SOIL SURVEY OF

Appanoose County, Iowa

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

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey.

Major fieldwork for this soil survey was completed in the period 1964–1968. Soil names and descriptions were approved in 1970. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1968. This survey was made cooperatively by the Soil Conservation Service and the Iowa Agriculture and Home Economics Experiment Station and Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished by the Appanoose County Soil Conservation District.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of Appanoose County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Guide to Mapping Units" can be used to find information. This guide lists all the soils of the county in numerical order by map symbol and gives the capability classification of each. It also shows the page where each soil is described and the page for the capability group to which the soil has been assigned.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and the information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils that have a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the discussions of the woodland groups.

Foresters and others can refer to the section "Woodland," where the soils of the county are grouped according to their suitability for trees.

Engineers and builders can find under "Engineering Properties of Soils" tables that contain test data, estimates of soil properties, and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of the Soils."

Newcomers in Appanoose County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given at the beginning of the publication.

Cover: Contour tillage and crop rotation on Pershing and Seymour soils help reduce soil loss.

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Issued January 1977

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SOIL SURVEY OF APPANOOSE COUNTY, IOWA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH THE IOWA AGRICULTURE AND HOME ECONOMICS EXPERIMENT STATION AND THE COOPERATIVE EXTENSION SERVICE, IOWA STATE UNIVERSITY, AND THE DEPARTMENT OF SOIL CONSERVATION, STATE OF IOWA

APPANOOSE COUNTY is in the southeastern part of Iowa (fig. 1). It has a total area of about 523 square miles, or 334,720 acres. Centerville, the county seat and largest town, is about 90 miles southeast of Des Moines, the State capital.

Most of the acreage of the county is in farms, and the population is mostly rural. Corn, soybeans, oats, hay, and pasture are the main crops. Corn is the principal grain crop. Most of the grain and forage that is grown on the farms is fed to hogs and feeder cattle.

Many of the nearly level to gently sloping soils on uplands formed under prairie vegetation, and many of the more sloping soils on uplands, such as those in the northeastern part of the county, formed under grass and forest or forest vegetation. The more intensively cropped areas generally are nearly level to sloping, and the more sloping areas are used largely for pasture or are wooded. Much of the acreage on the bottom lands such as those near the Chariton River are used for row crops. The climate is subhumid and continental. Winters are cold, summers are warm, and the growing season is long enough for crops grown in the county to mature. Elevation in the county ranges from approximately 800 feet to 1,080 feet above sea level.

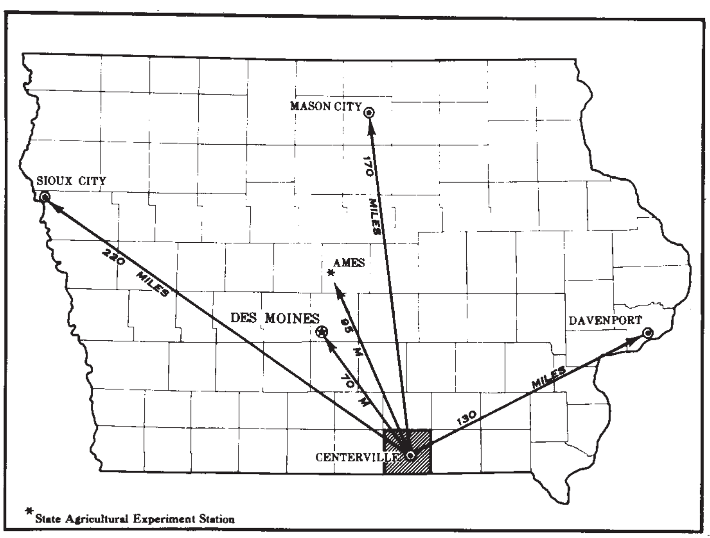

Figure 1.—**Location of Appanoose County in Iowa.**

The Climate of Appanoose County[1]

Appanoose County is located in the southernmost tier of Iowa counties, fourth from the Mississippi River and seventh from the Missouri River. Drainage is to the south and east. The primary stream, the Chariton River, traverses the county from the northwest corner to the southeast corner. Centerville is centrally located and is representative of the county. Minimum temperatures are variable over the rolling county, particularly on clear, calm nights. Rural valley temperatures generally are a few degrees or more lower than those on uplands or in urbanized areas.

Annual precipitation increases southeastward across the county. It is about 33.3 inches in the northwest and 34.2 inches in the southeast. About 70 percent of the precipitation falls during the cropping season, April to September. About 170 days per year have a trace or more of rain: 105 have at least 0.01 inch, 62 have 0.10 inch or more, and 25 have half an inch or more. Most of the heavy showers fall in spring and early in summer, when newly tilled fields are likely to be severely eroded.

Average annual snowfall is about 27 inches. Snowfalls of an inch or more first occur early in December and occur as late as early in March. First and last snow flurries generally occur early in November and in April, respectively. Snow accumulated as deep as 22 inches in February 1936 and March 1960.

Ideally, in the cropping season the subsoil contains abundant moisture. Variations from ideal soil moisture are frequent and occasionally extreme. Rain showers generally are heaviest in May and June followed by drier weather in July and August. Well-developed corn requires about an inch of moisture each week for

[1] By PAUL J. WAITE, State climatologist, National Weather Service.

optimum growth. The chance of receiving an inch or more rainfall each week in the maximum growing season varies from nearly one in two in the first half of June to one in five in the last half of July.

Temperatures have varied from −24° F to 110° in the past four decades. Freezing temperatures occur on about 140 days a year and temperatures equal to or greater than 90° occur on about 33 days each cropping season. Temperature of 90° is about the point at which optimum corn growth ceases. For Centerville, the average date of the last occurrence of a 32° freeze in spring is April 28. The average date of the first in fall is October 12. The average length of a growing season defined by these dates is 167 days. Table 1 gives the climatological summary for Centerville, Iowa.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Appanoose County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and speed of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Pershing and Kniffin, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface soil and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Weller silt loam, 2 to 5 percent slopes, is one of several phases within the Weller series.

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

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil of some other kind that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Only

TABLE 1.—*Temperature and precipitation*

[All data from Centerville, Appanoose County]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Average maximum	Average minimum	Average total	One year in 10 will have— Less than—	One year in 10 will have— More than—	Average number of days with snow cover of 1 inch or more	Average depth of snow on days with snow cover
	°F	°F	°F	°F	Inches	Inches	Inches		Inches
January	35	16	56	—11	1.4	0.3	2.9	12	5
February	39	19	57	—5	1.1	0.3	2.1	9	5
March	48	28	73	5	2.4	0.5	4.5	6	6
April	63	40	83	23	3.3	1.0	6.3	([1])	3
May	74	51	88	34	3.8	1.3	5.7	--	–
June	83	61	93	46	5.3	1.8	8.6	--	–
July	89	65	97	52	3.2	1.0	6.8	--	–
August	86	64	96	49	4.2	1.0	8.1	--	–
September	79	55	91	35	3.4	0,5	8.7	1	1
October	68	44	84	26	2.4	0.1	6.2	0	0
November	51	30	71	10	1.7	0.2	2.4	2	2
December	39	21	60	—4	1.3	0.5	2.4	9	3
Year	63	41	98	—13	33.5	27.7	40.7	38	5

[1] Less than 0.5.

one such mapping unit is shown on the soil map of Appanoose County: the soil complex.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. The name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded, is an example.

In most areas surveyed there are places where the soil material is so wet, so rocky, so shallow, or so severely eroded that it cannot be classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Marsh is a land type in Appanoose County.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

The soil scientists set up trial groups of soils on the basis of yield and practice tables and other data they have collected. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under present methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in Appanoose County. A soil association is a landscape that has a distinctive proportional pattern of soils. It normally consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association may occur in another, but in a different pattern.

A map showing soil associations is useful to people who want a general idea of the soils in a county, who want to compare different parts of a county, or who want to know the location of large tracts that are suitable for a certain kind of land use. Such a map is a useful general guide in managing a watershed, a wooded tract, or a wildlife area, or in planning engineering works, recreational facilities, and community developments. It is not a suitable map for planning the management of a farm or field, or for selecting the exact location of a road, building, or similar structure, because the soils in any one association ordinarily differ in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The seven soil associations in Appanoose County are described in the following pages.

1. Edina-Seymour-Clarinda association

Dark colored to moderately dark colored, poorly drained and somewhat poorly drained, nearly level to moderately sloping soils that have a clayey subsoil; formed in loess and glacial till on uplands

This association consists of nearly level soils on wide upland divides and of gently sloping to moderately sloping soils on the tops and sides of ridges. In places it is dissected by moderately wide, slightly concave drainageways. These drainageways originate in this association and are not so deeply entrenched as they are in other associations. A few scattered trees grow in the drainageways and along fences. This association is at a higher elevation than the adjacent associations.

This association makes up about 30 percent of the county. It is 27 percent Edina soils, 26 percent Seymour soils, 26 percent Clarinda soils, and 21 percent soils of minor extent.

Edina soils are on uplands, are nearly level, and are poorly drained. They formed in loess 6 to 8 feet thick (fig. 2). The surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer is very dark gray silt loam that dries to light gray. The subsoil, at a depth of 21 inches, is black and very dark gray, very slowly permeable silty clay in the upper part and mottled olive-gray silty clay loam in the lower part.

