/1) kneaded; weak thin platy fragments and some weak fine granular structure; friable; many fine strong brown (7.5YR 5/8) and few fine soft yellowish red (5YR 5/8) and reddish brown (2.5YR 4/4) accumulations (iron oxide); slightly acid; abrupt smooth boundary.

Ab1—25 to 32 inches; black (N 2/0) silty clay loam, black (N 2/0) kneaded; weak medium and fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Ab2—32 to 42 inches; black (10YR 2/1) silty clay loam, black (10YR 2/1) kneaded; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; slightly acid; clear smooth boundary.

Ab3—42 to 54 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) kneaded; moderate medium and coarse prismatic structure parting to weak medium and fine subangular blocky; firm; few medium and fine black (10YR 2/1) concretions (iron and manganese oxides); slightly acid; gradual smooth boundary.

Ab4—54 to 60 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) kneaded; moderate coarse prismatic structure; firm; neutral.

The depth to the Ab horizon ranges from 20 to 36 inches. The A and C horizons are commonly silt loam, but the range includes silty clay loam.

The A horizon is black (10YR 2/1), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). The C horizon is dominantly very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2), but the strata range from black (10YR 2/1) to grayish brown (10YR 5/2). The Ab horizon is black (N 2/0 or 10YR 2/1) or very dark gray (N 3/0 or 10YR 3/1).

Adair Series

The Adair series consists of moderately well drained or somewhat poorly drained, slowly permeable soils on ridges and side slopes and to some extent on south- and east-facing toe slopes along streams in the uplands. The upper part of the profile formed in a mixture of loess and pedisediments, and the lower part formed in a paleosol that formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 5 to 18 percent.

The Adair soils in this county are taxadjuncts to the series because their A horizon is not thick enough to qualify as a mollic epipedon.

Adair soils are similar to Lamoni soils and commonly are adjacent to Exira, Marshall, Sharpsburg, and Shelby soils. Lamoni soils are grayish brown and do not have the stone line that is common in the Adair soils. Exira, Marshall, and Sharpsburg soils formed in loess. They typically are upslope from the Adair soils. Shelby soils are lower on the landscape than the Adair soils. Also, their Bt horizon has a lower content of clay and does not have a reddish hue.

Typical pedon of Adair clay loam, 5 to 9 percent slopes, moderately eroded, in a previously cultivated pasture; 660 feet east and 410 feet south of the center of sec. 17, T. 78 N., R. 34 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; mixed with some streaks and pockets of dark yellowish brown (10YR 4/4) subsoil material; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

BA—8 to 16 inches; dark yellowish brown (10YR 4/4) clay loam; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

Bt1—16 to 22 inches; brown (7.5YR 4/4) clay loam; discontinuous dark grayish brown (10YR 4/2) coatings; moderate medium and fine subangular blocky structure; friable; thin discontinuous light gray (10YR 7/1) silt coatings on faces of peds when dry; strongly acid; clear smooth boundary.

2Bt2—22 to 34 inches; brown (7.5YR 4/4) and reddish brown (5YR 4/4) clay; common medium distinct brown (7.5YR 4/2) and few fine distinct red (2.5YR 4/8) mottles; weak coarse prismatic structure parting to moderate medium and fine subangular blocky; very firm; thin continuous clay films on faces of prisms; few pebbles and stones at the top of the horizon; strongly acid; clear smooth boundary.

2Bt3—34 to 47 inches; strong brown (7.5YR 5/6) clay loam; many medium and large distinct dark gray (5Y 4/1), common medium distinct brown (7.5YR 4/4), and few fine distinct yellowish red (5YR 5/6) mottles; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; very firm; thin continuous clay films on faces of prisms; few pebbles; many fine very dark brown (10YR 2/2) concretions (manganese oxide); medium acid; gradual smooth boundary.

2BC—47 to 60 inches; strong brown (7.5YR 5/6) clay loam; many medium and large distinct brown (7.5YR 5/2), common fine distinct brown (7.5YR 4/4), and few fine distinct light brownish gray (2.5Y 6/2) mottles; moderate coarse prismatic structure parting to moderate medium and fine subangular blocky; very firm; few pebbles; many black (N 2/0) streaks and concretions (manganese oxide); concentrations of oxide at a depth of 58 inches; few 1-centimeter stones at a depth of 60 inches; medium acid.

The thickness of the solum ranges from 40 to 65 inches. The thickness of the horizons, the depth to a pebble band, and the depth to the horizon that has the highest content of clay decrease as slope increases.

The Ap horizon is commonly 6 to 10 inches thick but in some pedons is as much as 14 inches thick. It has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It typically is clay loam. In some pedons, however, it is silty clay loam that has a noticeable content of sand, and in other pedons it is loam. The 2Bt horizon has hue of 7.5YR or 5YR, value of 3 to 5, and chroma of 4 to 6. It dominantly has reddish brown or brown mottles in the upper part and grayish mottles in the lower part. The content of clay in this horizon commonly ranges from 38 to 46 percent. The stone line does not occur in some pedons.

Clarinda Series

The Clarinda series consists of poorly drained, very slowly permeable soils on convex side slopes and toe slopes in the uplands. These soils formed in an exhumed, gray, clayey paleosol that formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 9 to 14 percent.

The Clarinda soils in this county are taxadjuncts to the series because their A horizon is not thick enough to qualify as a mollic epipedon.

Clarinda soils commonly are adjacent to Exira, Marshall, Sharpsburg, and Shelby soils. Exira, Marshall, and Sharpsburg soils formed in loess. They typically are in positions on the landscape similar to those of the Clarinda soils. Shelby soils formed in clay loam glacial till. They are moderately well drained and typically are downslope from the Clarinda soils.

Typical pedon of Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded, in a previously cultivated field; 2,385 feet north and 270 feet west of the southeast corner of sec. 16, T. 81 N., R. 34 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, grayish brown (10YR 5/2) dry; mixed with some streaks and pockets of dark gray (10YR 4/1) subsoil material; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.

Bt1—8 to 13 inches; dark gray (10YR 4/1) silty clay; few fine distinct brown (7.5YR 5/4) mottles; moderate fine subangular blocky structure; firm; thin discontinuous clay films on faces of peds; slightly acid; gradual smooth boundary.

Bt2—13 to 20 inches; dark gray (10YR 4/1) silty clay; few fine distinct brown (7.5YR 5/4) mottles; moderate fine angular and subangular blocky structure; firm; thick continuous clay films on faces of peds; few fine white sand grains; many fine roots; medium acid; gradual smooth boundary.

Bt3—20 to 28 inches; dark gray (10YR 4/1) silty clay; weak medium prismatic structure parting to moderate fine angular and subangular blocky; very firm; thick continuous clay films on faces of prisms; few fine white sand grains; slightly acid; gradual smooth boundary.

Btg1—28 to 38 inches; dark gray (5Y 4/1) silty clay; weak medium prismatic structure parting to moderate fine angular and subangular blocky; very firm; thick continuous clay films on faces of prisms; few fine white sand grains; many fine black (10YR 2/1) concretions (manganese oxide); slightly acid; gradual smooth boundary.

Btg2—38 to 47 inches; gray (5Y 5/1) silty clay; few medium distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate fine angular and subangular blocky; very firm; thick continuous clay films on faces of prisms; few fine white sand grains; many fine black (10YR 2/1) concretions (manganese oxide) and many fine distinct yellowish red (5YR 5/8) concretions (iron oxide); some dark brown (7.5YR 3/2) organic stains in old root channels; slightly acid; gradual smooth boundary.

Btg3—47 to 60 inches; gray (5Y 5/1) silty clay; weak coarse prismatic structure parting to moderate fine angular and subangular blocky; very firm; thick continuous clay films on faces of prisms; few fine distinct strong brown (7.5YR 5/8) concretions (iron oxide); neutral.

The solum is commonly more than 60 inches thick. The A or Ap horizon is silty clay loam or silt loam. It is commonly less than 10 inches thick but in some pedons is as much as 14 inches thick. It is black (10YR 2/1) or very dark gray (10YR 3/1). The Bt horizon ranges from 3 to 10 feet in thickness. It typically is silty clay or clay in which the maximum content of clay ranges from 45 to 58 percent. The distinctly gleyed part of this horizon has hue of 10YR, 2.5Y, or 5Y and value of 4 or 5 and dominantly has chroma of 1. The Bt horizon commonly is medium acid or strongly acid in the most acid part. In some pedons, calcium carbonates have been replenished by seepage water and reaction varies.

Colo Series

The Colo series consists of poorly drained, moderately permeable soils on flood plains, alluvial fans, and the lower parts of upland drainageways. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 5 percent.

Colo soils commonly are adjacent to Ackmore, Judson, Kennebec, Wabash, and Zook soils. Ackmore soils have a surface layer that is stratified in color and have a buried soil within a depth of 36 inches. They are in positions on the landscape similar to those of the Colo soils. Judson soils are well drained and are on alluvial fans and in upland drainageways. Kennebec soils contain less clay than the Colo soils. They are on flood plains. The average content of clay in the very slowly permeable Wabash and slowly permeable Zook soils is more than 35 percent. These soils are generally farther from the stream channel on flood plains than the Colo soils.

Typical pedon of Colo silty clay loam, 0 to 2 percent slopes, in a cultivated field; 2,360 feet south and 200 feet east of the northwest corner of sec. 25, T. 78 N., R. 36 W.

Ap—0 to 11 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.

A1—11 to 25 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few fine strong brown (7.5YR 5/8) and black (10YR 2/1) concretions (iron and manganese oxides); slightly acid; diffuse smooth boundary.

A2—25 to 35 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct brown (7.5YR 5/4) mottles; moderate coarse prismatic structure parting to weak fine subangular blocky; friable; few fine strong brown (7.5YR 5/8) and black (10YR 2/1) concretions (iron and manganese oxides); slightly acid; diffuse smooth boundary.

AC—35 to 49 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct brown (7.5YR 5/4) mottles; moderate coarse prismatic structure parting to moderate medium blocky; friable; slightly acid; diffuse smooth boundary.

Cg1—49 to 58 inches; very dark gray (10YR 3/1) silty clay loam; weak coarse prismatic structure parting to weak coarse blocky; firm; neutral; diffuse smooth boundary.

Cg2—58 to 60 inches; dark gray (10YR 4/1) silty clay loam; weak coarse prismatic structure parting to weak coarse blocky; firm; few fine yellowish red (5YR 5/8) concretions (iron oxide); neutral.

The thickness of the solum ranges from about 36 to 54 inches. The mollic epipedon is 36 or more inches thick. Reaction is neutral to medium acid in the surface layer and neutral or slightly acid below the surface layer. In some pedons stratified overwash sediments 6 to 18 inches thick overlie the A horizon.

The A horizon is neutral in hue or has hue of 5Y or 10YR. It has value of 2 or 3 and chroma of 0 or 1. In some pedons, low chroma mottles are as shallow as 24 inches in this horizon and the higher chroma mottles are below a depth of 36 inches. This horizon typically is silty clay loam in which the content of clay ranges from 27 to 35 percent. The content of clay in the Cg horizon generally is 32 to 35 percent.

Dickman Series

The Dickman series consists of well drained soils on convex side slopes in the uplands. Permeability is moderately rapid in the upper part of the profile and rapid in the lower part. These soils formed dominantly in wind-deposited sand. The native vegetation was prairie grasses. Slope ranges from 9 to 14 percent.

Dickman soils commonly are adjacent to Marshall soils. The adjacent soils formed in loess. Their solum is dominantly silty clay loam. Their positions on the landscape are similar to those of the Dickman soils.

Typical pedon of Dickman sandy loam in an area of Dickman-Marshall complex, 9 to 14 percent slopes, in a cultivated field; 780 feet north and 580 feet east of the southwest corner of sec. 26, T. 79 N., R. 35 W.

Ap—0 to 6 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; strongly acid; abrupt smooth boundary.

A1—6 to 9 inches; very dark brown (10YR 2/2) sandy loam, dark grayish brown (10YR 4/2) dry; mixed with some streaks and pockets of very dark grayish brown (10YR 3/2); weak fine subangular blocky structure parting to weak fine granular; friable; strongly acid; abrupt smooth boundary.

A2—9 to 16 inches; very dark grayish brown (10YR 3/2) sandy loam; weak fine subangular blocky structure; very friable; medium acid; gradual smooth boundary.

Bw—16 to 24 inches; brown (10YR 4/3) loamy sand; single grained; very friable; medium acid; gradual smooth boundary.

BC—24 to 48 inches; dark yellowish brown (10YR 4/4) loamy sand; single grained; loose; less than 5 percent coarse sand; medium acid; gradual smooth boundary.

C—48 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; medium acid.

The thickness of the solum ranges from 30 to 50 inches. The depth to loamy sand or sand ranges from 12 to 20 inches.

The A horizon has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. It is coarse sandy loam, fine sandy loam, or sandy loam. The Bw horizon has hue of 10YR, value of 3 or 4 in the upper part and 4 or 5 in the lower part, and chroma of 3 or 4. It is coarse sandy loam to loamy sand. The C horizon is coarse sand to fine sand.

Exira Series

The Exira series consists of well drained, moderately permeable soils on convex and plane upland side slopes and to some extent in coves at the head of upland drainageways. These soils formed in loess. The native vegetation was prairie grasses. Slope ranges from 5 to 18 percent.

The Exira soils in this county are taxadjuncts to the series because their A horizon is not thick enough to qualify as a mollic epipedon.

Exira soils are similar to Marshall soils and commonly are adjacent to Adair, Ida, Marshall, Sharpsburg, and Shelby soils. Adair soils typically are lower on the landscape than the Exira soils. Also, they contain less silt and more clay. They formed in a paleosol. Ida soils are calcareous silt loam throughout. They are in upslope areas. Marshall and Sharpsburg soils do not have mottles within a depth of 30 inches. They are in positions on the landscape similar to those of the Exira soils. Shelby soils have a clay loam solum that formed in glacial till. They typically are downslope from the Exira soils.

Typical pedon of Exira silty clay loam, 5 to 9 percent slopes, moderately eroded, in a cultivated field; 1,320 feet north and 1,100 feet west of the southeast corner of sec. 1, T. 81 N., R. 36 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; mixed with some streaks and pockets of brown (10YR 4/3) subsoil material; moderate fine subangular blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.

Bw1—8 to 16 inches; brown (10YR 4/3) silty clay loam; some very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) coatings on faces of peds and in root channels; weak fine subangular blocky structure; friable; medium acid; abrupt smooth boundary.

Bw2—16 to 22 inches; brown (10YR 4/3) silt loam; common fine distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/8) and few fine distinct reddish brown (5YR 4/4) mottles; weak fine subangular blocky structure; friable; few medium black (10YR 2/1) concretions (manganese oxide) and stains; medium acid; gradual smooth boundary.

Bw3—22 to 34 inches; brown (10YR 4/3) silt loam; some discontinuous brown (7.5YR 4/2) coatings on faces of peds; common fine distinct light brownish gray (2.5Y 6/2) and reddish brown (5YR 4/4) and few fine distinct yellowish red (5YR 5/8) mottles; weak fine subangular blocky structure; friable; few medium black (10YR 2/1) concretions (manganese oxide) and stains; medium acid; gradual smooth boundary.

BC1—34 to 41 inches; light brownish gray (2.5Y 6/2) silt loam; some brown (7.5YR 4/2) coatings on faces of prisms and in root channels; many medium and fine distinct yellowish red (5YR 5/8) mottles and streaks and few fine distinct reddish brown (5YR 4/4) mottles; weak medium prismatic structure; friable; few fine black (10YR 2/1) concretions (manganese oxide); slightly acid; gradual smooth boundary.

BC2—41 to 49 inches; light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/4) silt loam; few fine distinct reddish brown (5YR 4/4) and yellowish red (5YR 5/6) mottles; weak medium prismatic structure parting to weak fine subangular blocky; friable; few medium and fine black (10YR 2/1) streaks and concretions (manganese oxide); neutral; gradual smooth boundary.

C—49 to 60 inches; light brownish gray (2.5Y 6/2) and brown (7.5YR 5/4) silt loam; few fine distinct reddish brown (5YR 4/4) mottles; massive; friable; many very fine black (10YR 2/1) concretions (manganese oxide); neutral.

The thickness of the solum typically is more than 40 inches but ranges from 30 to 50 inches. The thickness of the A horizon, the thickness of the B horizon, and the depth to gray mottles decrease as slope increases. The gray mottled colors are not indicative of present drainage conditions.

The A horizon typically has hue of 10YR, value of 2 or 3, and chroma of 1 or 2. The content of clay in this horizon is 28 to 34 percent. The Bw horizon typically is brown (10YR 4/3). It has dark coatings in some pedons. Light brownish gray (2.5Y 6/2), reddish brown (5YR 4/4), grayish brown (2.5Y 5/2), or yellowish brown (10YR 5/4) mottles are common in the lower part of this horizon, typically within 12 inches of the bottom of the A horizon and within a depth of 30 inches. The BC and C horizons are silt loam or silty clay loam.

Gara Series

The Gara series consists of moderately well drained, moderately slowly permeable soils on convex or plane upland side slopes and in slightly concave coves in upland drainageways. These soils formed in glacial till. The native vegetation was mixed prairie grasses and deciduous trees. Slope ranges from 14 to 40 percent.

Gara soils are similar to Shelby soils and commonly are adjacent to Adair, Knox, Marshall, and Sharpsburg soils. Shelby soils do not have an E horizon. Adair soils are upslope from the Gara soils. They formed in a paleosol. Knox, Marshall, and Sharpsburg soils formed in loess. They typically are upslope from the Gara soils.

Typical pedon of Gara loam, 14 to 18 percent slopes, in a pasture; 1,800 feet west and 440 feet south of the center of sec. 36, T. 78 N., R. 36 W.

A—0 to 6 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; slightly acid; clear smooth boundary.

E—6 to 9 inches; dark grayish brown (10YR 4/2) loam; mixed with some very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2) when dry; weak medium platy structure parting to weak fine granular; friable; very strongly acid; clear smooth boundary.

Bt1—9 to 15 inches; brown (10YR 4/3) loam; some dark grayish brown (10YR 4/2) coatings on faces of peds; moderate medium and fine angular blocky and subangular blocky structure; friable; thin nearly continuous clay films on faces of peds; few pebbles; very strongly acid; gradual smooth boundary.

Bt2—15 to 20 inches; dark yellowish brown (10YR 4/4) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate medium and fine angular and subangular blocky; firm; thin continuous clay films on faces of prisms; few pebbles; very strongly acid; gradual smooth boundary.

Bt3—20 to 29 inches; yellowish brown (10YR 5/6) clay loam; discontinuous brown (7.5YR 4/2) coatings on faces of prisms and in root channels; common fine distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to moderate medium and fine angular and subangular blocky; firm; thin continuous clay films on faces of prisms; few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); very strongly acid; gradual smooth boundary.

Bt4—29 to 41 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) and few medium distinct strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to moderate fine angular blocky; firm; thin discontinuous clay films on faces of prisms; few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); very strongly acid; gradual smooth boundary.

Bt5—41 to 48 inches; yellowish brown (10YR 5/6) clay loam; common fine distinct grayish brown (2.5Y 5/2) and few fine distinct strong brown (7.5YR 5/8) mottles; weak coarse prismatic structure parting to moderate fine angular blocky; firm; brown (7.5YR 4/2) coatings in root channels; thin discontinuous clay films on faces of prisms; few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); strongly acid; gradual smooth boundary.

C—48 to 60 inches; yellowish brown (10YR 5/4) and gray (10YR 5/1) clay loam; common fine distinct strong brown (7.5YR 5/6) and few fine distinct yellowish red (5YR 4/6) mottles; massive; firm; few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); slightly acid.

The thickness of the solum and the depth to carbonates range from 36 to 70 inches. The total thickness of the A and E horizons, the maximum content of clay, the thickness of the Bt horizon, and the depth to carbonates and grayish mottles decrease as slope increases.

The A horizon typically is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). It is loam or silt loam. The Bt horizon has hue of 10YR or 7.5YR, value of 4 or 5, and chroma of 3 to 6. It ranges from medium acid to very strongly acid.

Ida Series

The Ida series consists of well drained, moderately permeable soils on low, narrow interfluves and on convex side slopes in the uplands. These soils formed in loess. The native vegetation was prairie grasses. Slope ranges from 5 to 9 percent.

Ida soils commonly are adjacent to Adair, Exira, and Marshall soils. Adair soils are lower on the landscape than the Ida soils. Also, they contain less silt and more clay. They formed in a paleosol. Exira and Marshall soils have a silty clay loam surface layer and silty clay loam subsoil horizons. They typically are not calcareous within a depth of 40 inches. They generally are in positions on the landscape similar to those of the Ida soils.

Typical pedon of Ida silt loam, 5 to 9 percent slopes, severely eroded, in a cultivated field; 740 feet north and 290 feet east of the southwest corner of sec. 5, T. 81 N., R. 36 W.

Ap—0 to 7 inches; brown (10YR 4/3) silt loam, brown (10YR 4/3) rubbed, grayish brown (10YR 5/2) dry; some dark brown (10YR 3/3) coatings; weak fine granular structure; very friable; few calcium carbonate nodules; slight effervescence; mildly alkaline; abrupt smooth boundary.

C1—7 to 16 inches; yellowish brown (10YR 5/4) silt loam; common fine faint light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles in the lower part; weak fine subangular blocky structure; very friable; few calcium carbonate nodules; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—16 to 30 inches; yellowish brown (10YR 5/4) silt loam; common fine distinct light brownish gray (2.5Y

6/2) and few fine distinct yellowish brown (10YR 5/6) mottles; massive; very friable; few calcium carbonate nodules; few fine black (10YR 2/1) concretions (manganese oxide); strong effervescence; mildly alkaline; diffuse smooth boundary.

C3—30 to 60 inches; yellowish brown (10YR 5/4) silt loam; common fine distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles; massive; very friable; few calcium carbonate nodules; few fine black (10YR 2/1) concretions (manganese oxide); slight effervescence; mildly alkaline.

The thickness of the solum is less than 10 inches. It is the same as the thickness of the A or Ap horizon.

The A horizon is brown (10YR 4/3 or 5/3) or dark grayish brown (10YR 4/2). It is neutral to moderately alkaline. The C horizon typically is yellowish brown (10YR 5/4 or 5/6), but it has value of 4 or 5 and chroma of 3 to 6. It has few or common mottles, which generally are 6 to 18 inches below the bottom of the A horizon. The content of clay in the C horizon commonly is 18 to 25 percent. It decreases with increasing depth. Calcium carbonates typically are throughout the profile, but in some pedons they do not occur in the A or Ap horizon.

Judson Series

The Judson series consists of well drained, moderately permeable soils on foot slopes in the uplands, on alluvial fans, and in upland drainageways. These soils formed in moderately fine textured sediments, which eroded mostly from adjacent upland soils formed in loess. The native vegetation was prairie grasses. Slope ranges from 2 to 9 percent.

Judson soils are similar to Kennebec soils and commonly are adjacent to Ackmore, Colo, Marshall, and Sharpsburg soils. Kennebec soils are moderately well drained. Ackmore soils have a silt loam surface layer that is stratified in color and have a buried soil within a depth of 36 inches. Ackmore and Colo soils are poorly drained. They are in positions on the landscape similar to those of the Judson soils. Marshall and Sharpsburg soils are higher on the landscape than the Judson soils. Also, their A horizon is thinner, and their B horizon is more strongly expressed.

Typical pedon of Judson silty clay loam, 2 to 5 percent slopes, in a cultivated field; 1,095 feet north and 745 feet east of the center of sec. 20, T. 80 N., R. 35 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—9 to 16 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; medium acid; gradual smooth boundary.

A2—16 to 24 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

AB—24 to 29 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; very dark brown (10YR 2/2) coatings on faces of peds; weak medium and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

Bw1—29 to 41 inches; dark brown (10YR 3/3) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate medium and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

Bw2—41 to 48 inches; brown (10YR 4/3) silty clay loam; dark brown (10YR 3/3) coatings on faces of peds; moderate medium subangular blocky structure; friable; slightly acid; gradual smooth boundary.

BC—48 to 60 inches; brown (10YR 4/3) silty clay loam; moderate coarse subangular blocky structure; friable; neutral.

The thickness of the solum ranges from 40 to more than 60 inches. The thickness of the A horizon ranges from 20 to 36 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. The content of clay in this horizon ranges from 25 to 32 percent. Reaction ranges from neutral to medium acid. The Bw and BC horizons have value and chroma of 3 or 4. In some pedons value of 3 extends to a depth of 40 to 60 inches.

Kennebec Series

The Kennebec series consists of moderately well drained, moderately permeable soils on flood plains. These soils formed in medium textured alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Kennebec soils are similar to Judson soils and commonly are adjacent to Ackmore, Colo, Nodaway, and Zook soils. Judson soils are well drained and are on foot slopes. Ackmore, Colo, and Zook soils are poorly drained and are commonly farther from the stream channels than the Kennebec soils. Nodaway soils do not have a mollic epipedon. Their positions on the landscape are similar to those of the Kennebec soils.

Typical pedon of Kennebec silt loam, 0 to 2 percent slopes, in a cultivated field; 670 feet west and 75 feet north of the center of sec. 36, T. 78 N., R. 36 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; slightly acid; abrupt smooth boundary.

A1—9 to 18 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak thin platy structure parting to weak medium and fine granular; friable; slightly acid; clear smooth boundary.

A2—18 to 32 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; diffuse smooth boundary.

AC—32 to 40 inches; very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; few fine yellowish brown (10YR 5/6) concretions (iron oxide); some wormholes and wormcasts; medium acid; diffuse smooth boundary.

C1—40 to 49 inches; very dark gray (10YR 3/1) silt loam; weak fine subangular blocky structure; friable; few fine yellowish brown (10YR 5/6) concretions (iron oxide); few wormholes and wormcasts; less than 10 percent fine sand and very fine sand; medium acid; diffuse smooth boundary.

C2—49 to 60 inches; very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) crushed; massive; friable; some very fine yellowish brown (10YR 5/6) concretions (iron oxide); less than 10 percent fine sand and very fine sand; medium acid.

The solum and the mollic epipedon typically are more than 36 inches thick. The content of fine sand or coarser sand typically is less than 10 percent in the upper 40 inches.

The A horizon is black (10YR 2/1), very dark brown (10YR 2/2), or very dark gray (10YR 3/1). Value commonly increases 1 or 2 units with increasing depth, but chroma remains 1 or 2 to a depth of 60 inches or more. The content of clay in the A and C horizons typically is 24 to 30 percent.

Knox Series

The Knox series consists of well drained, moderately permeable soils on ridges and side slopes in the uplands. These soils formed in loess. The native vegetation was mixed prairie grasses and deciduous trees. Slope ranges from 5 to 25 percent.

Knox soils commonly are adjacent to Gara and Marshall soils. Gara soils typically are loam in the upper part. They formed in glacial till on the lower parts of the landscape. Marshall soils have a silty clay loam surface layer and do not have an E horizon. Their positions on the landscape are similar to those of the Knox soils.

Typical pedon of Knox silt loam, 5 to 9 percent slopes, in a pasture; 1,460 feet north and 400 feet west of the southeast corner of sec. 28, T. 79 N., R. 35 W.

A—0 to 6 inches; very dark brown (10YR 2/2) silt loam, grayish brown (10YR 5/2) dry; weak thin platy structure parting to weak fine granular; friable; neutral; clear smooth boundary.

E—6 to 12 inches; dark grayish brown (10YR 4/2) silt loam, brown (10YR 5/3) dry; weak thin platy structure parting to weak fine subangular blocky; friable; neutral; abrupt smooth boundary.

BE—12 to 15 inches; brown (10YR 4/3) silt loam; weak fine subangular blocky structure; friable; common thin discontinuous light gray (10YR 7/2) silt coatings on faces of peds when dry; neutral; clear smooth boundary.

Bt1—15 to 22 inches; yellowish brown (10YR 5/4) silty clay loam; brown (10YR 4/3) coatings on faces of peds; moderate medium and fine angular and subangular blocky structure; friable; common thin discontinuous light gray (10YR 7/2) silt coatings on faces of peds when dry; thin nearly continuous clay films on faces of peds; medium acid; clear smooth boundary.

Bt2—22 to 32 inches; dark yellowish brown (10YR 4/4) silty clay loam; weak fine prismatic structure parting to moderate medium and fine angular and subangular blocky; friable; few thin discontinuous light gray (10YR 7/2) silt coatings on faces of prisms when dry; thin discontinuous clay films on faces of prisms; medium acid; gradual smooth boundary.

Bt3—32 to 42 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine prismatic structure parting to moderate medium and fine angular and subangular blocky; friable; few thin discontinuous light gray (10YR 7/2) silt coatings on faces of prisms when dry; thin discontinuous clay films on faces of prisms; medium acid; gradual smooth boundary.

Bt4—42 to 50 inches; dark yellowish brown (10YR 4/4) silty clay loam; few fine distinct grayish brown (2.5Y 5/2) and few very fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular and angular blocky; friable; few thin discontinuous light gray (10YR 7/1) silt coatings on faces of prisms when dry; thin discontinuous clay films on faces of prisms; medium acid; gradual smooth boundary.

C—50 to 60 inches; yellowish brown (10YR 5/4) silty clay loam; few medium distinct yellowish brown (10YR 5/8) mottles; massive; friable; few thin patchy light gray (10YR 7/1) silt coatings when dry; some fine black (10YR 2/1) concretions (manganese oxide); medium acid.

The thickness of the solum ranges from 36 to more than 60 inches. The A horizon has hue of 10YR and value and chroma of 2 or 3. The Bt horizon has hue of

10YR, value of 4 or 5, and chroma of 4 to 6. It is silt loam or silty clay loam. The content of clay in this horizon is 25 to 35 percent. The depth to carbonates ranges from 4 to 7 feet or more.

Lamoni Series

The Lamoni series consists of somewhat poorly drained, slowly permeable or very slowly permeable soils on convex side slopes in the uplands. These soils formed in loess and a grayish brown paleosol that formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 9 to 14 percent.

The Lamoni soils in this county are taxadjuncts to the series because their A horizon is not thick enough to qualify as a mollic epipedon.

Lamoni soils are similar to Adair soils and commonly are adjacent to Exira, Marshall, and Shelby soils. The B horizon of Adair soils is redder than that of the Lamoni soils and commonly has a stone line in the upper part. Exira and Marshall soils formed entirely in loess. They typically are upslope from the Lamoni soils. Shelby soils are lower on the landscape than the Lamoni soils. Also, their Bt horizon has a lower content of clay, and their B horizon is lighter colored.

Typical pedon of Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded, in a cultivated field; 1,600 feet east and 305 feet north of the center of sec. 14, T. 81 N., R. 34 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; some streaks and pockets of dark brown (10YR 3/3) organic stains in the lower part; weak fine subangular blocky structure parting to weak fine granular; friable; few fine black (10YR 2/1) concretions (manganese oxide); neutral; abrupt wavy boundary.

2Bt1—9 to 16 inches; dark grayish brown (10YR 4/2) clay; few fine distinct brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; moderate fine subangular blocky structure; very firm; thick nearly continuous clay films on faces of peds; some coarse sand grains and very fine pebbles; some fine black (10YR 2/1) concretions (manganese oxide); neutral; gradual smooth boundary.

2Bt2—16 to 24 inches; dark grayish brown (10YR 4/2) clay; many medium distinct grayish brown (10YR 5/2), common fine distinct brown (7.5YR 4/4), and few fine distinct strong brown (7.5YR 5/6) mottles; moderate fine angular and subangular blocky structure; very firm; thick nearly continuous clay films on faces of peds; some coarse sand grains and very fine pebbles; some fine black (10YR 2/1) concretions (manganese oxide); neutral; clear smooth boundary.

2Bt3—24 to 33 inches; grayish brown (10YR 5/2) clay; many medium distinct yellowish brown (10YR 5/6), common fine distinct strong brown (7.5YR 5/6) and dark grayish brown (10YR 4/2), few fine distinct brown (7.5YR 4/4), and few medium distinct gray (10YR 5/1) mottles; moderate coarse prismatic structure parting to moderate fine angular and subangular blocky; very firm; thin discontinuous clay films on faces of prisms; some coarse sand grains and very fine pebbles; few fine black (10YR 2/1) concretions (manganese oxide); neutral; gradual smooth boundary.

2Bt4—33 to 48 inches; grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) clay loam; few fine distinct brown (7.5YR 4/4) and few medium distinct gray (10YR 5/1) mottles; moderate coarse prismatic structure parting to moderate fine subangular blocky; firm; thin discontinuous clay films on faces of prisms; some coarse sand grains and fine and very fine pebbles; some dark organic stains in root channels; neutral; clear smooth boundary.

2C—48 to 60 inches; yellowish brown (10YR 5/6) clay loam; few fine distinct grayish brown (10YR 5/2), strong brown (7.5YR 5/6), and red (2.5YR 4/6) mottles; massive; firm; some coarse sand grains and very fine pebbles; many medium black (10YR 2/1) concretions (manganese oxide); neutral.