Seymour soils are gently sloping and moderately sloping and somewhat poorly drained. They are generally adjacent to the nearly level Edina soils. They formed in loess adjacent to the nearly level Edina soils. They formed in loess 6 to 8 feet thick. The surface layer is very dark gray silt loam. The subsoil is mottled, dark grayish-brown silty clay.

Clarinda soils are moderately sloping, poorly drained soils in slightly concave drainageways (fig. 3). They formed in highly weathered glacial till. The surface layer is very dark gray silty clay loam. The subsoil, 3 to 5 feet thick, is mottled dark-gray clay or silty clay in the upper part.

Less extensive in this association are Appanoose, Kniffin, Belinda, Adair, and Lineville soils. The nearly level Appanoose and Belinda soils are on divides, and the gently sloping Adair, Kniffin, and Lineville soils are on narrow ridgetops. Appanoose, Kniffin, and Belinda soils formed in loess under a cover of trees and grasses. Adair soils formed in highly weathered glacial till. Lineville soils formed in loess underlain by other sediments and weathered glacial till.

This association is an important grain-producing area in the county. Most of the soils are well suited to cultivated crops. The nearly level Edina soils are used extensively for row crops. Residue management, crop rotations, and contour tillage, terracing, or stripcropping are needed on the moderately sloping Seymour and Clarinda soils. Surface drainage is needed on the poorly drained Edina soils. Moderate slopes and poor drainage make the Clarinda soils difficult to manage.

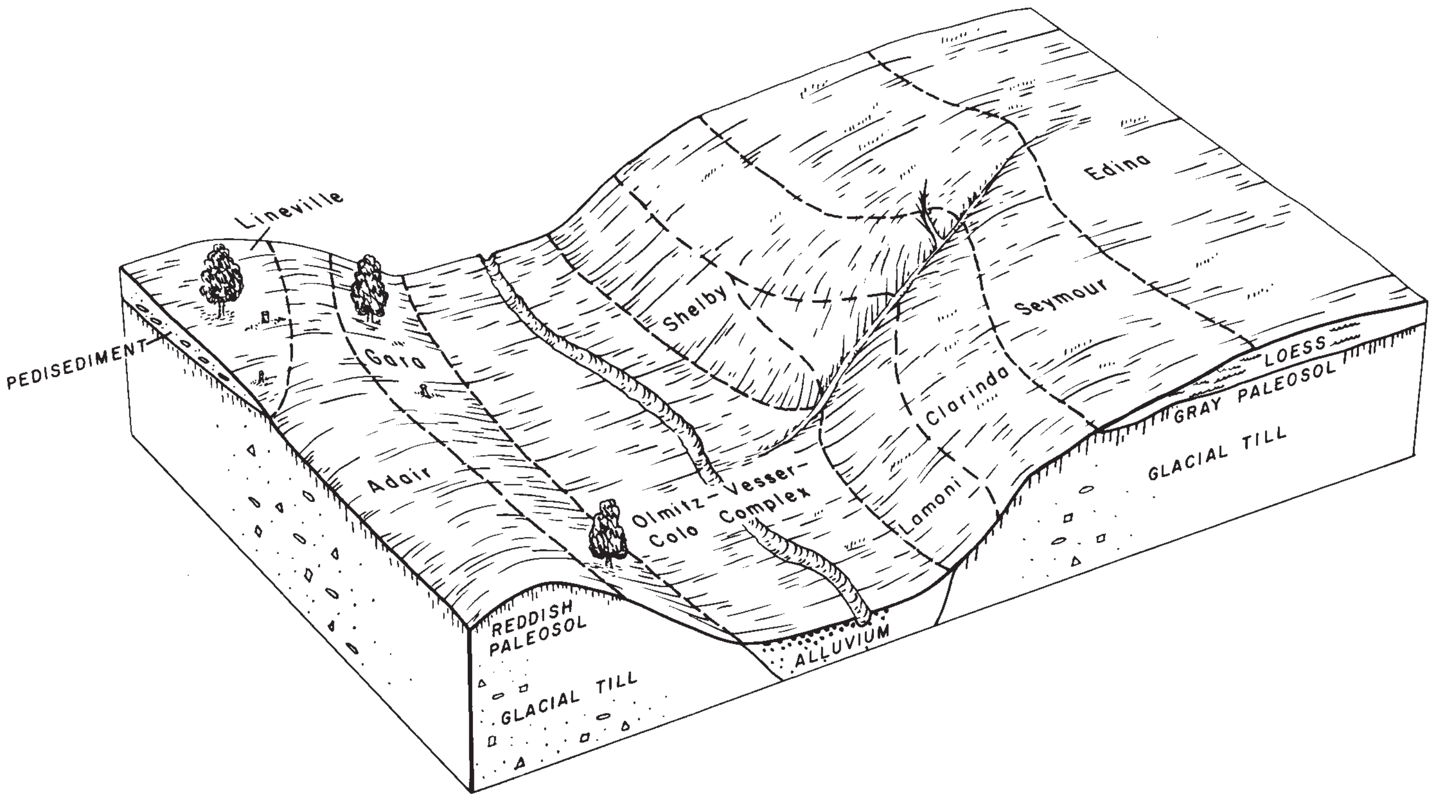

Figure 2.—**Typical pattern of soils and parent material in association 1.**

A large part of the association is used for corn and soybeans. On many farms the grain is fed to livestock. Nearly all farmsteads are occupied and are in good repair. Farms vary in size, but many are between 160 and 240 acres. Almost all roads are on section lines.

In most areas fertility is medium to low, and additions of nitrogen, phosphorous, potassium, and lime are needed. Response is good to applications of fertilizer and lime.

2. *Clarinda-Grundy-Haig association*

Dark-colored, poorly drained and somewhat poorly drained, nearly level to moderately sloping soils that have a clayey subsoil; formed in glacial till and loess on uplands

This association consists of nearly level soils on wide upland divides and of gently sloping to moderately sloping soils on the tops and sides of ridges and in concave drainageways. In places it is dissected by moderately wide, slightly concave drainageways. These drainageways originate in this association and are not so deeply entrenched as they are in other associations. A few scattered trees grow in the drainageways and along fences. This association is at a higher elevation than the adjacent associations.

This association makes up about 5 percent of the county. It is about 27 percent Clarinda soils, 26 percent Grundy soils, 16 percent Haig soils, and 31 percent soils of minor extent.

The poorly drained, gently sloping and moderately sloping Clarinda soils are below Grundy and Haig soils. In most areas they are moderately eroded. They formed in highly weathered glacial till that is commonly called gumbotil. The surface layer is dark-gray silty clay loam about 10 inches thick. The subsoil extends to a depth of 48 inches or more. It is very firm clay or silty clay that is mottled dark gray in the upper part and light brownish gray below a depth of 31 inches.

Grundy soils are gently sloping and somewhat poorly drained and commonly are between the nearly level Haig soils and the sloping Clarinda soils. The surface layer is black or very dark gray silty clay loam 18 inches thick. The upper 4 inches of the subsoil is dark-gray silty clay loam. Below a depth of 22 inches it is dark-gray silty clay. Beginning at a depth of 41 inches, the subsoil is mottled light olive-gray silty clay loam. Mottling begins at a depth of about 13 inches.

Haig soils are on uplands, are nearly level, and are poorly drained. The surface layer is black silty clay loam 13 inches thick. Mottling begins at a depth of 13 inches and extends throughout the profile. The subsoil is black to very dark gray silty clay in the upper part and olive-gray silty clay loam below a depth of 42 inches.

Less extensive in this association are the Edina, Belinda, Pershing, Lineville, and Adair soils. Edina and Belinda soils are on flats and have a lighter colored

Figure 3.—**Representative landscape of moderately sloping Clarinda soils and nearly level Seymour and Edina soils on soil association 1. Trees along the natural drain are on the Olmitz-Vesser-Colo complex.**

surface layer than the Haig and Grundy soils. The Pershing soils have gentle slopes. Lineville soils are on the lower slopes, and the sloping Adair soils are on the ridgetops and upper side slopes.

This is one of the most productive associations in the county. Nearly all of it is well suited to row crops. The nearly level Haig and the gently sloping Grundy soils are used intensively for row crops, mainly corn and soybeans. Crop rotations, crop residue management, and contour tillage or terracing are needed on the moderately sloping soils. Livestock is raised on many farms and the grain grown is fed to hogs, cattle, and some dairy herds. Farms vary in size, but many are between 200 and 300 acres. The general trend is toward larger farm units.

Fertility in this association is low to medium, and additions of nitrogen, phosphorus, potassium, and lime are needed. Response is good to applications of lime and fertilizer.

3. *Gara-Armstrong-Shelby association*

Dark colored to moderately dark colored, moderately well drained and somewhat poorly drained, moderately sloping to steep soils that have a loamy and clayey subsoil; formed in glacial till on uplands

This association consists of moderately sloping soils on narrow rounded ridgetops and moderately steep and steep soils on side slopes that are dissected by waterways. Narrow valleys are typical of this association. The main branches of upland drainageways originate in this association. Gullies and noncrossable drains are common and affect field size and shape.