The thickness of the solum ranges from 40 to 60 inches. The A horizon typically is silty clay loam, but the range includes loam and clay loam. This horizon is black (10YR 2/1), very dark gray (10YR 3/1), very dark brown (10YR 2/2), or very dark grayish brown (10YR 3/2). The color and texture of the B horizon vary, depending mainly on the remaining amount of the truncated paleosol. The part of the B horizon that is clay typically is 12 to 24 inches thick. The content of clay in the finest textured part of this horizon commonly is 40 to 50 percent.

Marshall Series

The Marshall series consists of well drained, moderately permeable soils on ridges and side slopes in the uplands and to some extent on high stream benches. These soils formed in loess. The native vegetation was prairie grasses. Slope ranges from 0 to 20 percent.

Marshall soils are similar to Exira soils and commonly are adjacent to Adair, Clarinda, Dickman, Exira, and Shelby soils. Exira soils have relict grayish mottles within a depth of 30 inches and commonly have a silt loam subsoil. Adair and Clarinda soils formed in a paleosol. They have a higher content of clay than the Marshall soils. Also, they typically are lower on the landscape. Dickman soils are coarse textured or moderately coarse textured throughout. They are in positions on the landscape similar to those of the Marshall soils. Shelby soils typically have a clay loam solum, which formed in glacial till. They typically are downslope from the Marshall soils.

Typical pedon of Marshall silty clay loam, 2 to 5 percent slopes, in a cultivated field; 1,680 feet north and 1,300 feet west of the southeast corner of sec. 27, T. 81 N., R. 35 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.

A—9 to 14 inches; very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; gradual smooth boundary.

AB—14 to 20 inches; very dark grayish brown (10YR 3/2) silty clay loam; mixed with some brown (10YR 4/3) in the lower part; grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; clear smooth boundary.

Bw1—20 to 27 inches; brown (10YR 4/3) silty clay loam; mixed with some very dark grayish brown (10YR 3/2) in the upper part; weak medium and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

Bw2—27 to 34 inches; brown (10YR 4/3) silty clay loam; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; some thin discontinuous clay films on faces of prisms; medium acid; gradual smooth boundary.

Bw3—34 to 42 inches; brown (10YR 4/3) silty clay loam; few medium distinct grayish brown (2.5Y 5/2) and few fine distinct brown (7.5YR 4/4) mottles; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; few thin discontinuous clay films on faces of prisms; medium acid; gradual smooth boundary.

BC—42 to 57 inches; brown (10YR 5/3) silt loam; many medium distinct grayish brown (2.5Y 5/2), common fine distinct brown (7.5YR 4/4) and reddish brown (5YR 4/4), and few fine distinct strong brown (7.5YR 5/6) mottles; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; some fine root holes and channels; common fine black (10YR 2/1) concretions (manganese oxide); slightly acid; gradual smooth boundary.

C—57 to 60 inches; grayish brown (2.5Y 5/2) silt loam; many medium distinct yellowish brown (10YR 5/6) mottles and streaks and common medium distinct brown (7.5YR 4/4) mottles; massive; friable; some fine root holes and channels; common fine black (10YR 2/1) concretions (manganese oxide); slightly acid.

The thickness of the solum ranges from 40 to 70 inches. The thickness of the mollic epipedon typically decreases as slope increases.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The content of clay in this horizon ranges from 25 to 35 percent. The Bw horizon has value and chroma of 3 or 4. The darker colors are in the upper part. Mottles typically do not occur within a depth of 30 inches but in some pedons are as shallow as 26 inches. The content of clay in the Bw horizon ranges from 27 to 34 percent. The BC and C horizons have hue of 10YR to 5Y, value of 4 or 5, and chroma of 2 to 6. Reaction is medium acid or slightly acid in the A and Bw horizons and neutral or slightly acid in the BC and C horizons.

The moderately eroded and severely eroded Marshall soils and the Marshall soil in the Dickman-Marshall complex, 9 to 14 percent slopes, are taxadjuncts to the Marshall series because their A horizon is not thick enough to qualify as a mollic epipedon.

Nodaway Series

The Nodaway series consists of moderately well drained, moderately permeable soils on flood plains. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Nodaway soils commonly are adjacent to Ackmore, Colo, Kennebec, and Zook soils. The adjacent soils commonly are farther from the main stream channel than the Nodaway soils. Ackmore soils have a dark buried soil within a depth of 20 to 36 inches. Colo and Zook soils have a thick, dark, nonstratified A horizon. They have a higher content of clay than the Nodaway soils. Kennebec soils have a thick, nonstratified A horizon.

Typical pedon of Nodaway silt loam, 0 to 2 percent slopes, in a cultivated field; 2,380 feet west and 100 feet north of the southeast corner of sec. 8, T. 79 N., R. 34 W.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

C—8 to 60 inches; stratified dark grayish brown (10YR 4/2), very dark gray (10YR 3/1), grayish brown (10YR 5/2), and brown (10YR 5/3) silt loam; massive; friable; some very thin fine strata of silty clay loam; some fine brown (7.5YR 4/4) stains (iron oxide) in the upper part; slightly acid.

The Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The strata in the C horizon generally have hue of 10YR, value of 4 or 5, and chroma of 2 to 4, but some have hue of 10YR, value of 3, and chroma of 1 or 2. The C horizon is neutral or slightly acid.

Olmitz Series

The Olmitz series consists of moderately well drained, moderately permeable soils on alluvial fans and slightly concave or plane foot slopes. These soils formed in loamy local alluvium derived from glacial till. The native vegetation was prairie grasses. Slope ranges from 5 to 9 percent.

Olmitz soils commonly are adjacent to Gara, Judson, and Shelby soils. Gara and Shelby soils formed in glacial till. They contain some pebbles. They are higher on the landscape than the Olmitz soils. Also, their A horizon is thinner and their B horizon more strongly expressed. Judson soils have a low content of sand. They are in positions on the landscape similar to those of the Olmitz soils.

Typical pedon of Olmitz loam, 5 to 9 percent slopes, in a cultivated field; 1,800 feet north and 500 feet east of the southwest corner of sec. 31, T. 78 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine granular structure; friable; neutral; abrupt smooth boundary.

A1—8 to 14 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium and fine subangular blocky and moderate fine granular structure; friable; neutral; gradual smooth boundary.

A2—14 to 21 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; moderate medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

AB—21 to 30 inches; very dark grayish brown (10YR 3/2) clay loam, very dark grayish brown (10YR 3/2) kneaded, dark grayish brown (10YR 4/2) and grayish brown (10YR 5/2) dry; very dark brown (10YR 2/2) organic coatings; moderate medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

Bw1—30 to 35 inches; dark brown (10YR 3/3) clay loam; some very dark grayish brown (10YR 3/2) organic coatings; weak coarse prismatic structure parting to weak fine subangular blocky; friable; medium acid; gradual smooth boundary.

Bw2—35 to 47 inches; brown (10YR 4/3) clay loam; dark brown (10YR 3/3) faces of peds; some very dark grayish brown (10YR 3/2) organic coatings; weak coarse prismatic and weak coarse blocky structure parting to weak fine subangular blocky; friable; medium acid; gradual smooth boundary.

BC—47 to 60 inches; brown (10YR 4/3) clay loam; some very dark grayish brown (10YR 3/2) organic coatings; few fine distinct yellowish brown (10YR 5/4) mottles; weak fine subangular blocky structure; friable; few fine strong brown (7.5YR 5/8) concretions (iron oxide); medium acid.

The thickness of the solum typically is more than 40 inches but ranges from 36 to 65 inches. The A horizon is loam or clay loam. The Bw horizon typically is clay loam in which the content of clay ranges from 28 to 34 percent. It typically is slightly acid or medium acid in the most acid part, but the range includes strongly acid.

Sharpsburg Series

The Sharpsburg series consists of moderately well drained soils on ridges and side slopes in the uplands. These soils are moderately slowly permeable in the upper part and moderately permeable in the lower part. They formed in loess. The native vegetation was prairie grasses. Slope ranges from 2 to 14 percent.

The Sharpsburg soils in this county are taxadjuncts to the series because the average content of clay in the Bt horizon is less than 36 percent.

Sharpsburg soils commonly are adjacent to Adair, Clarinda, Exira, and Shelby soils. Adair and Clarinda soils formed in a paleosol that formed in glacial till. They have a higher content of clay than the Sharpsburg soils. Also, they typically are lower on the landscape. Exira soils have grayish relict mottles within a depth of 30 inches. They are in positions on the landscape similar to those of the Sharpsburg soils. Shelby soils typically have a clay loam solum that contains some pebbles. They formed in glacial till, generally on the lower parts of the landscape.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, in a cultivated field; 665 feet west and 285 feet south of the northeast corner of sec. 35, T. 78 N., R. 34 W.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam (33.1 percent clay), grayish brown (10YR 5/2) dry; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A—9 to 14 inches; very dark grayish brown (10YR 3/2) silty clay loam (29.3 percent clay), grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure parting to weak fine granular; friable; medium acid; gradual smooth boundary.

BA—14 to 18 inches; dark brown (10YR 3/3) silty clay loam (33.5 percent clay); some very dark grayish brown (10YR 3/2) coatings on faces of peds; weak very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

Bt1—18 to 24 inches; brown (10YR 4/3) silty clay loam (35.9 percent clay); moderate fine subangular blocky structure; friable; few thin discontinuous clay films on faces of peds; medium acid; gradual smooth boundary.

Bt2—24 to 31 inches; brown (10YR 4/3) silty clay loam (33.6 percent clay); weak fine prismatic structure parting to moderate medium and fine subangular blocky; friable; few thin discontinuous clay films on faces of prisms; few fine black (10YR 2/1) concretions (manganese oxide); medium acid; gradual smooth boundary.

Bt3—31 to 39 inches; brown (10YR 4/3) silty clay loam (31.3 percent clay); common fine distinct grayish brown (2.5Y 5/2) and brown (7.5YR 4/4) and few fine distinct yellowish brown (10YR 5/6) mottles; weak fine prismatic structure; friable; few thin discontinuous clay films on faces of prisms; few fine black (10YR 2/1) concretions (manganese oxide); medium acid; gradual smooth boundary.

Bt4—39 to 48 inches; mottled grayish brown (2.5Y 5/2), brown (7.5YR 4/4), and yellowish brown (10YR 5/6) silty clay loam (30.5 percent clay); weak medium prismatic structure; friable; few thin discontinuous clay films on faces of prisms; few fine black (10YR 2/1) concretions (manganese oxide); slightly acid; gradual smooth boundary.

C—48 to 60 inches; mottled light brownish gray (2.5Y 6/2), brown (7.5YR 4/4), and yellowish brown (10YR 5/6) silty clay loam (27.4 percent clay); massive; very friable; many fine black (10YR 2/1) concretions (manganese oxide); slightly acid.

The thickness of the solum ranges from 42 to 72 inches. The thickness of the solum, the depth to the horizon that has the highest content of clay, the depth to gray mottles, and the thickness of the A and Bt horizons decrease as slope increases.

The A horizon typically is about 8 to 20 inches thick. It has hue of 10YR and value and chroma of 2 or 3. It typically is silty clay loam in which the content of clay ranges from 28 to 34 percent. Mottles with hue of 7.5YR or 10YR, value of 4 or 5, and chroma of 4 to 8 and hue of 2.5Y, value of 4 to 6, and chroma of 2 commonly are in the lower part of the Bt horizon and in the C horizon. The C horizon typically is silty clay loam but commonly grades to silt loam at a depth of about 70 inches.

Shelby Series

The Shelby series consists of moderately well drained, moderately slowly permeable soils on narrow ridges and side slopes and in concave coves in drainageways on uplands. These soils formed in glacial till. The native vegetation was prairie grasses. Slope ranges from 5 to 25 percent.

The Shelby soils in this county are taxadjuncts to the series because their A horizon is not thick enough to qualify as a mollic epipedon.

Shelby soils are similar to Gara soils and commonly are adjacent to Adair, Clarinda, Exira, Marshall, and Sharpsburg soils. Adair, Clarinda, and Gara soils are in positions on the landscape similar to those of the Shelby soils. Gara soils have an E horizon. The upper part of the B horizon in Adair soils has a redder hue than that of the Shelby soils or has reddish mottles. The B horizon in Clarinda soils typically is gray or dark gray and is finer textured than that of the Shelby soils. Exira, Marshall, and Sharpsburg soils formed in loess. They typically are upslope from the Shelby soils.

Typical pedon of Shelby clay loam, 14 to 18 percent slopes, severely eroded, in a cultivated field; 2,450 feet west and 195 feet south of the northeast corner of sec. 23, T. 79 N., R. 34 W.

Ap—0 to 6 inches; dark brown (10YR 3/3), brown (10YR 4/3), and yellowish brown (10YR 5/4) clay loam, dark grayish brown (10YR 4/2), grayish brown (10YR 5/2), and light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

BA—6 to 11 inches; yellowish brown (10YR 5/4) clay loam; mixed with considerable dark brown (10YR 3/3) and brown (10YR 4/3); weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bt1—11 to 20 inches; yellowish brown (10YR 5/4) clay loam; few fine distinct strong brown (7.5YR 5/6) mottles; moderate medium and fine subangular and angular blocky structure; firm; thin nearly continuous clay films; some coarse sand and few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); slightly acid; gradual smooth boundary.

Bt2—20 to 29 inches; yellowish brown (10YR 5/4) clay loam; many fine distinct strong brown (7.5YR 5/6) and common fine distinct light brownish gray (2.5Y 6/2) mottles; weak medium and fine subangular and angular blocky structure; firm; thin nearly continuous clay films; some coarse sand and few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); medium acid; clear smooth boundary.

Bt3—29 to 40 inches; yellowish brown (10YR 5/4) clay loam; many medium distinct strong brown (7.5YR 5/6) and light brownish gray (2.5Y 6/2) and common fine distinct strong brown (7.5YR 5/8) mottles; weak medium prismatic structure parting to weak medium and fine angular and subangular blocky; firm; thin nearly continuous clay films on vertical faces of prisms; some coarse sand and few pebbles and stones; few fine black (10YR 2/1) concretions (manganese oxide); medium acid; gradual smooth boundary.

BC—40 to 44 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct strong brown (7.5YR 5/6) and light brownish gray (2.5Y 6/2) and common fine distinct strong brown (7.5YR 5/8) mottles; weak medium prismatic structure; firm; some coarse sand and few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); neutral; abrupt smooth boundary.

C—44 to 60 inches; yellowish brown (10YR 5/6) clay loam; nearly continuous light brownish gray (2.5Y 6/2) coatings on vertical faces of peds; common fine distinct strong brown (7.5YR 5/8) mottles;

massive; some vertical cleavage; firm; some coarse sand and few pebbles; few fine black (10YR 2/1) concretions (manganese oxide); some fine yellowish red (5YR 5/8) concretions (iron oxide); few calcium carbonate nodules; slight effervescence; mildly alkaline.

The thickness of the solum ranges from 40 to 50 inches. The depth to carbonates commonly ranges from 40 to 60 inches but is as shallow as 30 inches in some pedons. The thickness of the A horizon, the depth to the horizon that has the maximum content of clay, the thickness of the Bt horizon, the depth to relict mottles, the thickness of the solum, and the depth to carbonates typically decrease as slope increases.

The thickness of the A horizon typically is 8 inches but ranges to 12 inches. The Ap horizon has value of 2 to 5 and chroma of 2 to 4. It typically is clay loam or loam, but the range includes silt loam. The Bt horizon typically is 12 to 36 inches thick. It has hue of 10YR, value of 4 or 5, and chroma of 3 or 4. The content of clay in this horizon typically is 32 to 35 percent but in some pedons is as high as 38 percent. Reaction in the A, BA, Bt, and BC horizons is medium acid to neutral. The C horizon is neutral to moderately alkaline.

Wabash Series

The Wabash series consists of very poorly drained, very slowly permeable soils on flood plains. These soils formed in moderately fine textured and fine textured alluvium. The native vegetation was prairie grasses. Slope is 0 to 1 percent.

Wabash soils commonly are adjacent to Colo, Kennebec, and Zook soils. Their positions on the landscape are similar to those of the adjacent soils. Colo soils are moderately permeable. Their content of clay averages less than 35 percent. Kennebec soils are silt loam throughout. Zook soils are poorly drained and slowly permeable. Their content of clay averages less than 46 percent in the subsoil.

Typical pedon of Wabash silty clay loam, 0 to 1 percent slopes, in a cultivated field; 1,785 feet west and 520 feet south of the northeast corner of sec. 25, T. 78 N., R. 36 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (N 3/0) dry; weak fine granular structure; friable; medium acid; abrupt smooth boundary.

A1—8 to 12 inches; black (10YR 2/1) silty clay loam, very dark gray (N 3/0) dry; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

A2—12 to 18 inches; black (10YR 2/1) silty clay loam, very dark gray (N 3/0) dry; moderate fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

BA—18 to 24 inches; black (10YR 2/1) silty clay; weak medium prismatic structure parting to moderate fine subangular blocky; firm; few fine black (10YR 2/1) concretions (iron and manganese oxides); slightly acid; gradual smooth boundary.