This association makes up about 36 percent of the county. It is 18 percent Gara soils, 14 percent Armstrong soils, 6 percent Shelby soils, and 62 percent soils of minor extent and Lake Rathbun.

Gara soils are dominantly strongly sloping to steep and are moderately well drained. They are on the lower parts of side slopes below areas of Armstrong and Lamoni soils. The soils formed in glacial till under a plant cover of grasses and forest. The surface layer is very dark gray loam in the upper 6 inches and dark grayish-brown loam in the lower part. The subsoil is brown or dark yellowish-brown firm clay loam.

Armstrong soils are moderately sloping to moderately steep and are somewhat poorly drained and moderately well drained. They are on the lower parts of ridgetops and on the upper parts of side slopes. They formed in weathered leached glacial till under a plant cover of grasses and forest. The upper part of the surface layer is very dark grayish-brown loam 7 inches thick and the lower part is grayish-brown loam. The upper part of the subsoil, from a depth of 11 to 18 inches, is dark yellowish-brown or brown clay loam that has a stone line at its base. Brown clay that has reddish mottles is below a depth of 18 inches. The lower part of the subsoil is mottled, strong-brown to yellowish-brown clay loam.

Shelby soils are strongly sloping and moderately steep and moderately well drained. They formed in glacial till under a plant cover of grasses. The surface layer is black to very dark grayish-brown loam 11 inches thick. The subsoil is brown clay loam in the upper part and yellowish-brown, mottled, firm clay loam below a depth of 28 inches.

Less extensive in this association are gently sloping Pershing, Kniffin, Seymour, and Grundy soils on the higher ridgetops, sloping Lamoni soils on the upper part of drainageways, Lineville soils below loess soils on ridgetops and the upper parts of side slopes, and Caleb and Mystic soils on benchlike areas 30 to 40 feet high along the major stream valleys. Small areas of Gosport, Clanton, and Sogn soils are near the base of steep slopes. Kennebec, Amana, Colo, Vesser, and Humeston soils are on bottoms of narrow valleys.

This association is used mostly for hay and pasture, but the less sloping soils are suited to row crops. The soils are slightly to severely eroded. If row crops are grown, crop rotations that provide protective cover, contour tillage, and terracing are needed. In places gullies and waterways need reshaping and seeding. Farming is diversified, and most of the hay and grain is fed to livestock. Ponds used to water livestock are common. Most ponds are less than 2 acres in size.

Most farmsteads are occupied, but some houses have been abandoned. The general trend is toward larger farm units. Farms vary in size, but many are between 200 and 300 acres.

In most areas fertility is low to medium, and additions of nitrogen, phosphorus, potassium, and lime are needed. Response is fair to applications of fertilizer and lime.

4. Weller-Keswick association

Light-colored, moderately well drained to somewhat poorly drained, gently sloping to strongly sloping soils that have a clayey and loamy subsoil; formed in loess and glacial till on uplands

This association consists of narrow, moderately sloping ridgetops and moderately sloping to strongly sloping side slopes that are dissected by V-shaped waterways. Many fields have been dissected by gullies and noncrossable drains and are thus limited in size and irregular in shape. Scattered trees and shrubs grow along most of the waterways and along the fences that enclose permanent pastures. Patches of forest and scattered trees remain from the original forest cover.

This association makes up 3 percent of the county. It is 48 percent Weller soils, 43 percent Keswick soils, and 9 percent soils of minor extent.

Weller soils are gently sloping to strongly sloping and are moderately well drained to somewhat poorly drained. They formed in loess, mainly on the higher ridgetops. The surface layer is very dark grayish-brown silt loam 5 inches thick, and the subsurface layer is grayish-brown silt loam 11 inches thick. The subsoil extends to a depth of 40 inches. It is mottled grayish-brown to brown silty clay in the upper part and grades to silty clay loam with increasing depth.

Keswick soils are moderately sloping and strongly sloping and somewhat poorly drained to moderately well drained. They are on the lower ridgetops and upper parts of side slopes below areas of Weller soils. They formed in highly weathered, leached glacial till. The surface layer is dark grayish-brown loam 3 inches thick, and the subsurface layer is brown loam 7 inches thick. The upper part of the subsoil is strong-brown clay that has reddish mottles. A distinct stone line is in the upper 4 inches of the subsoil. The lower part of the subsoil is reddish-yellow clay loam.

Less extensive in this association are Armstrong, Beckwith, Belinda, and Pershing soils. Armstrong soils are in similar positions to Keswick soils, but they have a thicker, darker surface layer. Beckwith and Belinda soils are on the highest flat ridgetops above Weller and Pershing soils.

This association is used mainly for hay and pasture, but occasional row crops are grown on the lesser slopes, mostly on the crests of divides. The sloping ridge crests and side slopes are subject to severe erosion. If row crops are grown, they should be planted on the contour in terraced fields and the crop rotation should include a high percentage of close-growing crops. Areas suitable for cultivation are generally small in size and irregular in shape.

Many farms are partly in this association and partly in association 6. Farms vary in size, but many are between 240 and 320 acres. The general trend is toward larger farm units. In many places the roads follow the ridgetops.

In most areas fertility is low, and large additions of nitrogen, phosphorus, potassium, and lime generally are needed. Response is fair to applications of lime and fertilizer.

5. Rathbun-Keswick association

Light-colored, somewhat poorly drained and moderately well drained, gently sloping to strongly sloping soils that have a dominantly clayey subsoil; formed in loess and glacial till on uplands

This association consists of narrow, sloping ridgetops and adjoining moderately to strongly sloping side slopes that are dissected by V-shaped valley waterways. Many fields and farms have been dissected by gullies and noncrossable drains and are thus limited in size and irregular in shape. Scattered trees and brush grow along most of the waterways and fence rows. Patches of forest and scattered trees remain from the original forest cover.

This association makes up 4 percent of the county. It is 47 percent Rathbun soils, 42 percent Keswick soils, and 11 percent soils of minor extent.

Rathbun soils are somewhat poorly drained. They are gently sloping and moderately sloping and are on higher ridgetops. They formed in loess. The surface layer is very dark gray silt loam 4 inches thick, and the subsurface layer is yellowish-brown silt loam 9 inches thick. The subsoil is brown or yellowish-brown silty clay in the upper part that grades to mottled grayish-brown silty clay loam in the lower part.

Keswick soils are somewhat poorly drained and moderately well drained and moderately sloping and strongly sloping. They are on lower parts of ridgetops and upper parts of side slopes below areas of Rathbun soil. They formed in highly weathered, leached glacial till. The surface layer is grayish-brown loam 3 inches thick. Below this is a brown loam layer 7 inches thick. A distinct stone line is in the upper 4 inches of the clay loam subsoil. The subsoil, beginning at a depth of 14 inches, is reddish-brown clay that has reddish mottles. The lower part of the subsoil is reddish-yellow clay loam.

Less extensive in this association are Appanoose, Armstrong, and Kniffin soils. Appanoose soils are at higher elevations on flat ridgetops above areas of Kniffin and Rathbun soils. Armstrong soils generally are below areas of Kniffin soils in this association and have a darker surface layer than Keswick soils.

A large acreage of this association is used for hay and pasture, but occasional row crops are grown on the lesser slopes. The sloping ridge crests and side slopes are subject to severe erosion, and terracing, contouring, and frequent meadow crops are needed to reduce soil losses. Areas suitable for cultivation are generally small in size and irregular in shape. Cultivated areas are mostly on the crests of divides.

Many of the farms are partly in this association and partly in associations 1 and 6. Most farms are between 240 and 320 acres in size. The general trend is toward larger farm units. In many places the roads follow the ridgetops.

In most areas fertility is low and large additions of nitrogen, phosphorus, potassium, and lime generally are needed. Response is fair to applications of lime and fertilizer.

6. *Lindley-Gara association*

Moderately dark colored and light colored, moderately well drained, strongly sloping to steep soils that have a loamy subsoil; formed in glacial till on uplands

This association is largely in the south-central, southeast, and northeastern parts of the county. It consists of strongly sloping to steep soils on valley sides that are dissected by V-shaped waterways. It borders the valleys of major streams. Many fields and farms have been dissected by gullies and noncrossable drains and are thus limited in size and irregular in shape. Scattered trees and shrubs grow along most of the waterways and along the fences that enclose permanent pastures (fig. 4).

***Figure 4.*—Typical landscape of strongly sloping Lindley and Gara soils.**

This association makes up 14 percent of the county. It is 52 percent Lindley soils, 8 percent Gara soils, and 40 percent soils of minor extent.

Lindley soils are moderately steep or steep and are moderately well drained. They generally are on the rounded ends of narrow ridgetops or on irregular, complex side slopes. The surface layer is very dark gray loam 3 inches thick. The subsurface layer is yellowish-brown loam 5 inches thick. The subsoil is yellowish-brown firm clay loam.

Gara soils are strongly sloping to steep and are moderately well drained. The surface layer is very dark gray loam 8 inches thick. The subsurface layer is dark grayish-brown loam 6 inches thick. The subsoil is brown or dark yellowish-brown firm clay loam.