Bw—24 to 32 inches; very dark gray (10YR 3/1) silty clay; moderate fine prismatic structure parting to moderate fine subangular blocky; very firm; few fine black (10YR 2/1) concretions (iron and manganese oxides); neutral; gradual smooth boundary.

Bg1—32 to 40 inches; very dark gray (10YR 3/1) silty clay, dark gray (5Y 4/1) kneaded; moderate medium and fine prismatic structure parting to moderate fine angular blocky; very firm; neutral; gradual smooth boundary.

Bg2—40 to 50 inches; dark gray (5Y 4/1) silty clay, gray (5Y 5/1) kneaded; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very firm; neutral; clear smooth boundary.

BCg1—50 to 59 inches; olive gray (5Y 4/2) silty clay; discontinuous dark gray (5Y 4/1) coatings on faces of prisms; common medium distinct olive gray (5Y 5/2) mottles; moderate medium prismatic structure parting to moderate medium and fine angular blocky; very firm; some fine black (10YR 2/1) concretions (iron and manganese oxides); neutral; gradual smooth boundary.

BCg2—59 to 60 inches; olive gray (5Y 4/2) silty clay; nearly continuous dark gray (5Y 4/1) coatings on faces of prisms; many fine distinct olive gray (5Y 5/2) and yellowish brown (10YR 5/6) mottles; moderate medium and fine prismatic structure parting to moderate medium and fine angular blocky; very firm; some fine black (10YR 2/1) concretions (iron and manganese oxides); neutral.

The thickness of the solum ranges from about 40 to more than 60 inches. The A horizon and the upper part of the B horizon are neutral in hue or have hue of 10YR to 5Y. They have value of 2 or 3 and chroma of 1 or 0. Below a depth of 36 inches, value is 4 or 5 in some pedons. The A horizon and the upper part of the B horizon are medium acid to neutral, and the lower part of the B horizon is slightly acid to mildly alkaline. The content of clay in the B horizon ranges from 40 to 50 percent.

Wiota Series

The Wiota series consists of well drained, moderately permeable soils on slightly convex, low stream terraces, commonly only a few feet above the flood plain. These soils formed in silty alluvium. The native vegetation was prairie grasses. Slope ranges from 1 to 4 percent.

Wiota soils commonly are adjacent to Ackmore, Colo, Wabash, and Zook soils. The adjacent soils generally are at the slightly lower elevations on the flood plains. Ackmore soils have a silt loam surface layer that is stratified in color. They have a buried soil within a depth of 36 inches. The poorly drained Colo and Zook and very poorly drained Wabash soils have a mollic epipedon that is thicker than that of the Wiota soils.

Typical pedon of Wiota silty clay loam, 1 to 4 percent slopes, in a cultivated field; 360 feet east and 270 feet south of the northwest corner of sec. 25, T. 78 N., R. 34 W.

Ap—0 to 8 inches; very dark brown (10YR 2/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.
A—8 to 13 inches; very dark grayish brown (10YR 3/2) silty clay loam; mixed with some dark brown (10YR 3/3); dark grayish brown (10YR 4/2) dry; some very dark brown (10YR 2/2) coatings; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.
AB—13 to 19 inches; very dark grayish brown (10YR 3/2) and brown (10YR 4/3) silty clay loam, dark grayish brown (10YR 4/2) and brown (10YR 5/3) dry; some very dark brown (10YR 2/2) coatings; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.
Bt1—19 to 30 inches; brown (10YR 4/3) silty clay loam; nearly continuous dark brown (10YR 3/3) coatings; moderate fine angular and subangular blocky structure; friable; thin nearly continuous clay films on faces of peds; some very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) organic stains on faces of peds and in root channels; slightly acid; clear smooth boundary.
Bt2—30 to 38 inches; brown (10YR 4/3) silty clay loam; some dark brown (10YR 3/3) coatings; moderate fine subangular blocky structure; friable; thin discontinuous clay films on faces of peds; some very dark gray (10YR 3/1) and very dark grayish brown (10YR 3/2) organic stains on faces of peds and in root channels; slightly acid; gradual smooth boundary.
BC—38 to 46 inches; brown (10YR 4/3) silty clay loam; some dark brown (10YR 3/3) coatings; few fine distinct light brownish gray (2.5Y 6/2) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; very dark grayish brown (10YR 3/2) organic stains in root channels; many very fine black (10YR 2/1) concretions (manganese oxide); slightly acid; gradual smooth boundary.
C—46 to 60 inches; brown (10YR 4/3) silty clay loam; common fine distinct light brownish gray (2.5Y 6/2), yellowish brown (10YR 5/6), and strong brown (7.5YR 5/6) mottles; massive; some vertical cleavage; friable; very dark grayish brown (10YR 3/2) coatings in root channels; many very fine black (10YR 2/1) concretions (manganese oxide); slightly acid.

The thickness of the solum typically is more than 40 inches but ranges from 36 to 60 inches. The A horizon ranges from 18 to 30 inches in thickness. It typically is black (10YR 2/1), very dark brown (10YR 2/2), very dark gray (10YR 3/1), or very dark grayish brown (10YR 3/2). It is slightly acid to strongly acid. The Bt horizon is brown (10YR 4/3) or dark yellowish brown (10YR 4/4).

Zook Series

The Zook series consists of poorly drained, slowly permeable soils on flood plains and the lower part of upland drainageways. These soils formed in moderately fine textured and fine textured alluvium. The native vegetation was prairie grasses. Slope ranges from 0 to 2 percent.

Zook soils commonly are adjacent to Ackmore, Colo, Kennebec, Nodaway, and Wabash soils. Ackmore soils have a silt loam surface layer that is stratified in color. They have a buried soil within a depth of 36 inches. The average content of clay in the Colo soils is less than 35 percent. Ackmore and Colo soils are on flood plains and in upland drainageways. Kennebec and Nodaway soils are silt loam throughout. They are moderately well drained. Wabash soils contain more clay than the Zook soils. They are very poorly drained and are very slowly permeable. Kennebec, Nodaway, and Wabash soils are on flood plains.

Typical pedon of Zook silty clay loam, 0 to 2 percent slopes, in a cultivated field; 333 feet south and 248 feet east of the northwest corner of sec. 14, T. 79 N., R. 35 W.

Ap—0 to 8 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.
A1—8 to 17 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure parting to weak fine granular; friable; medium acid; gradual smooth boundary.
A2—17 to 22 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular and angular blocky structure; friable; medium acid; gradual smooth boundary.
AB—22 to 33 inches; black (N 2/0) silty clay, very dark gray (10YR 3/1) dry; moderate medium prismatic structure parting to moderate medium and fine blocky; firm; sheen on faces of prisms; common soft black (10YR 2/1) concretions (iron and manganese oxides); medium acid; gradual smooth boundary.

Bg—33 to 46 inches; very dark gray (10YR 3/1) silty clay, very dark grayish brown (2.5Y 3/2) dry; some black (N 2/0) coatings on faces of prisms; moderate medium prismatic structure; firm; sheen on faces of prisms; few soft black (10YR 2/1) concretions (iron and manganese oxides); medium acid; gradual smooth boundary.

Cg—46 to 60 inches; dark gray (5Y 4/1) silty clay loam; massive; some vertical cleavage; firm; few soft black (10YR 2/1) concretions (iron and manganese oxides); slightly acid.

The thickness of the solum typically is more than 40 inches but ranges from 36 to 64 inches. The thickness of the mollic epipedon ranges from 36 to 50 inches. Reaction commonly is medium acid or slightly acid throughout the profile, but the range includes neutral or mildly alkaline if the soils are noncalcareous.

The A horizon ranges from about 26 to 40 inches in thickness. The value of 3 or less extends to a depth of more than 36 inches. The B and C horizons are very dark gray (10YR 3/1) or dark gray (10YR to 5Y 4/1). The content of clay in the lower part of the profile typically is 36 to 45 percent.

Formation of the Soils

In this section the factors that affect the formation of soils in Audubon County are discussed. The formation involved many steps and processes.

Factors of Soil Formation

Soil forms through processes that act on deposited or accumulated geologic material. The characteristics of the soil at any given point are determined by the physical and mineralogical composition of the parent material, the climate under which the soil material has accumulated and existed since accumulation, the plant and animal life on and in the soil, the relief, and the length of time that the forces of soil formation have acted on the soil material (*9*). Human activities also affect soil formation.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material and slowly change it into a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material affects the kind of profile that forms and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. A long period generally is needed for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the others (*20*).

Parent Material

The accumulation of parent material is the first step in the formation of a soil. The deposition of the various parent materials in Audubon County and the subsequent geologic erosion have resulted in the formation of landscapes characterized by narrow to broad, stable ridgetops and strongly sloping to very steep side slopes. The soils on these landscapes formed in loess, wind-blown sand, glacial till, and alluvium in numerous large and small stream valleys (fig. 17).

Loess, a silty material deposited by wind, is the most extensive parent material in the county. It consists of silt particles and smaller amounts of clay and sand. It probably was calcareous when deposited. Loess was deposited in western Iowa during the Wisconsin glacial period, from about 24,500 to 14,000 years ago (*14*). The wind probably carried most of the loess from the Missouri River flood plain along the western side of Iowa to the uplands (*8*). The thickness of the loess and the differences among the soils that formed in it are related to the distance from the source. The loess in western and southwestern Iowa gradually thins out and becomes fine textured from west to east. The thickness of the loess in Audubon County is about 18 to 28 feet on the nearly level, stable divides, but it is thinner on the side slopes. In many strongly sloping to very steep areas, the loess has been removed by erosion and glacial till is exposed. Exira, Ida, Knox, Marshall, and Sharpsburg soils formed in loess. Exira and Marshall soils are the most extensive of these soils, and Ida, Knox, and Sharpsburg soils are much less extensive. The loess in western and southwestern Iowa has been analyzed in a number of studies (*6, 13, 19, 22, 23*).

Glacial till is the second most extensive parent material in Audubon County. It was deposited during the Nebraskan and Kansan glacial periods. The Nebraska till, deposited about 750,000 years ago, is evident only in some areas throughout the county. The Kansan till, deposited about 500,000 years ago, is exposed in all parts of the county. It is on the side slopes, which form an extensive part of the landscape (*12*). The unweathered glacial till is a heterogeneous mixture. It is firm, calcareous clay loam that contains pebbles, boulders, and sand as well as silt and clay. It shows little evidence of sorting or stratification. The glacial till deposits in Audubon County are as much as 100 feet thick or more. The thickness and hardness of the underlying sediments or bedrock have apparently had a direct effect on the thickness of the glacial till.

Soils formed on the Kansan till plain during the Yarmouth and Sangamon interglacial periods prior to loess deposition (*17*). On the nearly level interstream divides, the soils are strongly weathered and have a gray, plastic subsoil called a paleosol. The paleosol is locally referred to as gumbotil (*15, 17*). It is very slowly permeable and is several feet thick. It is on many side slopes. Clarinda soils, which are in areas throughout the county, formed in this paleosol. Lamoni soils also formed in this paleosol, but they have been subject to more erosion and the clay material is not so thick as that in the Clarinda soils.

During the late Sangamon period, geologic erosion cut through the Yarmouth-Sangamon paleosol and into the Kansan till. The erosion surface generally is

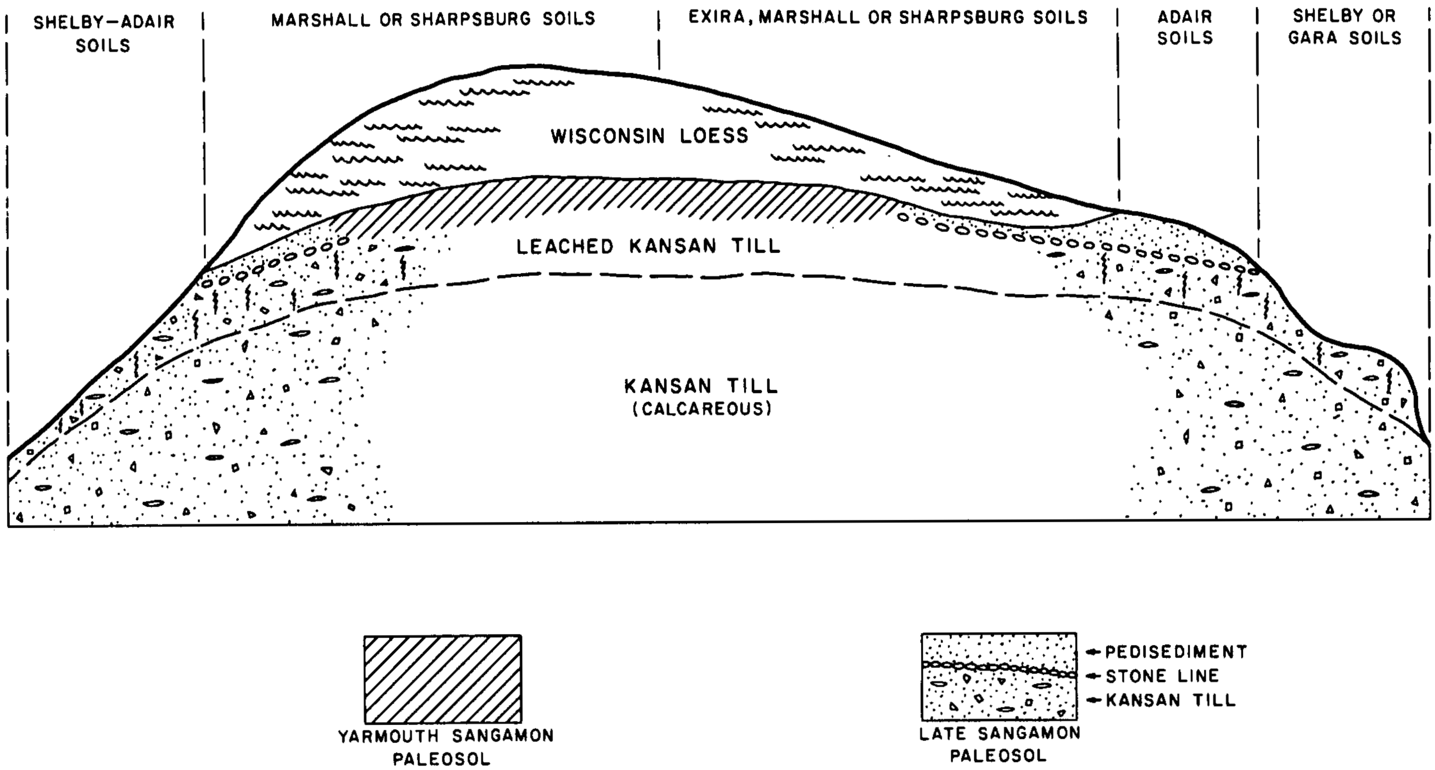

Figure 17.—Relationship of the major soils in Audubon County to the parent material.

characterized by a stone line or subjacent till, both of which are overlain by pedisediment (*15, 16, 18*). A palesol formed in this pedisediment. Adair soils formed when the paleosol was exposed again.

The soils that formed in the Kansan till during the Yarmouth and Sangamon periods were covered by loess. Geologic erosion has removed the loess from many slopes and has exposed the paleosol. In some areas erosion has beveled or truncated the paleosol so that only the strongly weathered lower part remains. This erosion took place prior to loess deposition, or before about 25,000 years ago (*17*). In other areas erosion has removed all of the paleosol and has exposed till that is only slightly weathered. This erosion took place mostly in the postglacial period. Gara and Shelby soils formed in the slightly weathered glacial till.

Alluvium is sediment deposited by water along streams and drainageways. The texture of the alluvium varies widely because the sources of the material and the manner in which it was deposited differ from area to area. Most alluvium in Audubon County is derived from the erosion of loess and glacial till.

The alluvial material that has been transported only a short distance is called local alluvium or colluvium. It retains many characteristics of the soils from which it has been washed. Judson soils, for example, generally are at the base of slopes below soils that formed in loess. They have textures similar to those of the soils upslope. Olmitz soils formed downslope from soils that formed in glacial till and thus have textures similar to those of the till soils. They contain more sand than the Judson soils. Ackmore soils consist of recently deposited, stratified silty sediments which buried dark, slowly deposited alluvium. Colo soils in upland drainageways also formed in local alluvium.

When rivers and streams overflow their channels and the water spreads outward across the flood plain toward the uplands, the coarse textured sandy material is deposited first, adjacent to the stream or as sandbars within the channel. As the water moves more slowly, silt and clay particles are deposited. As the floodwater recedes, these particles settle and form the heaviest textured soils on bottom land. Thus, the coarser textured soils are near the stream channel, and the clayey soils are farther away from the stream channel, toward the base of the uplands. This pattern of deposition is evident in many places on the wider stream bottoms of the Nishnabotna River and its tributaries. Nodaway soils, typically closest to the stream channel, are stratified coarse silt that contains some fine sand and clay.

Kennebec soils, typically slightly inland from the stream channel and adjacent to Nodaway soils, are siltier and contain less sand and more clay. Colo and Zook soils, which are farther away from the main stream channel, are finer textured and are poorly drained. Ackmore soils, which formed in the more recently deposited, stratified silty sediments on flood plains, typically overlie a buried Colo or Zook soil. Wabash soils, the farthest from the stream channel, are the finest textured and are very poorly drained.

Eolian, or wind-deposited, sand is the least extensive parent material in Audubon County. This material is dominantly fine quartz sand and in most areas is mixed with some silt. It was picked up from stream bottoms and deposited on nearby side slopes on narrow ridgetops. Dickman soils are the only soils in the county that formed in this material.

Eolian volcanic ash is in a small area in the southeast corner of section 32, T. 81 N., R. 34 W., and in other scattered small areas throughout the west-central part of the county.

Climate

Climate is an important factor in the formation of soils. The soils of Audubon County differ considerably from the soils that formed in the dry climate of the Great Plains States and from the soils that formed in the humid climate of the Southeastern States. According to recent research, the soils in the county have been forming under a variety of climatic conditions. During the post-Cary Glaciation, about 13,000 to 10,500 years ago, the climate was cool and the vegetation was dominantly conifers (*26*). During the period beginning about 10,500 years ago and ending about 8,000 years ago, a warming trend changed the vegetation from conifers to a mixed forest dominated by hardwoods. Beginning about 8,000 years ago, the climate became warmer and drier and herbaceous prairie plants became dominant. About 3,000 years ago, a change from a dry to a more mesic climate began (*26*). The present climate is midcontinental and subhumid.

The influence of the general climate is modified by local conditions. For example, soils on south-facing slopes formed under a microclimate that is warmer and less humid than that of the soils on the north-facing slopes. Also, the poorly drained soils on bottom land formed under a microclimate that is typically wetter and colder than that of most of the surrounding soils. These local conditions account for some of the minor differences among the soils in the county.

Changes in temperature activate the weathering of the parent material by water and air. As the parent material weathers, changes caused by physical and chemical actions take place. Rainfall affects the amount of leaching in the soil and the kinds of plants and animals on or in the soil.

Plant and Animal Life

Several kinds of living organisms affect soil formation. Burrowing animals, worms, crayfish, and micro-organisms, for example, influence soil properties. Differences in the kind of vegetation, however, commonly cause the most marked differences among soils (*11*).

The soils in Audubon County were influenced by prairie grasses and trees. The main prairie grasses were big bluestem and little bluestem. The trees were mainly oak, hickory, maple, elm, basswood, cottonwood, and other deciduous species. Tall prairie grasses were the dominant plants at the time when Audubon County was settled. Trees grew on about 30,000 acres, mainly in the southeastern part of the county and along the rivers and streams in other parts of the county (*7*).

Because grasses have many roots and tops that decay, soils that formed under prairie vegetation typically have a thicker, darker surface layer than the soils that formed under trees. The organic matter in the soils that formed under trees is derived principally from fallen leaves. It is deposited mainly on the surface layer. As a result, the surface layer of these soils is thinner and lighter colored than that of the soils that formed under prairie vegetation. Soils that formed under trees generally are more acid than the soils that formed under grasses. Also, more of the bases and clay minerals have moved downward in their profiles.

Marshall, Exira, and Sharpsburg soils are typical of soils that formed in loess under prairie vegetation. Shelby soils are typical of soils that formed in glacial till under prairie vegetation. None of the soils in the county formed entirely under the influence of forest vegetation. Knox soils, which formed in loess, and Gara soils, which formed in glacial till, have properties that are intermediate between those of soils that formed entirely under prairie vegetation and those that formed entirely under trees. They probably formed under grasses but later were covered by trees.

Very poorly drained soils, such as the Wabash soils, formed under a native vegetation of sedges, cattails, and other water-tolerant plants.

Relief

Relief indirectly affects soil formation through its effect on drainage, runoff, the water table, and geologic erosion. A difference in slope is the main reason for the differing properties among some of the soils in the county. The soils range from slightly depressional to very steep. The majority of the soils are nearly level to strongly sloping. Most nearly level soils on bottom land are frequently flooded or occasionally flooded. Water ponds in depressional areas, and in these areas the water table fluctuates. The steepest soils are generally along the south and west sides of the major streams and their tributaries. The intricate pattern of upland drainageways indicates that in nearly all of the county the landscape has been modified by geological processes.

The influence of relief is evident in the color, the thickness of the solum, and the development of horizons. Water that does not run off the surface percolates downward through the soils, evaporates, or is used by plants. The water that percolates through soils removes clay from the A horizon, and much of this clay accumulates in the B horizon. As a result, the content of clay in the B horizon generally is higher in the gently sloping or level soils than in the more sloping soils.

Relief affects the color of the B horizon through its effect on drainage and soil aeration. In well drained soils, typically the gently sloping to very steep soils on uplands, the subsoil generally is brown because oxidized iron compounds are well distributed throughout the horizon. In poorly drained or very poorly drained soils, typically those in depressional areas or the nearly level soils on flood plains, the subsoil generally is grayish and mottled.

Marshall, Sharpsburg, Shelby, Knox, and Gara are examples of soils that formed in areas where, because of the slope, runoff is adequate, drainage is good, and the water table is not in the solum. Their subsoil is yellowish brown and has the highest clay accumulation in the upper part. The subsoil of Colo, Zook, Wabash, and other soils that formed on nearly level or slightly depressional flood plains is black or grayish and has a very high content of organic matter. These soils are poorly drained or very poorly drained and have a seasonal high water table. Runoff is very slow. Although Exira soils are well drained, are moderately sloping to moderately steep, and formed in loess, their subsoil is grayish and mottled. The color and the mottles are inherited characteristics from a geological weathering zone and are not a reflection of the present drainage. In Shelby and other soils that occur on a wide range of slopes and landscapes, the depth to carbonates is systematically less as the percent of slope increases and the slopes are more convex. Because slope affects runoff, which in turn affects the amount of moisture available to plants, the lack of moisture may have restricted the growth of plants in some areas of the more sloping Exira, Marshall, and Shelby soils. Plant growth probably accounts for differences in the thickness and organic matter content of the surface layer of these soils.

Time

Time enables relief, climate, and plant and animal life to change the parent material. The length of time that soil material remains in place and is acted on by soil-forming processes affects the kind of soil that forms. The older soils, such as those on gently sloping uplands, have strongly expressed genetic horizons. The younger soils, such as those on frequently flooded bottom land, have only weakly expressed horizons or do not have horizons.

Soil material is generally removed from the steeper soils before a thick profile with strongly expressed horizons has had time to form. Even though the material has been in place for a long time, the soil can still be immature because much of the water runs off the slopes rather than through the soil material. Shelby and Gara soils, which formed on slopes recently exposed by the geological removal of the overlying loess of the late Wisconsin age, are no older than 11,000 to 14,000 years and probably are much younger (*14*). Adair, Clarinda, and Lamoni soils are among the oldest soils in the county (*17*). Clarinda and Lamoni soils formed in Kansan glacial till, which was strongly weathered during the Yarmouth-Sangamon period. Adair soils formed in material deposited and weathered before the late Sangamon interglacial stage. Exira, Marshall, and Knox soils formed in wind-deposited loess of Wisconsin age.

The radiocarbon technique for determining the age of carbonaceous material in loess and till has been useful in dating soils formed partly in the Wisconsin age (*13, 19*). Loess deposition began about 25,000 years ago and continued to about 14,000 years ago. These dates indicate that the surface of the nearly level, loess-mantled upland divides is about 14,000 years old. In areas where geologic erosion has beveled and in places removed the loess on side slopes, the material exposed on the side slopes is younger than the loess on the upland divides. That is, it is less than 14,000 years old.

The sediment stripped from the side slopes accumulated at the base of the slope as local alluvium. The age of the soils on the side slopes is determined by dating the alluvial fill at the base of the slopes. The age of this material ranges from about 7,000 to 1,800 years old (*5*). Some of the alluvium in which Ackmore and Nodaway soils formed was deposited after the county was settled.

Human Activities

Important changes took place when Audubon County was settled. Breaking the prairie sod, draining the wetlands, and clearing the timber removed and changed the protective plant cover. Some of these changes have had little effect on soil productivity; others have had drastic effects.

Changes caused by water erosion are the most significant. As the land was cultivated, the runoff rate increased and the rate at which water moved into the soil decreased. As a result, accelerated erosion removed part or all of the original surface layer from many of the more sloping soils. In some areas shallow to deep gullies have formed. Cultivation and erosion also changed the structure and consistence of the surface layer of some soils and the content of organic matter and level of fertility. In most moderately or severely eroded areas, the

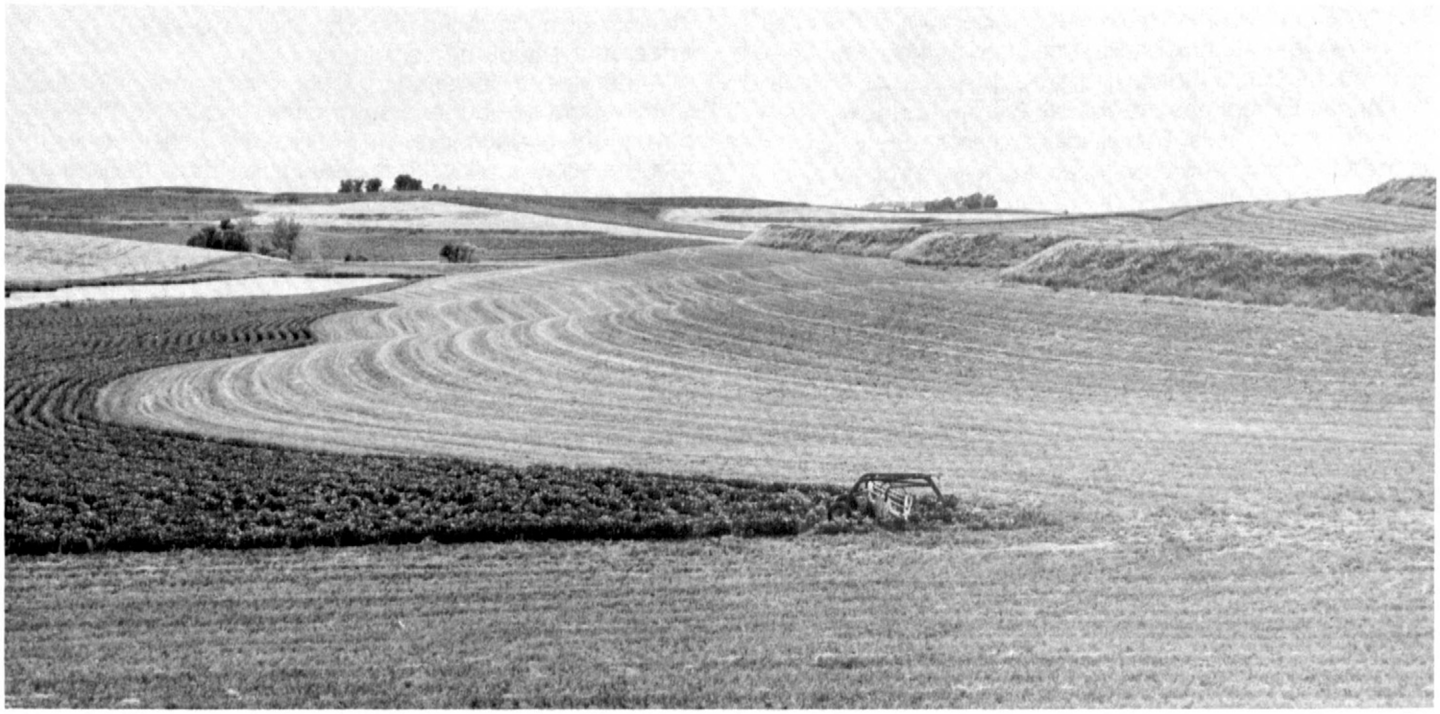

Figure 18.—Terraces, contour farming, and stripcropping on Marshall silty clay loam, 9 to 14 percent slopes, moderately eroded. These practices help to control erosion.

plow layer includes the upper part of the subsoil, which is typically less friable and finer textured than the surface layer. Even in areas that are not subject to erosion, compaction by heavy machinery reduces the thickness of the surface layer and changes the structure. The granular structure characteristic of virgin grassland breaks down when the soils are intensively cropped.

Some management practices have increased soil productivity, decreased soil loss, and reclaimed areas that otherwise are not suited to crops or pasture. For example, a tile drainage system, which has been installed in many areas, has lowered the water table so that the areas can be cropped. Terraces and other erosion-control measures have reduced and, in places, controlled runoff and erosion (fig. 18). Large areas on bottom land are suitable for cultivation because flooding and deposition are controlled by diversions at the base of the slopes, by drainage ditches, and by grassed waterways. Many soils are more productive than they were in their virgin state because applications of animal waste or commercial fertilizers and lime have overcome deficiencies in plant nutrients. A conservation tillage system reduces the number of times that farm machinery works the soil when a crop is planted. Also, it leaves a mulch or plant cover on the surface, which helps to control water erosion and wind erosion and conserves moisture.

Processes of Horizon Differentiation

Horizon differentiation is the result of four processes. These are additions, removals, transfers, and transformations (*20*). Each of these affects many substances in the soils, such as organic matter, carbonates, sesquioxides, or silicate clay minerals. The changes brought about by these processes help to determine the ultimate nature of the soil profile.

The accumulation of organic matter is an early phase in the formation of most soils. The content of organic matter ranges from high to very low in the A horizon of the soils in Audubon County. It is low in the thin A horizon of Ida soils and high in the thick A horizon of Colo and Zook soils. In some soils it is low because erosion has removed part of the A horizon.

The removal of substances from parts of the profile is important in the development of soil horizons in Audubon

County. The downward movement of calcium carbonates and bases is an example. Free calcium carbonates have been leached from the upper part of most of the soils in the county. Exceptions are Ida silt loam and a few severely eroded soils. Some soils are so strongly leached that they are strongly acid or very strongly acid in the subsoil.

A number of transfers from one horizon to another are evident in the soils of the county. Phosphorus, for example, is removed from the subsoil by plant roots and transferred to the parts of the plant growing above the ground. When the plant decays, part of the phosphorus is returned to the surface layer in the plant residue. This process affects the form and distribution of phosphorus in the profile.

The translocation of silicate clay minerals has an important effect on horizon differentiation. The clay minerals in the A horizon are carried downward in suspension by percolating water. They accumulate in the B horizon as fillings in pores and root channels and as clay films on the faces of peds. This process has affected many of the soils in the county.

Another kind of transfer occurs mainly in clayey soils. Cracks form when these soils shrink and swell. They form in the surface layer and commonly extend deep into the subsoil, allowing material from the surface layer to move into the lower parts of the profile. Clarinda and Wabash soils are examples of soils in which this kind of physical transfer can occur.

Transformations are physical and chemical. The weathering of soil particles to smaller sizes is an example of a transformation. The reduction of iron is another example. This process is called gleying. It occurs when the soil is saturated for long periods. The soil contains enough organic matter for biologic activity to take place during the periods of saturation. Gleying is evidenced by ferrous iron and gray colors in the soil. It is a characteristic of poorly drained soils, such as Zook soils. Reductive extractable iron, or free iron, is in the lower part of the subsoil of some loess soils, such as Exira and Ida soils. This iron is not an indication of drainage but is the result of erosion.

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Glossary

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.

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

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

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

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

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

Benches (geologic). Higher, older terraces (old alluvial plains) that are now a part of the erosion surface of the valley. In Iowa, the benches are of pre-Wisconsin age and are covered with loess.

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

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.

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.

Coarse textured soil. Sand or loamy sand.

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

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

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

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

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

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

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

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

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

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

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not a source of gravel or sand for construction purposes.

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

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

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

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

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

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Gumbotil. Leached, deoxidized clay containing siliceous stones; the product of thorough chemical decomposition of clay-rich glacial till.

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.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

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

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

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

Miscellaneous area. An area that has little or no natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

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

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

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

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

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Paleosol. A buried soil or formerly buried soil, especially one that formed during an interglacial period and was covered by deposits of later glaciers.

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

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

Pedisediment. Water-sorted sediment at the top of a paleosol.

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

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 of moisture content within which the soil remains plastic.

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

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

Poor filter (in tables). Because of rapid permeability the soil may not adequately filter effluent from a waste disposal system.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

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

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

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

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

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.