Less extensive in this association are Caleb, Mystic, Gosport, Clanton, Sogn, Kennebec, Colo, and Nodaway soils. Caleb, Mystic, Gosport, Clanton, and Sogn soils are on uplands. The Caleb and Mystic soils formed in old alluvium. They generally have the more gentle south- and east-facing slopes in benchlike areas 30 to 40 feet above the bottom lands of the major streams. Small areas of Gosport, Clanton, and Sogn soils formed in shale or limestone. They are at the base of steep slopes along major stream valleys. Kennebec, Colo, and Nodaway soils are on bottom lands in the narrow valleys.

This association is used mainly for hay, pasture, and timber. Standing timber or brush covers about 50 percent of the association. If row crops are grown, they should be planted on the contour in terraced fields, and the crop rotation should include a high percentage of close-growing crops. The hazard of erosion is very severe.

Many of the farms are partly in this association and partly in associations 4, 5, and 7. Many farm buildings are unoccupied. Farms vary in size, but many are between 240 and 320 acres, and others are much larger. The general trend is toward larger farm units. Farm ponds are numerous and provide water for livestock.

In most areas fertility is low to very low, and large additions of nitrogen, phosphorus, potassium, and lime generally are needed. Response is only fair to applications of lime and fertilizer.

7. *Kennebec-Chequest-Vesser association*

Dark colored and moderately dark colored, moderately well drained to poorly drained, nearly level soils that have a loamy subsoil; formed in alluvium on bottom land

This association is largely in the central and eastern parts of the county. It consists of nearly level soils on flood plains that are dissected by abandoned stream channels, particularly channels that have been straightened. Many fields and farms have been dissected by these channels and are thus irregular in shape. Many fields are also dissected by gullies and noncrossable drainageways that extend from the uplands. Trees and bushes grow in most stream channels and along fence rows.

This association makes up 8 percent of the county. It is 16 percent Kennebec soils, 14 percent Chequest soils, 10 percent Vesser soils, and 60 percent soils of minor extent.

Nearly all the soils in this association formed in water-deposited sediments several feet thick. The deposits are coarser textured near the stream channel and finer textured with increasing distance from the channel.

The moderately well drained Kennebec soils are in alluvium on bottom land. They are commonly along local streams and are flooded more often than Chequest and Vesser soils. The surface layer is very dark gray silt loam 33 inches thick. The subsoil is very dark gray or very dark grayish-brown silt loam.

The poorly drained Chequest soils formed in silty, moderately fine textured alluvium. They are in large areas mostly along major streams or rivers. The surface layer is very dark gray silty clay loam. The subsoil is dark-gray silty clay loam that extends to a depth of 4 feet or more. The subsoil is mottled throughout.

The somewhat poorly drained to poorly drained Vesser soils are on nearly level to gently sloping, slightly concave foot slopes. They are subject to flooding and have a seasonal high water table. The surface layer is very dark gray silt loam 12 inches thick. The subsurface layer, about 20 inches thick, is gray silt loam that grades to silty clay loam in the lower part. The subsoil is black to dark-gray silty clay loam below a depth of 32 inches.

Less extensive in this association are Amana, Coppock, Wabash, Carlow, Zook, Humeston, and Colo soils. Amana and Coppock soils are fairly extensive along the natural channel and old levees of the Chariton River (fig. 5). The poorly drained or very poorly drained Wabash, Carlow, and Zook soils are in slackwater areas. The poorly drained and very poorly drained Humeston soils are also on flood plains. The poorly drained Colo soils are on the larger flood plains.

This association is important for grain, much of which is fed to hogs, cattle, and dairy cows. Much of the association has been cleared and is used intensively for cultivated crops. About 15 percent is in standing timber, most of which can be cut for logs.

This association is flooded occasionally. Areas that are flooded more frequently or that are not accessible to farm machinery are in pasture or trees. Unless the soils are artificially drained, cultivation is often delayed. Tile lines work well in soils that do not have a highly clayey subsoil. Shallow surface ditches are needed in soils that have a heavy clay subsoil.

Most farms in this association extend into the sloping uplands of soil associations 3 and 4. Nearly all farmsteads are in the adjoining uplands because occasional flooding is a hazard. Farms vary in size, but many are between 160 and 240 acres. The general trend is toward larger farm units. Many roads do not follow section lines because bridges would have to be built and maintained.

In most areas fertility is medium to high and additions of nitrogen, phosphorus, potassium, and lime generally are needed. Response is good to applications of lime and fertilizer.

Figure 5.—**Typical nearly level soils on bottom land along the Chariton River.**

Descriptions of the Soils

This section describes the soil series and mapping units in Appanoose County. Each soil series is described in considerable detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second, detailed and in technical terms, is for scientists, engineers, and others who need to make thorough and precise studies of soils. Unless it is otherwise stated, the colors given in the descriptions are those of a moist soil.

As mentioned in the section "How This Survey Was Made," not all mapping units are of a soil series. Marsh, for example, does not belong to a soil series, but nevertheless, is listed in alphabetic order along with the soil series.

Following the name of each mapping unit is a symbol in parentheses. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and woodland suitability group to which the mapping unit has been assigned. The page for the description of each of these groups can be found by referring to the "Guide to Mapping Units" at the back of this survey.

The acreage and proportionate extent of each mapping unit are shown in table 2. Many of the terms used in describing soils can be found in the Glossary at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*17*).[2]

[2] Italic numbers in parentheses refer to Literature Cited, p. 126.

Adair Series

The Adair series consists of somewhat poorly drained to moderately well drained soils on uplands. These soils formed in a reddish, fine-textured soil that had formed during an older geologic period from glacial till, was later buried by loess, and still later was exposed by geologic erosion. Adair soils formed

TABLE 2.—*Approximate acreage and proportionate extent of the soils*

Soil	Acres	Percent
Adair clay loam, 5 to 9 percent slopes	290	0.1
Adair clay loam, 5 to 9 percent slopes, moderately eroded	4,015	1.2
Adair clay loam, 9 to 14 percent slopes, moderately eroded	630	.2
Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded	3,585	1.1
Adair-Shelby complex, 9 to 14 percent slopes, severely eroded	910	.3
Amana silt loam	2,025	.6
Appanoose silt loam	1,590	.5
Armstrong loam, 5 to 9 percent slopes, moderately eroded	16,220	4.8
Armstrong loam, 9 to 14 percent slopes, moderately eroded	3,420	1.0
Armstrong soils, 5 to 9 percent slopes, severely eroded	670	.2
Armstrong soils, 9 to 14 percent slopes, severely eroded	935	.3
Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded	7,360	2.2
Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded	880	.3
Armstrong-Gara complex, 9 to 14 percent slopes, severely eroded	2,660	.8
Armstrong-Gara complex, 14 to 18 percent slopes, severely eroded	515	.2
Ashgrove silt loam, 5 to 9 percent slopes, moderately eroded	415	.1
Ashgrove silt loam, 9 to 14 percent slopes, moderately eroded	310	.1
Beckwith silt loam	260	.1
Belinda silt loam	985	.3
Belinda silt loam, benches	185	.1
Cantril loam, 2 to 5 percent slopes	370	.1
Carlow silty clay	1,090	.3
Chequest silty clay loam	3,755	1.1
Clarinda silty clay loam, 5 to 9 percent slopes	2,565	.8
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	27,135	8.1
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	395	.1
Clarinda soils, 5 to 9 percent slopes, severely eroded	1,635	.5
Colo silt loam, overwash	215	.1
Colo silty clay loam, 0 to 2 percent slopes	875	.3
Colo silty clay loam, 2 to 5 percent slopes	610	.2
Coppock silt loam	1,760	.5
Edina silt loam	27,575	8.2
Gara loam, 9 to 14 percent slopes, moderately eroded	1,940	.6
Gara loam, 14 to 18 percent slopes	585	.2
Gara loam, 14 to 18 percent slopes, moderately eroded	13,545	4.0
Gara loam, 18 to 24 percent slopes, moderately eroded	2,355	.7
Gara soils, 9 to 14 percent slopes, severely eroded	620	.2
Gara soils, 14 to 18 percent slopes, severely eroded	2,855	.8
Gosport-Clanton silt loams, 9 to 14 percent slopes, moderately eroded	780	.2
Gosport-Clanton silt loams, 14 to 18 percent slopes, moderately eroded	755	.2
Gosport-Clanton silt loams, 18 to 24 percent slopes, moderately eroded	255	.1
Grundy silty clay loam, 2 to 5 percent slopes	4,815	1.4
Haig silty clay loam	3,040	.9
Humeston silt loam, 0 to 2 percent slopes	480	.1
Humeston silt loam, 2 to 5 percent slopes	155	([1])
Kennebec-Amana silt loams	6,025	1.8
Keswick loam, 5 to 9 percent slopes	950	.3
Keswick loam, 5 to 9 percent slopes, moderately eroded	5,405	1.6
Keswick loam, 9 to 14 percent slopes	520	.2
Keswick loam, 9 to 14 percent slopes, moderately eroded	2,845	.8
Keswick soils, 9 to 14 percent slopes, severely eroded	575	.2
Kniffin silt loam, 2 to 5 percent slopes	13,355	4.0
Kniffin silt loam, 5 to 9 percent slopes	1,100	.3
Kniffin silt loam, 5 to 9 percent slopes, moderately eroded	1,940	.6
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	5,870	1.7
Lamoni soils, 9 to 14 percent slopes, severely eroded	885	.3
Landes fine sandy loam, heavy subsoil variant	565	.2
Lindley loam, 14 to 18 percent slopes, moderately eroded	4,980	1.5
Lindley loam, 18 to 24 percent slopes	2,625	.8
Lindley loam, 18 to 24 percent slopes, moderately eroded	15,330	4.5
Lindley loam, 24 to 40 percent slopes, moderately eroded	1,040	.3
Lindley soils, 14 to 18 percent slopes, severely eroded	1,250	.4
Lindley soils, 18 to 24 percent slopes, severely eroded	1,000	.3
Lineville silt loam, 2 to 5 percent slopes	235	.1
Lineville silt loam, 5 to 9 percent slopes	1,000	.3
Lineville silt loam, 5 to 9 percent slopes, moderately eroded	890	.3
Lineville silt loam, dark variant, 5 to 9 percent slopes	720	.2
Lineville silt loam, dark variant, 5 to 9 percent slopes, moderately eroded	1,575	.5
Marsh	370	.1
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	1,805	.5
Mystic silt loam, 9 to 14 percent slopes, moderately eroded	3,890	1.1
Mystic soils, 5 to 9 percent slopes, severely eroded	180	.1
Mystic soils, 9 to 14 percent slopes, severely eroded	3,020	.9
Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded	600	.2
Mystic-Caleb complex, 9 to 14 percent slopes, severely eroded	225	.1
Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded	910	.3
Mystic-Caleb complex, 14 to 18 percent slopes, severely eroded	670	.2
Nodaway silt loam	1,710	.5
Nodaway-Alluvial land complex	1,025	.3
Olmitz loam, 2 to 5 percent slopes	885	.3
Olmitz-Vesser-Colo complex, 2 to 5 percent slopes	24,915	7.4
Pershing silt loam, 2 to 5 percent slopes	3,560	1.1
Pershing silt loam, 5 to 9 percent slopes	625	.2
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	875	.3
Pershing silt loam, benches, 2 to 5 percent slopes	550	.2
Pershing silt loam, benches, 5 to 9 percent slopes	200	.1
Radford silt loam	615	.2
Rathbun silt loam, 2 to 5 percent slopes	1,960	.6
Rathbun silt loam, 2 to 5 percent slopes, moderately eroded	990	.3
Rathbun silt loam, 5 to 9 percent slopes	830	.2
Rathbun silt loam, 5 to 9 percent slopes, moderately eroded	2,610	.8
Seymour silt loam, 2 to 5 percent slopes	26,460	7.9