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.

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

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the substratum. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

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

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

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

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 insure satisfactory performance of the soil for a specific use.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

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

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

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

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

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

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 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 wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single 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 wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Subsoiling. Breaking up a compact subsoil by pulling a special chisel through the soil.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 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. Includes all subdivisions of these horizons.

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

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill; part of a foot slope.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Valley fill. In glaciated regions, material deposited in stream valleys by glacial melt water. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Water table. The highest level of a saturated zone in the soil in most years.

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

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

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

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data were recorded in the period 1951-73 at Audubon, Iowa]

Month	Temperature: Average daily maximum	Temperature: Average daily minimum	Temperature: Average daily	Temperature: 2 years in 10 will have-- Maximum temperature higher than--	Temperature: 2 years in 10 will have-- Minimum temperature lower than--	Temperature: Average number of growing degree days*	Precipitation: Average	Precipitation: 2 years in 10 will have-- Less than--	Precipitation: 2 years in 10 will have-- More than--	Precipitation: Average number of days with 0.10 inch or more	Precipitation: Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	28.6	8.0	18.4	55	-22	0	0.93	0.42	1.34	3	7.9
February---	34.9	13.9	24.4	61	-19	0	1.20	.52	1.74	4	7.1
March------	44.6	23.3	34.0	77	-6	35	2.21	.96	3.21	5	7.8
April------	62.1	37.4	49.8	87	16	99	3.31	1.73	4.59	7	1.1
May--------	73.4	48.5	61.0	91	28	349	4.30	2.69	5.75	7	.0
June-------	82.9	58.5	70.7	96	41	621	4.82	2.99	6.46	7	.0
July-------	86.6	62.2	74.4	100	45	756	4.08	1.62	6.06	6	.0
August-----	85.0	60.2	72.6	99	43	701	4.40	2.43	6.01	7	.0
September--	75.9	50.8	63.4	94	29	402	3.75	1.34	5.68	6	.0
October----	65.9	40.2	53.1	88	18	175	2.09	.61	3.27	5	.2
November---	47.9	25.8	36.9	74	0	6	1.52	.39	2.41	3	3.2
December---	34.1	14.6	24.4	60	-15	0	1.08	.52	1.53	3	7.0
Yearly:											
Average--	60.2	37.0	48.6	---	---	---	---	---	---	---	---
Extreme--	---	---	---	101	-23	---	---	---	---	---	---
Total----	---	---	---	---	---	3,144	33.69	27.61	39.49	63	34.3

* 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° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data were recorded in the period 1951-73 at Audubon, Iowa]

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--	April 25	May 7	May 14
2 years in 10 later than--	April 21	May 1	May 9
5 years in 10 later than--	April 13	April 21	April 30
First freezing temperature in fall:			
1 year in 10 earlier than--	October 14	September 30	September 19
2 years in 10 earlier than--	October 18	October 5	September 24
5 years in 10 earlier than--	October 27	October 14	October 4

TABLE 3.--GROWING SEASON

[Data were recorded in the period 1951-73 at Audubon, Iowa]

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	179	155	139
8 years in 10	185	162	145
5 years in 10	196	175	156
2 years in 10	207	188	168
1 year in 10	213	195	174

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

Map symbol	Soil name	Acres	Percent
1C3	Ida silt loam, 5 to 9 percent slopes, severely eroded	540	0.2
7B	Wiota silty clay loam, 1 to 4 percent slopes	110	*
8B	Judson silty clay loam, 2 to 5 percent slopes	3,490	1.2
8C	Judson silty clay loam, 5 to 9 percent slopes	765	0.3
9	Marshall silty clay loam, 0 to 2 percent slopes	655	0.2
9B	Marshall silty clay loam, 2 to 5 percent slopes	10,240	3.6
9B2	Marshall silty clay loam, 2 to 5 percent slopes, moderately eroded	15,125	5.3
9C	Marshall silty clay loam, 5 to 9 percent slopes	2,155	0.8
9C2	Marshall silty clay loam, 5 to 9 percent slopes, moderately eroded	39,700	13.9
9D2	Marshall silty clay loam, 9 to 14 percent slopes, moderately eroded	45,070	15.7
9E2	Marshall silty clay loam, 14 to 20 percent slopes, moderately eroded	6,485	2.3
9E3	Marshall silty clay loam, 14 to 20 percent slopes, severely eroded	975	0.3
11B	Judson-Colo-Ackmore complex, 2 to 5 percent slopes	54,480	19.0
24C3	Shelby clay loam, 5 to 9 percent slopes, severely eroded	720	0.3
24D2	Shelby clay loam, 9 to 14 percent slopes, moderately eroded	3,800	1.3
24D3	Shelby clay loam, 9 to 14 percent slopes, severely eroded	1,580	0.6
24E3	Shelby clay loam, 14 to 18 percent slopes, severely eroded	6,030	2.1
24F3	Shelby clay loam, 18 to 25 percent slopes, severely eroded	2,545	0.9
54	Zook silty clay loam, 0 to 2 percent slopes	6,895	2.4
71D	Dickman-Marshall complex, 9 to 14 percent slopes	395	0.1
93D2	Shelby-Adair complex, 9 to 14 percent slopes, moderately eroded	9,270	3.2
93D3	Shelby-Adair complex, 9 to 14 percent slopes, severely eroded	4,660	1.6
93E2	Shelby-Adair complex, 14 to 18 percent slopes, moderately eroded	5,470	1.9
93E3	Shelby-Adair complex, 14 to 18 percent slopes, severely eroded	4,550	1.6
99C2	Exira silty clay loam, 5 to 9 percent slopes, moderately eroded	5,330	1.9
99D2	Exira silty clay loam, 9 to 14 percent slopes, moderately eroded	17,760	6.2
99D3	Exira silty clay loam, 9 to 14 percent slopes, severely eroded	1,395	0.5
99E2	Exira silty clay loam, 14 to 18 percent slopes, moderately eroded	2,090	0.7
133	Colo silty clay loam, 0 to 2 percent slopes	7,380	2.6
179E	Gara loam, 14 to 18 percent slopes	540	0.2
179F	Gara loam, 18 to 25 percent slopes	660	0.2
179G	Gara loam, 25 to 40 percent slopes	570	0.2
192C2	Adair clay loam, 5 to 9 percent slopes, moderately eroded	640	0.2
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded	2,140	0.7
192D3	Adair clay loam, 9 to 14 percent slopes, severely eroded	305	0.1
212	Kennebec silt loam, 0 to 2 percent slopes	1,250	0.4
220	Nodaway silt loam, 0 to 2 percent slopes	2,625	0.9
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	835	0.3
248	Wabash silty clay loam, 0 to 1 percent slopes	740	0.3
268C	Knox silt loam, 5 to 9 percent slopes	270	0.1
268D	Knox silt loam, 9 to 14 percent slopes	265	0.1
268E	Knox silt loam, 14 to 18 percent slopes	255	0.1
268F	Knox silt loam, 18 to 25 percent slopes	375	0.1
273C	Olmitz loam, 5 to 9 percent slopes	675	0.2
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes	785	0.3
370B2	Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded	640	0.2
370C	Sharpsburg silty clay loam, 5 to 9 percent slopes	235	0.1
370C2	Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded	1,765	0.6
370D2	Sharpsburg silty clay loam, 9 to 14 percent slopes, moderately eroded	1,335	0.5
430	Ackmore silt loam, 0 to 2 percent slopes	6,150	2.1
509	Marshall silty clay loam, benches, 0 to 2 percent slopes	680	0.2
509B	Marshall silty clay loam, benches, 2 to 5 percent slopes	1,580	0.6
509C2	Marshall silty clay loam, benches, 5 to 9 percent slopes, moderately eroded	340	0.1
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	255	0.1
980G	Gullied land-Judson complex, 2 to 40 percent slopes	345	0.1
5010	Pits, sand and gravel	200	0.1
5040	Orthents, loamy	275	0.1
	Water	330	0.1
	Total	286,720	100.0

* Less than 0.1 percent.

TABLE 5.--PRIME FARMLAND

[Only the soils considered prime farmland are listed. Urban or built-up areas of the soils listed are not considered prime farmland. If a soil is prime farmland only under certain conditions, the conditions are specified in parentheses after the soil name]

Map symbol	Soil name
7B	Wiota silty clay loam, 1 to 4 percent slopes
8B	Judson silty clay loam, 2 to 5 percent slopes
9	Marshall silty clay loam, 0 to 2 percent slopes
9B	Marshall silty clay loam, 2 to 5 percent slopes
9B2	Marshall silty clay loam, 2 to 5 percent slopes, moderately eroded
11B	Judson-Colo-Ackmore complex, 2 to 5 percent slopes (where the Colo and Ackmore soils are drained)
54	Zook silty clay loam, 0 to 2 percent slopes (where drained)
133	Colo silty clay loam, 0 to 2 percent slopes (where drained)
212	Kennebec silt loam, 0 to 2 percent slopes
220	Nodaway silt loam, 0 to 2 percent slopes (where protected from flooding)
248	Wabash silty clay loam, 0 to 1 percent slopes (where drained)
370B	Sharpsburg silty clay loam, 2 to 5 percent slopes
370B2	Sharpsburg silty clay loam, 2 to 5 percent slopes, moderately eroded
430	Ackmore silt loam, 0 to 2 percent slopes (where drained)
509	Marshall silty clay loam, benches, 0 to 2 percent slopes
509B	Marshall silty clay loam, benches, 2 to 5 percent slopes

TABLE 6.--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	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
1C3 Ida	77	29	54	2.9	2.7	4.7	4.8
7B Wiota	108	41	59	4.5	4.0	6.4	7.5
8B Judson	124	47	93	5.2	4.2	7.3	8.6
8C Judson	119	45	90	5.0	4.1	7.1	8.3
9 Marshall	109	41	62	4.6	3.8	6.5	7.6
9B Marshall	107	41	61	4.5	3.8	6.3	7.5
9B2 Marshall	105	40	59	4.4	3.6	6.3	7.3
9C Marshall	102	39	58	4.3	3.5	6.1	7.1
9C2 Marshall	99	38	56	4.2	3.3	5.9	7.0
9D2 Marshall	90	34	51	3.8	3.0	5.3	6.3
9E2 Marshall	75	28	42	3.2	2.8	4.5	5.3
9E3 Marshall	70	26	34	2.8	2.7	4.0	4.9
11B Judson-Colo-Ackmore	100	38	80	4.1	3.8	6.0	6.8
24C3 Shelby	86	35	47	3.6	3.4	4.8	6.0
24D2 Shelby	81	31	44	3.4	3.3	4.9	5.6
24D3 Shelby	75	29	41	3.2	2.7	4.5	5.3
24E3 Shelby	---	---	---	2.9	1.7	4.0	4.9
24F3 Shelby	---	---	---	2.5	1.3	3.6	4.5
54 Zook	96	36	72	4.0	4.0	4.0	5.0
71D Dickman-Marshall	73	28	47	3.1	2.1	3.1	4.2
93D2 Shelby-Adair	69	26	38	3.0	3.0	4.0	5.0

See footnote at end of table.

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
93D3----------------------- Shelby-Adair	---	---	---	2.6	2.8	3.4	4.6
93E2----------------------- Shelby-Adair	---	---	---	2.3	1.9	3.3	3.9
93E3----------------------- Shelby-Adair	---	---	---	1.4	1.8	2.8	3.2
99C2----------------------- Exira	95	35	56	4.2	3.3	6.3	7.0
99D2----------------------- Exira	85	30	51	3.8	3.0	5.5	6.3
99D3----------------------- Exira	75	28	45	3.2	3.0	5.0	5.5
99E2----------------------- Exira	70	25	42	3.2	2.8	4.8	5.3
133------------------------ Colo	104	40	78	4.2	4.2	5.8	7.0
179E----------------------- Gara	---	---	---	2.5	1.7	3.3	4.1
179F----------------------- Gara	---	---	---	1.5	1.3	2.0	2.5
179G----------------------- Gara	---	---	---	1.0	1.0	1.0	1.6
192C2---------------------- Adair	65	25	36	2.7	2.3	3.5	4.5
192D2---------------------- Adair	54	20	30	2.3	1.9	2.9	3.8
192D3---------------------- Adair	---	---	---	1.6	1.5	2.0	2.6
212------------------------ Kennebec	121	46	80	5.1	4.2	7.1	8.5
220------------------------ Nodaway	110	42	60	4.6	4.0	5.5	4.0
222D2---------------------- Clarinda	46	17	25	1.8	1.7	2.9	3.0
248------------------------ Wabash	86	33	47	2.5	3.3	3.8	4.1
268C----------------------- Knox	90	34	63	3.4	3.6	8.0	5.6
268D----------------------- Knox	80	30	56	3.0	3.3	7.0	5.0
268E----------------------- Knox	65	25	46	2.5	2.4	6.4	4.2
268F----------------------- Knox	---	---	---	2.0	1.9	6.0	3.3
273C----------------------- Olmitz	95	36	52	4.0	3.7	5.7	6.6

See footnote at end of table.

TABLE 6.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Smooth bromegrass	Bromegrass-alfalfa
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
370B---------------------- Sharpsburg	113	43	62	4.7	4.2	6.7	7.8
370B2--------------------- Sharpsburg	110	42	61	4.6	4.1	6.6	7.6
370C---------------------- Sharpsburg	108	41	59	4.5	4.1	6.5	7.5
370C2--------------------- Sharpsburg	105	40	58	4.4	4.0	6.5	7.3
370D2--------------------- Sharpsburg	96	36	53	4.0	3.8	5.7	6.6
430----------------------- Ackmore	106	40	58	4.5	3.8	6.3	7.5
509----------------------- Marshall	109	41	62	4.6	3.8	6.5	7.6
509B---------------------- Marshall	107	41	61	4.5	3.8	6.3	7.5
509C2--------------------- Marshall	99	38	56	4.2	3.3	5.9	7.0
822D2--------------------- Lamoni	61	23	33	2.6	2.1	3.7	4.3
980G. Gullied land-Judson							
5010**. Pits							
5040. Orthents							

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 7.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	2,585	---	---	---
II	109,500	31,970	77,530	---
III	122,105	121,365	740	---
IV	25,675	25,675	---	---
V	---	---	---	---
VI	20,585	20,585	---	---
VII	5,465	5,465	---	---
VIII	---	---	---	---

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 heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
1C3. Ida	Tatarian honeysuckle, fragrant sumac.	Siberian peashrub	Honeylocust, northern catalpa, osageorange, Russian-olive, eastern redcedar, green ash, black locust.	---	---
7B. Wiota	---	Lilac, Amur honeysuckle, autumn-olive, Amur maple.	Eastern redcedar, hackberry, green ash, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
8B, 8C. Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
9, 9B, 9B2, 9C, 9C2, 9D2, 9E2, 9E3. Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, eastern white pine, honeylocust.	---
11B*:					
Judson	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
Ackmore	---	Silky dogwood, Amur honeysuckle, Amur privet, American cranberrybush.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce	Eastern white pine, pin oak.
24C3, 24D2, 24D3, 24E3, 24F3. Shelby	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, eastern white pine, honeylocust.	---
54. Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.
71D*:					
Dickman	Siberian peashrub, Tatarian honeysuckle, lilac, Peking cotoneaster.	Manchurian crabapple, hackberry, eastern redcedar.	Siberian elm, honeylocust, green ash, Russian-olive, ponderosa pine.	---	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
71D*: Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, eastern white pine, honeylocust.	---
93D2*, 93D3*, 93E2*, 93E3*: Shelby	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, eastern white pine, honeylocust.	---
Adair	Lilac	Amur honeysuckle, Manchurian crabapple, autumn-olive, Siberian crabapple.	Austrian pine, eastern redcedar, green ash, jack pine, Russian-olive, hackberry.	Honeylocust	---
99C2, 99D2, 99D3, 99E2 Exira	---	Lilac, Amur honeysuckle, Amur maple, autumn-olive.	Eastern redcedar, green ash, hackberry, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
133 Colo	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple, eastern cottonwood.	---
179E, 179F, 179G Gara	---	Autumn-olive, lilac, Amur honeysuckle, Amur maple.	Eastern redcedar, green ash, Russian-olive, hackberry.	Honeylocust, eastern white pine, Austrian pine.	---
192C2, 192D2, 192D3 Adair	Lilac	Amur honeysuckle, Manchurian crabapple, autumn-olive, Siberian crabapple.	Austrian pine, eastern redcedar, green ash, jack pine, Russian-olive, hackberry.	Honeylocust	---
212 Kennebec	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Eastern redcedar	Austrian pine, hackberry, pin oak, green ash, honeylocust.	Eastern white pine, eastern cottonwood.
220 Nodaway	---	Amur honeysuckle, autumn-olive, Amur maple, lilac.	Eastern redcedar	Austrian pine, hackberry, honeylocust, green ash, eastern white pine, pin oak.	Eastern cottonwood.
222D2 Clarinda	Lilac	Manchurian crabapple, Amur honeysuckle, Siberian peashrub, autumn-olive.	Eastern redcedar, Austrian pine, hackberry, green ash, jack pine, Russian-olive.	Honeylocust	---

See footnote at end of table.