TABLE 2.—*Appanoose County, Iowa* (*continued*)

Soil	Acres	Percent
Seymour silt loam, 5 to 9 percent slopes, moderately eroded	880	0.3
Shelby loam, 9 to 14 percent slopes, moderately eroded	3,790	1.1
Shelby loam, 14 to 18 percent slopes, moderately eroded	2,630	.8
Shelby soils, 9 to 14 percent slopes, severely eroded	695	.2
Shelby soils, 14 to 18 percent slopes, severely eroded	335	.1
Sogn-Gosport-Clanton complex, 9 to 18 percent slopes, moderately eroded	1,195	.3
Tuskeego silt loam, 0 to 2 percent slopes	775	.2
Tuskeego silt loam, 2 to 5 percent slopes	305	.1
Vesser silt loam, 0 to 2 percent slopes	1,990	.6
Vesser silt loam, 2 to 5 percent slopes	635	.2
Wabash silty clay	1,240	.4
Weller silt loam, 2 to 5 percent slopes	1,380	0.4
Weller silt loam, 2 to 5 percent slopes, moderately eroded	2,620	.8
Weller silt loam, 5 to 9 percent slopes, moderately eroded	2,635	.8
Weller silt loam, 9 to 14 percent slopes, moderately eroded	295	.1
Weller silt loam, benches, 2 to 5 percent slopes	335	.1
Weller silt loam, benches, 5 to 9 percent slopes, moderately eroded	275	.1
Wiota silt loam, 1 to 3 percent slopes	390	.1
Zook silty clay loam, 0 to 2 percent slopes	1,530	.4
Zook silty clay loam, 2 to 5 percent slopes	355	.1
Mines and quarries	920	.2
Lake Rathbun	11,335	3.3
Total	334,720	100.0

[1] Less than 0.05 percent.

after exposure of the buried soil. They are on the tops and upper sides of ridges, downslope from Seymour, Grundy, Clarinda, and Lineville soils and upslope from Shelby, Gara, and Armstrong soils. Adair soils are most extensive in the moderately dissected areas between the major divides and the major streams in the county. The native vegetation was prairie grasses.

In a representative profile the surface layer is about 10 inches thick. It is black or very dark gray clay loam. The upper 9 inches of the subsoil is brown very firm clay loam or clay mottled with red, and the lower 20 inches is clay loam that is brown and yellowish brown mottled with grayish brown in the upper part. A distinct stone line (fig. 6) occurs in the upper part of the subsoil. The underlying material is yellowish-brown and grayish-brown clay loam that has a few strong-brown mottles.

Adair soils are seasonally wet and seepy and are subject to erosion. Available water capacity is moderately high, and permeability is slow. Natural fertility is low to medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

Adair soils are difficult to manage. Most of the acreage is used for permanent pasture or hay. Row crops are grown occasionally in the less sloping areas.

Representative profile of Adair clay loam, 5 to 9 percent slopes, on a ridgetop where the slope is 7 percent; 260 feet east and 325 feet south of the northwest corner of the NE¼NE¼ sec. 21, T. 68 N., R. 16 W.

Ap—0 to 7 inches, black (10YR 2/1) to very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) when dry, very dark grayish brown (10YR 3/2) when kneaded; weak to moderate, fine, subangular blocky structure breaking to granular; friable; neutral; abrupt, smooth boundary.

A12—7 to 10 inches, very dark gray (10YR 3/1) clay loam, gray (10YR 5/1) to grayish brown (10YR 5/2) when dry, very dark grayish brown (10YR 3/2) when kneaded; common, fine, distinct, dark-brown to brown (10YR 4/3) mottles; weak, fine, subangular blocky structure; friable; slightly acid; clear, smooth boundary.

B1—10 to 13 inches, brown (10YR 4/3 and 7.5YR 4/4) clay loam; common, fine, distinct mottles of very dark grayish brown (10YR 3/2) and few, fine, distinct mottles of red (2.5YR 4/6); moderate, fine, sub-

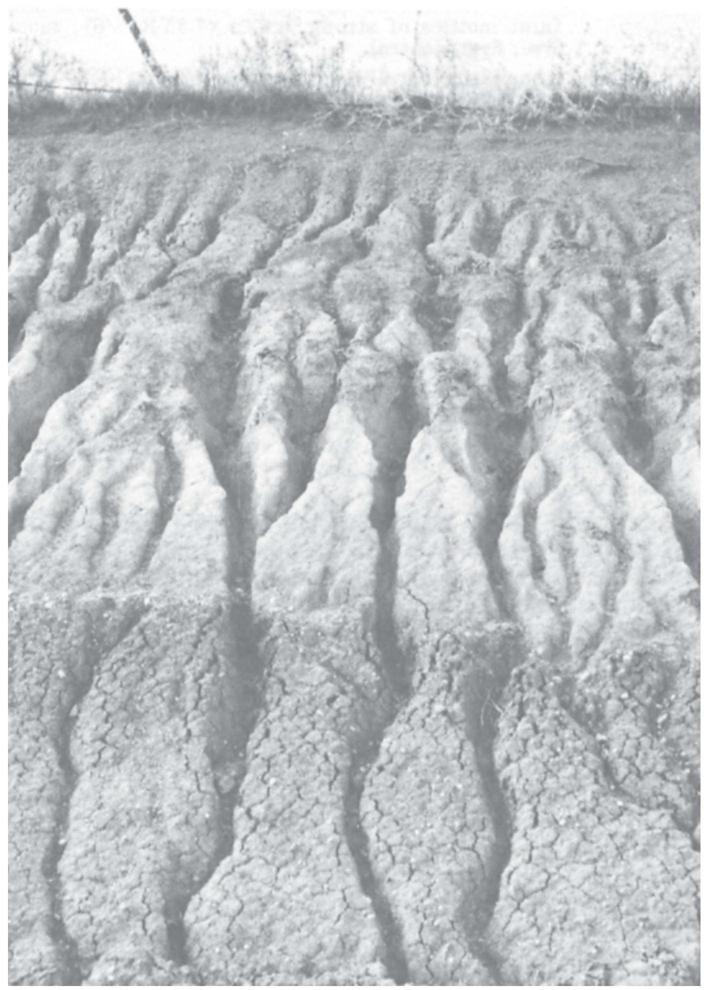

Figure 6.—**Road cut exposing light-colored layer and stone line in Adair soil.**

angular blocky structure; few grainy ped coatings; friable; medium acid; clear, smooth boundary.

IIB21t—13 to 19 inches, mixed brown (10YR 4/3) and strong-brown (7.5YR 5/6) light clay; common, fine, prominent mottles of dark red (2.5YR 3/6); moderate, fine, subangular blocky structure; very firm; few, thin, discontinuous clay films; weak stone line at about 18 inches; medium acid; gradual, smooth boundary.