TABLE 8.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
248----------------- Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
268C, 268D, 268E, 268F------------- Knox	---	Amur honeysuckle, autumn-olive, lilac, Amur maple.	Hackberry, eastern redcedar, green ash, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
273C-------------- Olmitz	---	Amur maple, lilac, autumn-olive, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, eastern white pine, honeylocust.	---
370B, 370B2, 370C, 370C2, 370D2----- Sharpsburg	---	Amur maple, Amur honeysuckle, lilac, autumn-olive.	Green ash, hackberry, eastern redcedar, Russian-olive.	Austrian pine, eastern white pine, honeylocust.	---
430--------------- Ackmore	---	Silky dogwood, Amur honeysuckle, Amur privet, American cranberrybush.	Austrian pine, white fir, blue spruce, northern white-cedar, Washington hawthorn.	Norway spruce-----	Eastern white pine, pin oak.
509, 509B, 509C2-- Marshall	---	Autumn-olive, lilac, Amur maple, Amur honeysuckle.	Eastern redcedar, Russian-olive, hackberry, green ash.	Austrian pine, eastern white pine, honeylocust.	---
822D2------------- Lamoni	---	Eastern redcedar, Washington hawthorn, arrowwood, Amur honeysuckle, Amur privet, Tatarian honeysuckle, American cranberrybush.	Austrian pine, green ash, osageorange.	Eastern white pine, pin oak.	---
980G*: Gullied land.					
Judson------------	---	Amur honeysuckle, Amur maple, autumn-olive, lilac.	Hackberry, green ash, Russian-olive, eastern redcedar.	Honeylocust, Austrian pine, eastern white pine.	---
5010*. Pits					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1C3 Ida	Slight	Slight	Severe: slope.	Slight	Slight.
7B Wiota	Severe: flooding.	Slight	Moderate: slope.	Slight	Slight.
8B Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
8C Judson	Slight	Slight	Severe: slope.	Slight	Slight.
9 Marshall	Slight	Slight	Slight	Slight	Slight.
9B, 9B2 Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
9C, 9C2 Marshall	Slight	Slight	Severe: slope.	Slight	Slight.
9D2 Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
9E2, 9E3 Marshall	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
11B*:					
Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Ackmore	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
24C3 Shelby	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
24D2, 24D3 Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
24E3, 24F3 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
54 Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
71D*:					
Dickman	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

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
93D2*, 93D3*:					
Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Adair	Severe: wetness.	Moderate: wetness, slope, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
93E2*, 93E3*:					
Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Adair	Severe: slope, wetness.	Severe: slope.	Severe: slope, wetness.	Moderate: wetness, slope.	Severe: slope.
99C2 Exira	Slight	Slight	Severe: slope.	Slight	Slight.
99D2, 99D3 Exira	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
99E2 Exira	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
133 Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
179E, 179F Gara	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
179G Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
192C2 Adair	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness.
192D2, 192D3 Adair	Severe: wetness.	Moderate: wetness, slope, percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: slope, wetness.
212 Kennebec	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
220 Nodaway	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
222D2 Clarinda	Severe: percs slowly, wetness.	Severe: percs slowly.	Severe: slope, wetness, percs slowly.	Severe: erodes easily.	Moderate: wetness, slope.
248 Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.
268C Knox	Slight	Slight	Severe: slope.	Slight	Slight.
268D Knox	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

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
268E, 268F: Knox	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
273C: Olmitz	Slight	Slight	Severe: slope.	Slight	Slight.
370B, 370B2: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
370C, 370C2: Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Slight	Slight.
370D2: Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
430: Ackmore	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
509: Marshall	Slight	Slight	Slight	Slight	Slight.
509B: Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
509C2: Marshall	Slight	Slight	Severe: slope.	Slight	Slight.
822D2: Lamoni	Severe: wetness, percs slowly.	Severe: percs slowly.	Severe: slope, wetness.	Moderate: wetness.	Moderate: wetness, slope.
980G*: Gullied land.					
Judson**	Slight	Slight	Moderate: slope.	Slight	Slight.
5010*. Pits					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.
** Most areas of the Judson soil are so small and narrow that recreational development is impractical.

TABLE 10.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
1C3----------------- Ida	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
7B------------------ Wiota	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
8B------------------ Judson	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
8C------------------ Judson	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
9, 9B, 9B2---------- Marshall	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
9C, 9C2, 9D2-------- Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
9E2, 9E3------------ Marshall	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
11B*:										
Judson-------------	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Colo---------------	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
Ackmore------------	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
24C3, 24D2, 24D3---- Shelby	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
24E3, 24F3---------- Shelby	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
54------------------ Zook	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
71D*:										
Dickman------------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Marshall-----------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
93D2*, 93D3*:										
Shelby-------------	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Adair--------------	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
93E2*, 93E3*:										
Shelby-------------	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Adair--------------	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
99C2, 99D2, 99D3, 99E2-------------- Exira	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Fair	Poor.
133----------------- Colo	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.

See footnote at end of table.

TABLE 10.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
179E, 179F--------- Gara	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
179G--------------- Gara	Very poor.	Very poor.	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
192C2, 192D2, 192D3------------- Adair	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
212---------------- Kennebec	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
220---------------- Nodaway	Fair	Good	Good	Poor	Poor	Good	Fair	Poor	Poor	Fair.
222D2-------------- Clarinda	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
248---------------- Wabash	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
268C, 268D--------- Knox	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
268E, 268F--------- Knox	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
273C--------------- Olmitz	Fair	Good	Fair	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
370B, 370B2-------- Sharpsburg	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
370C, 370C2, 370D2- Sharpsburg	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
430---------------- Ackmore	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
509, 509B---------- Marshall	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
509C2-------------- Marshall	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
822D2-------------- Lamoni	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
980G*: Gullied land.										
Judson------------	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
5010*. Pits										
5040. Orthents										

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
1C3 Ida	Slight	Slight	Slight	Moderate: slope.	Severe: frost action.	Slight.
7B Wiota	Slight	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
8B Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
8C Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
9, 9B, 9B2 Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
9C, 9C2 Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
9D2 Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
9E2, 9E3 Marshall	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, frost action, slope.	Severe: slope.
11B*:						
Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Ackmore	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action, shrink-swell.	Moderate: wetness, flooding.
24C3 Shelby	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
24D2, 24D3 Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
24E3, 24F3 Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
54 Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, 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
71D*:						
Dickman----------	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Marshall---------	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
93D2*, 93D3*:						
Shelby-----------	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Adair------------	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.	Moderate: slope, wetness.
93E2*, 93E3*:						
Shelby-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Adair------------	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: wetness, slope.	Severe: shrink-swell, wetness, slope.	Severe: low strength, slope, frost action.	Severe: slope.
99C2-------------- Exira	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
99D2, 99D3-------- Exira	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
99E2-------------- Exira	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, frost action, slope.	Severe: slope.
133--------------- Colo	Severe: wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, shrink-swell, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
179E, 179F, 179G-- Gara	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
192C2------------- Adair	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action.	Moderate: wetness.
192D2, 192D3------ Adair	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: wetness.	Severe: shrink-swell, wetness, slope.	Severe: low strength, frost action.	Moderate: slope, wetness.
212--------------- Kennebec	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
220--------------- Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	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
222D2: Clarinda	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell, slope.	Severe: frost action, low strength, shrink-swell.	Moderate: wetness, slope.
248: Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: wetness.
268C: Knox	Slight	Moderate: shrink-swell.	Slight	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
268D: Knox	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
268E, 268F: Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
273C: Olmitz	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength.	Slight.
370B, 370B2: Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
370C, 370C2: Sharpsburg	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
370D2: Sharpsburg	Moderate: too clayey, slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
430: Ackmore	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action, shrink-swell.	Moderate: wetness, flooding.
509, 509B: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
509C2: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
822D2: Lamoni	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness, slope.	Severe: shrink-swell, low strength.	Moderate: wetness, slope.
980G*: Gullied land.						
Judson**	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
5010*. Pits						
5040. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.
** Most areas of the Judson soil are so small and narrow that building site development is impractical.

TABLE 12.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
1C3: Ida	Slight	Severe: slope.	Slight	Slight	Good.
7B: Wiota	Moderate: flooding, percs slowly.	Moderate: seepage, slope.	Moderate: flooding, too clayey.	Moderate: flooding.	Fair: too clayey.
8B: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
8C: Judson	Slight	Severe: slope.	Slight	Slight	Good.
9: Marshall	Slight	Moderate: seepage.	Slight	Slight	Good.
9B, 9B2: Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
9C, 9C2: Marshall	Slight	Severe: slope.	Slight	Slight	Good.
9D2: Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
9E2, 9E3: Marshall	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
11B*:					
Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Ackmore	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
24C3: Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
24D2, 24D3: Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
24E3, 24F3: Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
54: Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.
71D*:					
Dickman	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.

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
71D*:					
Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
93D2*, 93D3*:					
Shelby	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
Adair	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
93E2*, 93E3*:					
Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Adair	Severe: percs slowly, slope, wetness.	Severe: slope, wetness.	Severe: wetness, slope.	Severe: wetness, slope.	Poor: slope, wetness.
99C2 Exira	Slight	Severe: slope.	Slight	Slight	Good.
99D2, 99D3 Exira	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
99E2 Exira	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
133 Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
179E, 179F, 179G Gara	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
192C2, 192D2, 192D3 Adair	Severe: percs slowly, wetness.	Severe: slope, wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
212 Kennebec	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
220 Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
222D2 Clarinda	Severe: wetness, percs slowly.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, wetness, hard to pack.
248 Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
268C Knox	Slight	Severe: slope.	Slight	Slight	Good.
268D Knox	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

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
268E, 268F: Knox	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
273C: Olmitz	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
370B, 370B2: Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
370C, 370C2: Sharpsburg	Moderate: percs slowly.	Severe: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
370D2: Sharpsburg	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
430: Ackmore	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
509: Marshall	Slight	Moderate: seepage.	Slight	Slight	Good.
509B: Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
509C2: Marshall	Slight	Severe: slope.	Slight	Slight	Good.
822D2: Lamoni	Severe: percs slowly, wetness.	Severe: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
980G*: Gullied land.					
Judson**	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
5010*. Pits					
5040. Orthents					

* See description of the map unit for composition and behavior characteristics of the map unit.
** Most areas of the Judson soil are so small and narrow that building site development and sanitary facilities are impractical.

TABLE 13.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1C3 Ida	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
7B Wiota	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
8B, 8C Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
9, 9B, 9B2, 9C, 9C2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
9D2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
9E2, 9E3 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
11B*:				
Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ackmore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
24C3 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
24D2, 24D3 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
24E3, 24F3 Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
54 Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
71D*:				
Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
93D2*, 93D3*:				
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
93E2*, 93E3*:				
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
93E2*, 93E3*: Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.
99C2 Exira	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
99D2, 99D3 Exira	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
99E2 Exira	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
133 Colo	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
179E, 179F Gara	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
179G Gara	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
192C2, 192D2, 192D3 Adair	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
212 Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
220 Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
222D2 Clarinda	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
248 Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
268C Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
268D Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
268E, 268F Knox	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
273C Olmitz	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
370B, 370B2, 370C, 370C2, 370D2 Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
430 Ackmore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
509, 509B, 509C2 Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 13.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
822D2: Lamoni	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
980G*: Gullied land.				
Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
5010*. Pits				
5040. Orthents				

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
1C3: Ida	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope, erodes easily.	Erodes easily	Erodes easily.
7B: Wiota	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
8B, 8C: Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
9: Marshall	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
9B, 9B2, 9C, 9C2: Marshall	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
9D2, 9E2, 9E3: Marshall	Severe: slope.	Slight	Deep to water	Slope	Erodes easily, slope.	Slope, erodes easily.
11B*:						
Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Colo	Moderate: seepage, slope.	Severe: wetness.	Flooding, frost action, slope.	Flooding, wetness, slope.	Wetness	Wetness.
Ackmore	Moderate: seepage, slope.	Severe: hard to pack, wetness.	Flooding, slope, frost action.	Wetness, erodes easily, slope.	Wetness, erodes easily.	Wetness, erodes easily.
24C3: Shelby	Moderate: slope.	Slight	Deep to water	Slope	Favorable	Favorable.
24D2, 24D3, 24E3, 24F3: Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
54: Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed	Not needed.
71D*:						
Dickman	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Marshall	Severe: slope.	Slight	Deep to water	Slope	Erodes easily, slope.	Slope, erodes easily.
93D2*, 93D3*, 93E2*, 93E3*:						
Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Adair	Severe: slope.	Moderate: wetness.	Percs slowly, slope, frost action.	Wetness, percs slowly, slope.	Slope, wetness.	Wetness, slope.
99C2: Exira	Moderate: seepage, slope.	Moderate: hard to pack.	Deep to water	Slope	Erodes easily	Erodes easily.

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
99D2, 99D3, 99E2-- Exira	Severe: slope.	Moderate: hard to pack.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
133--------------- Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness--------	Wetness.
179E, 179F, 179G-- Gara	Severe: slope.	Slight---------	Deep to water	Slope----------	Slope----------	Slope.
192C2------------- Adair	Moderate: slope.	Moderate: wetness.	Percs slowly, slope, frost action.	Wetness, percs slowly, slope.	Wetness--------	Wetness.
192D2, 192D3------ Adair	Severe: slope.	Moderate: wetness.	Percs slowly, slope, frost action.	Wetness, percs slowly, slope.	Slope, wetness.	Wetness, slope.
212--------------- Kennebec	Moderate: seepage.	Moderate: thin layer, piping, wetness.	Deep to water	Flooding-------	Favorable------	Favorable.
220--------------- Nodaway	Moderate: seepage.	Severe: piping.	Deep to water	Flooding, erodes easily.	Erodes easily	Erodes easily.
222D2------------- Clarinda	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, wetness, erodes easily.	Wetness, slope, erodes easily.
248--------------- Wabash	Slight---------	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
268C-------------- Knox	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
268D, 268E, 268F-- Knox	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
273C-------------- Olmitz	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Favorable------	Favorable.
370B, 370B2, 370C, 370C2------------ Sharpsburg	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
370D2------------- Sharpsburg	Severe: slope.	Slight---------	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
430--------------- Ackmore	Moderate: seepage.	Severe: hard to pack, wetness.	Flooding, frost action.	Wetness, erodes easily.	Wetness, erodes easily.	Wetness, erodes easily.
509--------------- Marshall	Moderate: seepage.	Slight---------	Deep to water	Favorable------	Erodes easily	Erodes easily.
509B, 509C2------- Marshall	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
822D2------------- Lamoni	Severe: slope.	Moderate: wetness, hard to pack.	Percs slowly, slope.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Slope, wetness, percs slowly.
980G*: Gullied land.						

See footnote at end of table.

TABLE 14.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
980G*:						
Judson-----------	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
5010*. Pits						
5040. Orthents						

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1C3-------------- Ida	0-60	Silt loam---------	ML, CL	A-4, A-6	0	100	100	95-100	95-100	30-40	5-15
7B--------------- Wiota	0-19	Silty clay loam	CL	A-6	0	100	100	100	90-95	30-40	10-20
	19-46	Silty clay loam	CL	A-7	0	100	100	95-100	90-95	40-50	15-25
	46-60	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	90-95	40-50	20-30
8B, 8C----------- Judson	0-29	Silty clay loam	CL, CL-ML	A-6, A-7, A-4, A-5	0	100	100	100	95-100	25-50	5-25
	29-41	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	41-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4, A-5	0	100	100	100	95-100	25-50	5-25
9, 9B------------ Marshall	0-20	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	20-42	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	42-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
9B2-------------- Marshall	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	8-42	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	42-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
9C--------------- Marshall	0-20	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	20-42	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	42-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
9C2, 9D2, 9E2, 9E3------------- Marshall	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	8-42	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	42-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
11B*:											
Judson----------	0-29	Silty clay loam	CL, CL-ML	A-6, A-7, A-4, A-5	0	100	100	100	95-100	25-50	5-25
	29-41	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	41-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4, A-5	0	100	100	100	95-100	25-50	5-25
Colo------------	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-49	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	49-60	Silty clay loam, clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
Ackmore---------	0-25	Silt loam--------	CL, ML	A-4, A-6, A-7, A-5	0	100	100	95-100	85-100	25-50	8-20
	25-60	Silty clay loam, silt loam.	CH, CL, MH, ML	A-7, A-6	0	100	100	95-100	85-100	35-60	15-30
24C3, 24D2, 24D3, 24E3, 24F3------ Shelby	0-6	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	6-44	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	44-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
54--------------- Zook	0-22	Silty clay loam	CH, CL	A-7	0	100	100	95-100	95-100	45-65	20-35
	22-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
71D*:											
Dickman---------	0-16	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	16-60	Fine sand, loamy sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP
Marshall--------	0-20	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	20-42	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	42-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
93D2*, 93D3*, 93E2*, 93E3*:											
Shelby---------	0-6	Clay loam--------	CL	A-6, A-7	0	90-95	85-95	75-90	55-70	35-45	15-25
	6-44	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	44-60	Clay loam--------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Adair----------	0-8	Clay loam--------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	10-20
	8-34	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
	34-60	Clay loam--------	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-50	15-25
99C2, 99D2, 99D3, 99E2------------ Exira	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	8-49	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	49-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
133-------------- Colo	0-11	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-60	15-30
	11-49	Silty clay loam	CL, CH	A-7	0	100	100	90-100	90-100	40-55	20-30
	49-60	Silty clay loam, silt loam.	CL, CH	A-7	0	100	100	95-100	80-100	40-55	15-30
179E, 179F, 179G- Gara	0-9	Loam-------------	CL, CL-ML	A-4, A-6	0	95-100	85-95	75-85	55-70	20-30	5-15
	9-48	Clay loam, loam	CL	A-6	0-5	90-95	85-95	70-85	55-75	30-40	15-25
	48-60	Loam, clay loam	CL	A-6, A-7	0-5	90-95	85-95	70-85	55-75	35-45	15-25
192C2, 192D2, 192D3----------- Adair	0-8	Clay loam--------	CL	A-6	0	95-100	80-95	75-90	60-80	30-40	10-20
	8-34	Silty clay, clay, clay loam.	CL, CH	A-7	0	95-100	80-95	70-90	55-80	40-55	20-30
	34-60	Clay loam--------	CL	A-6, A-7	0	95-100	80-95	70-90	55-80	35-50	15-25
212-------------- Kennebec	0-40	Silt loam--------	CL	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	40-60	Silt loam, silty clay loam.	CL, CL-ML	A-6, A-4	0	100	100	95-100	90-100	25-40	5-15
220-------------- Nodaway	0-60	Silt loam--------	CL, CL-ML	A-4, A-6	0	100	95-100	95-100	90-100	25-35	5-15
222D2------------ Clarinda	0-8	Silty clay loam	CL	A-7	0	100	95-100	90-100	85-100	40-50	20-30
	8-28	Silty clay, clay	CH	A-7	0	100	95-100	85-100	80-100	55-70	30-40
	28-60	Clay, silty clay	CH	A-7	0	95-100	95-100	80-95	75-90	55-70	35-45
248-------------- Wabash	0-18	Silty clay loam	CL, CH	A-6, A-7	0	100	100	100	95-100	30-55	12-35
	18-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
268C, 268D, 268E, 268F------------ Knox	0-15	Silt loam--------	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	90-100	20-35	2-15
	15-50	Silty clay loam, silt loam.	CL	A-7	0	100	100	95-100	95-100	40-50	20-30
	50-60	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	95-100	90-100	30-45	11-25

See footnote at end of table.

TABLE 15.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
273C-------------- Olmitz	0-30	Loam, clay loam	CL	A-6	0	100	90-100	85-95	60-80	30-40	11-20
	30-60	Clay loam--------	CL	A-6, A-7	0	100	90-100	85-95	60-80	35-45	15-25
370B-------------- Sharpsburg	0-18	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	18-24	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	24-48	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	48-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
370B2------------- Sharpsburg	0-8	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	8-24	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	24-48	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	48-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
370C-------------- Sharpsburg	0-18	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	18-24	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	24-48	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	48-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
370C2, 370D2----- Sharpsburg	0-8	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	18-32
	8-24	Silty clay loam	CH, CL	A-7	0	100	100	100	95-100	40-60	20-35
	24-48	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	48-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
430--------------- Ackmore	0-25	Silt loam--------	CL, ML	A-4, A-6, A-7, A-5	0	100	100	95-100	85-100	25-50	8-20
	25-60	Silty clay loam, silt loam.	CH, CL, MH, ML	A-7, A-6	0	100	100	95-100	85-100	35-60	15-30
509, 509B-------- Marshall	0-20	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	20-57	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	57-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
509C2------------ Marshall	0-8	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	15-25
	8-57	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
	57-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
822D2------------ Lamoni	0-9	Silty clay loam	CL	A-6, A-7	0	95-100	95-100	80-95	70-95	35-45	15-25
	9-33	Clay loam, clay	CH	A-7	0	95-100	95-100	90-100	85-100	50-60	25-35
	33-60	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	70-90	55-85	35-50	15-30
980G*: Gullied land.											
Judson-----------	0-29	Silty clay loam	CL, CL-ML	A-6, A-7, A-4, A-5	0	100	100	100	95-100	25-50	5-25
	29-41	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
	41-60	Silty clay loam, silt loam.	CL, CL-ML	A-6, A-7, A-4, A-5	0	100	100	100	95-100	25-50	5-25
5010*. Pits											
5040. Orthents											

* 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. 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/cm3	In/hr	In/in	pH					Pct
1C3---------------- Ida	0-60	18-25	1.20-1.30	0.6-2.0	0.20-0.22	6.6-8.4	Low----------	0.43	5-4	4L	.5-1
7B---------------- Wiota	0-19	24-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	6	3-4
	19-46	30-36	1.30-1.40	0.6-2.0	0.18-0.20	5.1-6.5	Moderate-----	0.43			
	46-60	28-34	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
8B, 8C----------- Judson	0-29	25-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	3-5
	29-41	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43			
	41-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate-----	0.43			
9, 9B------------ Marshall	0-20	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	3-5
	20-42	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	42-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
9B2-------------- Marshall	0-8	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	2-3
	8-42	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	42-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
9C--------------- Marshall	0-20	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	3-4
	20-42	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	42-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
9C2, 9D2, 9E2, 9E3------------- Marshall	0-8	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	.5-3
	8-42	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	42-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
11B*:											
Judson----------	0-29	25-32	1.30-1.35	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.28	5	7	4-5
	29-41	30-35	1.35-1.45	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.43			
	41-60	25-32	1.35-1.45	0.6-2.0	0.21-0.23	6.1-7.8	Moderate-----	0.43			
Colo------------	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-49	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	High---------	0.28			
	49-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
Ackmore---------	0-25	25-30	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.37	5	6	2-4
	25-60	26-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.8	High---------	0.37			
24C3, 24D2, 24D3, 24E3, 24F3------ Shelby	0-6	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28	4	6	.5-2
	6-44	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	44-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
54--------------- Zook	0-22	32-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	22-60	36-45	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	High---------	0.28			
71D*:											
Dickman---------	0-16	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	Low----------	0.20	3	3	2-4
	16-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	Low----------	0.15			
Marshall--------	0-20	27-35	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.32	5	7	1-3
	20-42	27-34	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	42-60	22-30	1.30-1.40	0.6-2.0	0.20-0.22	6.6-7.3	Moderate-----	0.43			
93D2*, 93D3*, 93E2*, 93E3*:											
Shelby----------	0-6	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28	4	6	.5-2
	6-44	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.1-7.3	Moderate-----	0.28			
	44-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
93D2*, 93D3*, 93E2*, 93E3*:											
Adair----------	0-8	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate-----	0.32	2	6	.5-3
	8-34	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High---------	0.32			
	34-60	30-38	1.60-1.85	0.2-0.6	0.14-0.16	5.6-7.8	Moderate-----	0.32			
99C2, 99D2, 99D3, 99E2------------ Exira	0-8	28-34	1.25-1.35	0.6-2.0	0.21-0.23	5.6-6.5	Moderate-----	0.32	5-4	7	.5-3
	8-49	25-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-6.5	Moderate-----	0.43			
	49-60	20-30	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
133-------------- Colo	0-11	27-32	1.28-1.32	0.6-2.0	0.21-0.23	5.6-7.3	High---------	0.28	5	7	5-7
	11-49	30-35	1.25-1.35	0.6-2.0	0.18-0.20	5.6-7.3	High---------	0.28			
	49-60	25-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	High---------	0.28			
179E, 179F, 179G- Gara	0-9	24-27	1.50-1.55	0.6-2.0	0.20-0.22	5.6-7.3	Moderate-----	0.28	5	6	.5-3
	9-48	25-38	1.55-1.75	0.2-0.6	0.16-0.18	4.5-6.5	Moderate-----	0.28			
	48-60	24-38	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	Moderate-----	0.37			
192C2, 192D2, 192D3----------- Adair	0-8	27-35	1.45-1.50	0.2-0.6	0.17-0.19	5.6-7.3	Moderate-----	0.32	2	6	.5-3
	8-34	38-50	1.50-1.60	0.06-0.2	0.13-0.16	5.1-6.5	High---------	0.32			
	34-60	30-38	1.60-1.85	0.2-0.6	0.14-0.16	5.6-7.8	Moderate-----	0.32			
212-------------- Kennebec	0-40	22-30	1.25-1.35	0.6-2.0	0.22-0.24	5.6-7.3	Moderate-----	0.32	5	6	4-6
	40-60	24-28	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Moderate-----	0.43			
220-------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	Moderate-----	0.37	5	6	1-3
222D2------------ Clarinda	0-8	30-38	1.45-1.50	0.2-0.6	0.17-0.19	5.1-7.3	Moderate-----	0.37	3	7	1-3
	8-28	40-60	1.45-1.60	<0.06	0.14-0.16	5.1-6.5	High---------	0.37			
	28-60	40-60	1.55-1.75	<0.06	0.14-0.16	5.6-7.3	High---------	0.37			
248-------------- Wabash	0-18	20-35	1.35-1.50	0.06-0.2	0.21-0.24	5.6-7.3	High---------	0.28	5	4	4-6
	18-60	40-60	1.20-1.45	<0.06	0.08-0.12	5.6-7.8	Very high----	0.28			
268C, 268D, 268E, 268F------------ Knox	0-15	18-27	1.20-1.30	0.6-2.0	0.22-0.24	5.6-7.3	Low----------	0.32	5	6	1-3
	15-50	25-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.3	Moderate-----	0.43			
	50-60	18-30	1.20-1.40	0.6-2.0	0.20-0.22	6.1-7.3	Low----------	0.43			
273C------------- Olmitz	0-30	24-34	1.40-1.45	0.6-2.0	0.19-0.21	5.6-7.3	Moderate-----	0.28	5	6	3-4
	30-60	28-34	1.45-1.55	0.6-2.0	0.15-0.17	5.1-6.5	Moderate-----	0.28			
370B------------- Sharpsburg	0-18	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	3-4
	18-24	32-38	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	24-48	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	48-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
370B2------------ Sharpsburg	0-8	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	2-3
	8-24	32-38	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	24-48	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	48-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
370C------------- Sharpsburg	0-18	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	3-4
	18-24	32-38	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	24-48	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	48-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
370C2, 370D2----- Sharpsburg	0-8	27-34	1.30-1.35	0.6-2.0	0.21-0.23	5.1-6.5	Moderate-----	0.32	5	7	1-3
	8-24	32-38	1.35-1.40	0.2-0.6	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	24-48	30-38	1.40-1.45	0.6-2.0	0.18-0.20	5.1-6.0	Moderate-----	0.43			
	48-60	28-32	1.40-1.45	0.6-2.0	0.18-0.20	6.1-6.5	Moderate-----	0.43			
430-------------- Ackmore	0-25	25-30	1.25-1.30	0.6-2.0	0.21-0.23	5.6-7.3	Moderate-----	0.37	5	6	2-4
	25-60	26-35	1.30-1.40	0.6-2.0	0.18-0.20	5.6-7.8	High---------	0.37			

See footnote at end of table.

TABLE 16.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH					Pct
509, 509B-------- Marshall	0-20 20-57 57-60	27-35 27-34 22-30	1.25-1.30 1.30-1.35 1.30-1.40	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.23 0.18-0.20 0.20-0.22	5.6-7.3 5.6-7.3 6.6-7.3	Moderate----- Moderate----- Moderate-----	0.32 0.43 0.43	5	7	3-5
509C2------------ Marshall	0-8 8-57 57-60	27-35 27-34 22-30	1.25-1.30 1.30-1.35 1.30-1.40	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.23 0.18-0.20 0.20-0.22	5.6-7.3 5.6-7.3 6.6-7.3	Moderate----- Moderate----- Moderate-----	0.32 0.43 0.43	5	7	2-3
822D2------------ Lamoni	0-9 9-33 33-60	27-40 38-50 32-40	1.45-1.50 1.55-1.75 1.75-1.85	0.2-0.6 <0.2 0.06-0.2	0.17-0.21 0.13-0.17 0.14-0.18	5.1-7.3 5.1-6.5 5.6-7.3	Moderate----- High--------- High---------	0.32 0.32 0.32	2	7	1-3
980G*: Gullied land.											
Judson-----------	0-29 29-41 41-60	25-32 30-35 25-32	1.30-1.35 1.35-1.45 1.35-1.45	0.6-2.0 0.6-2.0 0.6-2.0	0.21-0.23 0.21-0.23 0.21-0.23	5.6-7.3 5.6-7.3 6.1-7.8	Moderate----- Moderate----- Moderate-----	0.28 0.43 0.43	5	7	3-5
5010*. Pits											
5040. Orthents											

* 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 more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
1C3 Ida	B	None	---	---	>6.0	---	---	High	Low	Low.
7B Wiota	B	Rare	---	---	>6.0	---	---	High	Moderate	Moderate.
8B, 8C Judson	B	None	---	---	>6.0	---	---	High	Moderate	Low.
9, 9B, 9B2, 9C, 9C2, 9D2, 9E2, 9E3 Marshall	B	None	---	---	>6.0	---	---	High	Moderate	Moderate.
11B*:										
Judson	B	None	---	---	>6.0	---	---	High	Moderate	Low.
Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
Ackmore	B	Occasional	Very brief to brief.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Low.
24C3, 24D2, 24D3, 24E3, 24F3 Shelby	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
54 Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
71D*:										
Dickman	A	None	---	---	>6.0	---	---	Low	Low	Moderate.
Marshall	B	None	---	---	>6.0	---	---	High	Moderate	Moderate.
93D2*, 93D3*, 93E2*, 93E3*:										
Shelby	B	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
Adair	D	None	---	---	1.0-3.0	Perched	Nov-Jul	High	High	Moderate.
99C2, 99D2, 99D3, 99E2 Exira	B	None	---	---	>6.0	---	---	High	Moderate	Moderate.
133 Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High	High	Moderate.
179E, 179F, 179G Gara	C	None	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
192C2, 192D2, 192D3 Adair	D	None	---	---	1.0-3.0	Perched	Nov-Jul	High	High	Moderate.
212 Kennebec	B	Occasional	Brief	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	High	Moderate	Low.
220 Nodaway	B	Frequent	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Nov-Jul	High	Moderate	Low.
222D2 Clarinda	D	None	---	---	1.0-3.0	Perched	Nov-Jul	High	High	Moderate.

See footnote at end of table.

TABLE 17.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months		Uncoated steel	Concrete
					Ft					
248---------------- Wabash	D	Occasional	Brief to long.	Nov-May	0-1.0	Apparent	Nov-Jul	Moderate	High-----	Moderate.
268C, 268D, 268E, 268F------------- Knox	B	None---------	---	---	>6.0	---	---	High-----	Low------	Low.
273C--------------- Olmitz	B	None---------	---	---	>6.0	---	---	Moderate	Moderate	Moderate.
370B, 370B2, 370C, 370C2, 370D2----- Sharpsburg	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
430---------------- Ackmore	B	Occasional	Very brief to brief.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	High-----	High-----	Low.
509, 509B, 509C2-- Marshall	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Moderate.
822D2------------- Lamoni	D	None---------	---	---	1.0-3.0	Perched	Nov-Jul	Moderate	High-----	Moderate.
980G*: Gullied land.										
Judson------------	B	None---------	---	---	>6.0	---	---	High-----	Moderate	Low.
5010*. Pits										
5040. Orthents										

* 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
Ackmore	Fine-silty, mixed, nonacid, mesic Aeric Fluvaquents
*Adair	Fine, montmorillonitic, mesic Aquic Argiudolls
*Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
*Exira	Fine-silty, mixed, mesic Typic Hapludolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Ida	Fine-silty, mixed (calcareous), mesic Typic Udorthents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
Knox	Fine-silty, mixed, mesic Mollic Hapludalfs
*Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Olmitz	Fine-loamy, mixed, mesic Cumulic Hapludolls
Orthents	Loamy, mixed, mesic Typic Udorthents
*Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
*Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wiota	Fine-silty, mixed, mesic Typic Argiudolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

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