IIB22t—19 to 30 inches, mixed brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) heavy clay loam; few, fine, prominent mottles of dark red (2.5YR 3/6) and common, medium, distinct mottles of grayish brown (10YR 5/2); moderate, medium, subangular blocky structure; very firm; thin discontinuous clay films; slightly acid; gradual, smooth boundary.

IIB31t—30 to 39 inches, mixed brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) light clay loam; few, fine, faint mottles of dark grayish brown (10YR 4/2) and common, medium, distinct mottles of grayish brown (10YR 5/2); weak, medium, subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual, smooth boundary.

IIB32—39 to 52 inches, mixed yellowish-brown (10YR 5/6) and grayish-brown (2.5Y 5/2) light clay loam; few, medium, faint mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure to massive; firm; neutral; gradual, smooth boundary.

IIC—52 to 64 inches, mixed brown (7.5YR 4/4) and grayish-brown (2.5Y 5/2) light clay loam; few, medium, faint mottles of strong brown (7.5YR 5/6); massive; firm, neutral.

The A1 horizon generally ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A horizon, unless eroded, is 10 to 14 inches thick in most places. It is mainly clay loam, but ranges from loam to silty clay loam. The upper part of the IIB2t horizon ranges from dark reddish brown (5YR 4/3) to dark brown (7.5YR 4/4) and brown (10YR 4/3). The upper part of the B horizon has dominantly reddish mottles, and the lower part dominantly grayish mottles. At the most developed part of the IIB2t horizon, the clay content is 40 to 46 percent. The IIC horizon is dominantly clay loam that is 30 to 36 percent clay.

Adair soils formed in about the same kind of parent material as Clarinda, Lamoni, Armstrong, and Keswick soils. They are associated with Shelby soils. Adair soils differ from Clarinda and Lamoni soils in having a stone line and a brown matrix color and reddish mottles in the B horizon. They have a thicker A1 or Ap horizon than Armstrong and Keswick soils and do not have the A2 horizon, which is typical of those soils. They have more clay in the B horizon than Shelby soils.

Adair clay loam, 5 to 9 percent slopes (192C).—This soil is most extensive on ridgetops in moderately dissected areas between the major divides and the major streams in the county.

This soil has the profile described as representative of the series. The surface layer is clay loam that is 10 to 14 inches thick in most places.

Included with this soil in mapping are areas where the surface layer is loam or silty clay loam that has a gritty feel and small areas of a soil, mostly in coves, that has a thick, gray clay subsoil like that of Clarinda soils. Also included are a few small areas of a moderately eroded Adair clay loam.

This soil is better suited to hay or pasture than to row crops. It commonly occurs with steeper areas of Shelby and Gara soils. Much of the acreage is permanent pasture. Some areas are cultivated along with adjacent areas of better soils. The organic-matter content of this soil is medium.

Terracing helps in erosion control, but the clayey subsoil, which is in poor tilth, is exposed in borrow areas. Exposing the subsoil can be avoided by stockpiling the surface soil during construction and replacing it afterward. Although amounts of seepage water vary, artificial drainage generally is not needed or is not practical. Surface wetness can be reduced by installing tile interceptor drains in the soils upslope. Capability unit IIIe–5; woodland suitability group 5c1.

Adair clay loam, 5 to 9 percent slopes, moderately eroded (192C2).—This soil is most extensive on the tops and upper sides of ridges in moderately dissected areas between the major divides and the major streams in the county.

This soil has a profile similar to the one described as representative of the Adair series, but part of the original surface layer has been removed by erosion and plowing has mixed the remaining 3 to 6 inches with material from the subsoil. The present surface layer is about 8 inches thick and is very dark grayish brown. Included in mapping are small areas of soils that have a thick, gray clay subsoil like that of Clarinda soils. These areas are mostly in coves. Also included are small areas that are severely eroded.

This soil is moderately suited to row crops. Much of the acreage is used for permanent pasture, especially where this soil is managed along with steeper, downslope soils. Terracing helps in erosion control, but the clayey subsoil, which is in poor tilth and is low in fertility, is exposed in borrow areas. Exposing the subsoil can be avoided by stockpiling the surface soil during construction and replacing it afterward. Interceptor tile is needed in places to drain spots that become seepy in spring. Capability unit IIIe–5; woodland suitability group 5c1.

Adair clay loam, 9 to 14 percent slopes, moderately eroded (192D2).—This soil is generally on the tops and sides of ridges below other Adair soils. In places on the crest of rounded side slopes, the brown subsoil is exposed. Part of the subsoil, especially on the side slopes, has been mixed with the surface layer.

This soil has a thinner, generally browner surface layer than the one in the profile described as representative of the Adair series. The surface layer is 4 to 8 inches thick in most places, but can be as much as 12 inches thick where lower slopes are near drains. It has been mixed with material from the subsoil by plowing in most areas. It is cloddy and hard when dry. Included in mapping are small areas of Clarinda soils and small areas of severely eroded Adair soils.

This soil is well suited to pasture, and much of the acreage in steeper areas of Shelby and Gara soils is pasture. Generally, areas in pasture can be used occasionally for row crops before the pasture is renovated. Where this soil occurs along with better soils, it is moderately suited to row crops. The content of organic matter is low.

In cultivated areas, this soil is susceptible to severe erosion because the subsoil is clayey and slopes are strong. If erosion continues, the soil soon becomes unsuitable for cultivation. Capability unit IVe–2; woodland suitability group 5c1.

Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded (93D2).—This mapping unit occurs throughout the county, normally on irregular side

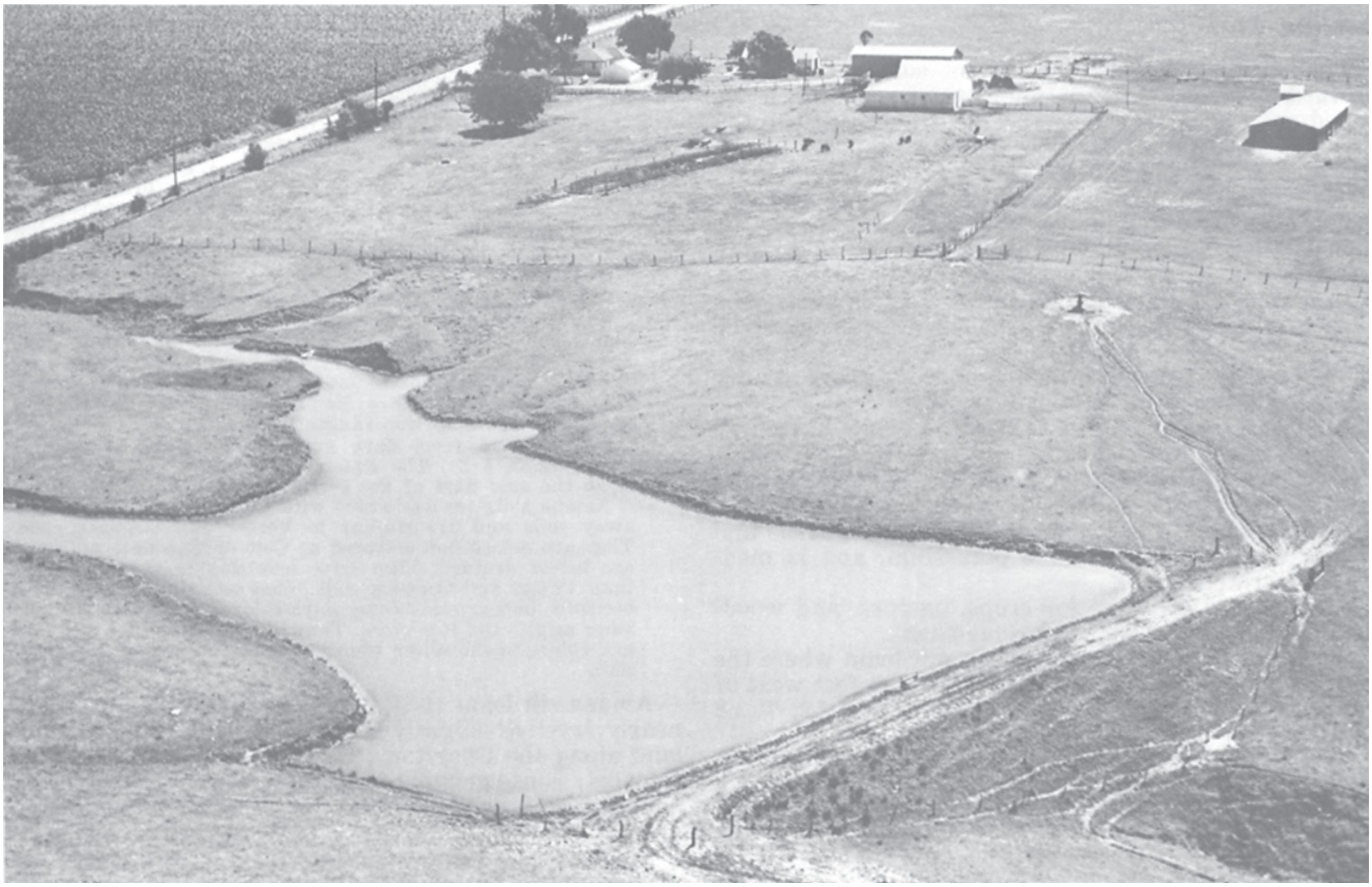

Figure 7.—Farm pond in Adair-Shelby complex. The less sloping areas are Seymour and Edina soils.

slopes and in coves. It is about 60 percent Adair soils and 40 percent Shelby soils. These soils are generally downslope from Clarinda and Lamoni soils. They formed in weathered glacial till and glacial till of clay loam texture. Sloping areas are commonly dissected by crossable drains and some gullies.

These soils have profiles similar to those described as representative of their respective series, but the surface layer is thinner. In most areas the surface layer is very dark grayish-brown loam or clay loam 3 to 10 inches thick. It is thinnest on the shoulders of the side slopes and on the crests of the rounded slopes between waterways in coves. Plowing has exposed the clay subsoil in places. Included in mapping are areas of Gara soils on the lower parts of slopes and areas of Clarinda and Lamoni soils on the upper parts.

These Adair and Shelby soils are moderately suited to row crops. They are generally low in organic-matter content and are in only fair tilth. They are better suited to pasture than to cultivated crops. Areas adjacent to steeper areas of Shelby and Gara soils are ordinarily used for pasture. These soils are suitable sites for farm ponds (fig. 7). Capability unit IVe–2; woodland suitability group 5c1.

Adair-Shelby complex, 9 to 14 percent slopes, severely eroded (93D3).—This mapping unit is on rounded crests between drains on side slopes or at the heads of drainageways and is dissected by crossable drains and many gullies. It is about 60 percent Adair soils and 40 percent Shelby soils. These soils are generally associated with Adair and Lamoni soils upslope and with Shelby or Gara soils downslope.

These soils have profiles similar to those described as representative of their respective series, but the surface layer is thinner and browner. In much of the area the present surface layer is former subsoil material that is dark-brown clay loam to clay. In places it is very dark grayish-brown loam. It is thicker on the lower parts of the slopes where material eroded from the hillsides accumulates. Wet spots of less than 1 acre occur in some places.

These soils are not suited to row crops, but are suited to pasture. Runoff is rapid, and susceptibility to erosion is severe. The subsoil, if exposed, hardens and cracks deeply as it dries. Because the content of organic matter is low and tilth is generally poor, seedbed preparation and tillage are difficult. Capability unit VIe–3; woodland suitability group 5c1.

Amana Series

The Amana series consists of somewhat poorly drained soils on wide stream bottoms, on high abandoned natural stream levees, and in meander belts of streams. These soils formed in silty alluvium under tree and grass vegetation. They are not likely to be flooded except during periods of very high rainfall. Slopes are only 0 to 2 percent, but are more undulating than those of some other soils on bottom land. Individual areas are ordinarily large.

In a representative profile the surface layer is very dark gray or dark grayish-brown silt loam about 20 inches thick. The subsoil to a depth of 60 inches or more is dark grayish-brown and dark-gray, friable silt loam.

Amana soils are subject to flooding. They have high available water capacity and are moderately permeable. Natural fertility is medium. The surface layer is neutral and generally does not need lime. The subsoil is acid, is medium to low in available phosphorus and low to very low in available potassium, and is moderately aerated.

Amana soils are used for crops, pasture, and woodland. They respond well to management.

Representative profile of Amana silt loam where the slope is 1 percent; 770 feet north and 220 feet west of the southeast corner of the SW¼SE¼ sec. 12, T. 68 N., R. 17 W.

A11—0 to 10 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry, very dark grayish brown (10YR 3/2) when kneaded; moderate, fine, granular structure; friable; numerous roots; few fine pores; neutral; abrupt, smooth boundary.

A12—10 to 14 inches, dark grayish-brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) when dry; weak to moderate, fine, granular structure; friable; common roots; few fine pores; few, discontinuous, grainy ped coatings when dry; few very dark grayish brown (10YR 3/2) ped coatings; strongly acid; clear, smooth boundary.

A3—14 to 20 inches, dark grayish-brown (10YR 4/2) silt loam; few, fine, faint mottles of brown (10YR 4/3, pale brown (10YR 6/3) to light gray (10YR 7/2) when dry; moderate, fine, subangular blocky structure; friable; few roots; common fine pores; common light-gray (10YR 7/1) grainy ped coatings when dry; few very dark grayish-brown (10YR 3/2) ped coatings; strongly acid; clear, smooth boundary.

B1—20 to 26 inches, dark grayish-brown (10YR 4/2) silt loam, light gray (10YR 7/2) when dry; weak to moderate, fine, subangular blocky structure; friable; few roots; many fine pores; common light-gray (10YR 7/1) grainy ped coatings when dry; strongly acid; clear, smooth boundary.

B21—26 to 31 inches, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) when dry; few, fine, faint mottles of very dark grayish brown (10YR 3/2); weak, fine, subangular blocky structure; friable; many fine pores; few roots; few soft oxides; common light-gray (10YR 7/1) grainy ped coatings when dry; strongly acid; gradual, smooth boundary.

B22—31 to 36 inches, dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) silt loam, light gray faint mottles of very dark grayish brown (10YR 3/2); weak, fine, subangular blocky structure; friable; many fine pores; few soft oxides; common light gray (10YR 7/1) grainy ped coatings when dry; strongly acid; gradual, smooth boundary.

B23—36 to 42 inches, dark grayish-brown (10YR 4/2) silt loam; few, fine, faint mottles of very dark grayish brown (10YR 3/2); weak, medium, subangular blocky structure; friable; nearly continuous light gray (10YR 7/1) grainy ped coatings when dry; few soft oxides; many fine pores; strongly acid; gradual, smooth boundary.

B3—42 to 60 inches, dark-gray (10YR 4/1) silt loam; few, faint mottles of very dark grayish brown (10YR 3/2) and dark reddish brown (5YR 3/2); weak, medium, subangular blocky structure; friable; few thin patchy clay films; common light-gray (10YR 7/1) grainy ped coatings when dry; many fine pores; strongly acid.

The A1 horizon ranges from 10 to 14 inches in thickness and from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). Light-gray (10YR 7/2) silt grains are prominent on peds in the lower part of the A and B horizons when the soil is dry, but are indistinct when the soil is moist. The B2 horizon ranges from silt loam to light silty clay loam and from dark gray (10YR 4/1) to grayish brown (2.5Y 5/2). The Amana soils in this county tend to be in the acid part of the series range.

Amana soils are associated with Colo, Chequest, and Nodaway soils and are similar to Vesser and Coppock soils. They are not so fine textured as Colo or Chequest soils and are better drained. They have less clay in the B horizon than Vesser and Coppock soils. They are similar to Kennebec soils, but have a thinner dark-colored A horizon and are more acid in the B horizon. They lack the stratified textures and colors in the solum that are characteristic of Nodaway soils.

Amana silt loam (0 to 2 percent slopes) (422).—This nearly level or slightly undulating soil is on bottom land along the Chariton River in the meander belt of streams; consequently, it is dissected by old oxbows and former stream channels. It is commonly mapped near Coppock soils.

This soil has the profile described as representative of the series. Included in mapping are a few small areas of Coppock soils and some areas, commonly in slightly higher positions between swales, where the surface layer of this Amana soil is thinner and darker colored than in the typical Amana soil.

If protected from flooding, this soil is well suited to row crops. Much of the acreage is cultivated. Part of it is pasture and woodland because it is inaccessible. Tilth is usually not a problem. This soil warms up quickly and can be worked early in spring. Organic-matter content is medium. Capability unit IIw–1; woodland suitability group 5w2.

Appanoose Series

The Appanoose series consists of poorly drained soils on uplands. These soils formed in leached loess 6 to 8 feet thick over a buried, very slowly permeable, gray clayey soil. They are on flat ridgetops near major streams in the central and southern parts of the county. Slopes range from 0 to 2 percent.

In a representative profile the surface layer is very dark gray silt loam 7 inches thick. The subsurface layer is grayish-brown, friable silt loam 8 inches thick. The subsoil to a depth of 60 inches is grayish-brown and dark-gray, firm silty clay that grades to mottled light brownish-gray silty clay loam in the lower part.

Appanoose soils are seasonally wet and are occasionally ponded after periods of heavy rainfall. Available water capacity is moderately high, and permeability is very slow. Natural fertility is medium or low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low to very low in available phosphorus and potassium, and is poorly aerated.

Most of the acreage is used for cultivated crops. Some areas require surface drainage.

Representative profile of Appanoose silt loam, 240 feet east and 50 feet south of the northwest corner of the SW¼ sec. 25, T. 68 N., R. 19 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; light brownish gray (10YR 6/2) when dry; weak, thick, platy structure breaking to weak, thin, platy; friable; few, fine, soft, dark reddish-brown (5YR 3/2) oxides; common fine roots; slightly acid; clear, smooth boundary.

A21—7 to 9 inches, mixed dark-gray (10YR 4/1) and grayish-brown (10YR 5/2) silt loam; few, fine, faint, light olive-brown (2.5Y 5/4) and yellowish-brown (10YR 5/4) mottles, gray (10YR 6/1) when dry; moderate, medium, platy structure; friable; discontinuous grainy light-gray (10YR 7/1) dry coatings on plates; few, fine, dark reddish-brown (5YR 3/2) oxides; medium acid; clear, smooth boundary.

A22—9 to 15 inches, grayish-brown (10YR 5/2) silt loam; few, fine and medium, light olive-brown (2.5Y 5/4) mottles, light gray (10YR 7/2) when dry; moderate, medium, platy structure breaking to weak, thin, platy; friable; thin, discontinuous, grainy, light-gray (10YR 7/1) coatings on plates; common, fine, dark reddish-brown (5YR 3/2) oxides; very strongly acid; abrupt, smooth boundary.

B1g—15 to 16 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam; faces of peds light brownish gray (10YR 6/2); common, fine, faint, light olive-brown (2.5Y 5/4) mottles; moderate, fine, subangular blocky structure; firm; continuous grainy white (10YR 8/1) dry ped coatings; strongly acid; abrupt, smooth boundary.

B21tg—16 to 20 inches, dark-gray (10YR 4/1) with streaks of very dark gray (10YR 3/1) and dark grayish-brown (2.5Y 4/2) silty clay; common, fine, distinct, yellowish-brown (10YR 5/6) and light olive-brown (2.5Y 5/4) mottles; strong, very fine, angular and subangular blocky structure; very firm, very hard when dry; common, fine, hard, dark reddish-brown (5YR 3/2) oxides; continuous clay films; strongly acid; gradual, smooth boundary.

B22tg—20 to 26 inches, mottled dark-gray (10YR 4/1) and light olive-brown (2.5Y 5/4) silty clay; faces of peds grayish brown (2.5Y 5/2); common, fine, distinct, yellowish-brown (10YR 5/6) mottles; strong, fine, angular and subangular blocky structure; very firm, very hard when dry; thick, continuous clay films; common, fine, hard, dark reddish-brown (5YR 3/2) oxides; strongly acid; gradual, smooth boundary.

B23tg—26 to 33 inches, light brownish-gray (2.5Y 6/2) silty clay; many, fine, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; moderate, coarse, subangular blocky structure: firm, very hard when dry; discontinuous dark-gray (10YR 4/1) clay films; many, fine, soft, dark reddish-brown (5YR 3/2) and dark-brown to brown (7.5YR 4/4) oxides; medium acid; gradual, smooth boundary.

B31tg—33 to 41 inches, light brownish-gray (2.5Y 6/2) heavy silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; weak, coarse, subangular blocky structure; firm, very hard when dry; few dark-gray (10YR 4/1) clay-filled root channels and streaks on peds; many, fine, hard, dark reddish-brown (5YR 3/2) and dark-brown to brown (7.5YR 4/4) oxides; medium acid; gradual, smooth boundary.

B32tg—41 to 60 inches, light brownish-gray (2.5Y 6/2) silty clay loam; many, fine, distinct, yellowish-brown (10YR 5/6) and strong-brown (7.5YR 5/6) mottles; clay content slightly less than in B31tg horizon; weak, coarse, subangular blocky structure; firm, hard when dry; very many, fine, hard, dark reddish-brown (5YR 3/2) and dark-brown to brown (7.5YR 4/4) oxides; slightly acid.

The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from dark gray (10YR 4/1) to grayish brown (10YR 5/2). Thickness of the combined A1 and A2 horizons is typically 12 to 18 inches. The B1 horizon, if present, has prominent gray (10YR 5/1) to white (10YR 8/1) silt coatings on peds. Content of clay abruptly increases from the A2 horizon to the upper part of the B2t horizon. The B2t horizon ranges from very dark gray (10YR 3/1) to light brownish gray (2.5Y 6/2). Maximum clay content in the B2t horizon ranges from 48 to 60 percent. The B3 horizon ranges from light silty clay to heavy silty clay loam. Clay content decreases with increasing depth to light or medium silty clay loam in the C horizon.

Appanoose soils formed in about the same kind of parent material as Kniffin, Pershing, Belinda, Edina, and Seymour soils. They differ from Kniffin and Pershing soils in having an abrupt clay increase from the A horizon to the B horizon and a thicker A2 horizon. They have a thinner A horizon and a browner A2 horizon than Edina soils. They have a higher clay content in the B2t horizon and a thinner A2 horizon than Belinda soils. They differ from Seymour soils in having a distinct A2 horizon.

Appanoose silt loam (0 to 2 percent slopes) (261).—This soil is on the flat ridgetops on uplands near major streams in the central and southern parts of the county. Most areas are 10 to 30 acres in size.

This soil has the profile described as representative of the series. Included in mapping are ashy appearing spots in the field where plowing has mixed the grayish subsurface layer with the surface layer.

In some places runoff water collects and forms ponds in shallow depressions because there are no natural outlets for draining off surface water. Where surface drainage has been installed, this soil is moderately suitable for row crops. In periods when rainfall is more than normal, crops may turn yellow and be stunted. Because the subsoil contains large amounts of clay, tile lines are not suitable for drainage. Shallow ditches, however, will remove excess water and improve drainage. This soil puddles if it is worked wet. Capability unit IIIw-3; woodland suitability group 5w3.

Armstrong Series

The Armstrong series consists of somewhat poorly drained to moderately well drained soils on uplands. These soils formed in glacial till under grass and forest vegetation. They are typically in the more strongly dissected areas along the major streams in the county. They are on the sloping tops and upper sides of ridges, just downslope from Pershing, Kniffin, or Lineville soils and upslope from Gara, Lindley, and Mystic soils and are adjacent to Adair and Keswick soils, which occur in similar positions.

In a representative profile the surface layer is very dark grayish-brown loam about 7 inches thick. The subsurface layer is grayish-brown, friable loam 4 inches thick. The subsoil is about 40 inches thick. The upper 7 inches is brown to dark yellowish-brown, firm clay loam that has reddish mottles. These soils are marked by a distinct stone line in the upper part of the subsoil. The lower 33 inches of the subsoil is mottled brown and strong-brown very firm clay that grades to strong-brown and yellowish-brown very firm and firm clay loam with increasing depth.

Available water capacity is moderately high, and permeability is slow. Natural fertility is low to very low. The surface soil is medium acid unless it has been limed within the past few years. The subsoil is very low in available phosphorus and potassium and somewhat poorly aerated.

The Armstrong soils are used mostly for pasture and meadow. Some less sloping areas are suitable for cultivation. These soils have a high susceptibility to erosion.

Representative profile of Armstrong loam, 5 to 9 percent slopes, moderately eroded, on west aspect of shoulder side slope where the slope is 6 percent; 50 feet west and 320 feet south of the northeast corner of the NW¼SE¼ sec. 13, T. 67 N., R. 16 W.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loam, grayish brown (10YR 5/2) when dry; mixing of brown (10YR 4/3); weak, fine, granular structure; cloddy; friable; slightly acid; abrupt, smooth boundary.

A2—7 to 11 inches, grayish-brown (10YR 5/2) loam; moderate, thin, platy structure; friable; strongly acid; clear, smooth boundary.

B1—11 to 14 inches, dark yellowish-brown (10YR 4/4) light clay loam; weak, fine, subangular blocky structure; friable; thin, discontinuous, gray (10YR 6/1) silt coatings; strongly acid; clear, smooth boundary.

B21t—14 to 18 inches, brown (7.5YR 4/4) clay loam; few, fine, distinct mottles of reddish brown (5YR 4/4) and yellowish red (5YR 5/6); moderate, fine, subangular blocky structure; firm; few, thin, discontinuous clay films; thin, continuous, gray (10YR 6/1 when dry) silt coatings; stone line in base of horizon; strongly acid; gradual, smooth boundary.

IIB22t—18 to 26 inches, mottled brown (7.5YR 4/4) and dark grayish-brown (10YR 4/2) light clay that contains some pebbles; few, fine, prominent mottles of red (2.5YR 4/6); moderate, fine, subangular blocky structure; very firm; thin, continuous, gray (10YR 6/1 when dry) silt coatings; clay films on most peds; very strongly acid; gradual smooth boundary.

IIB23t—26 to 31 inches, mottled, strong-brown (7.5YR 5/6) and light brownish-gray (10YR 6/2) light clay that contains some pebbles; few, fine, distinct mottles of dark red (2.5YR 3/6) and common, medium, distinct mottles of yellowish red (5YR 4/6); moderate, fine, subangular blocky structure; very firm; thick, discontinuous clay films; strongly acid; gradual, smooth boundary.

IIB24t—31 to 41 inches, strong-brown (7.5YR 5/6) heavy clay loam that contains common pebbles; common, fine, distinct mottles of light brownish gray (10YR 6/2) and yellowish red (5YR 4/6); moderate, fine, prismatic structure breaking to weak, medium, subangular blocky; very firm; few, thin, discontinuous clay films on peds and in old root channels; black (N 2/0) organic material on vertical ped faces; common, fine, black (10YR 2/1) oxide concretions; strongly acid; gradual, smooth boundary.

IIB3t—41 to 51 inches, yellowish-brown (10YR 5/6) medium clay loam; common, fine and medium, distinct mottles of gray (10YR 6/1); weak, medium, prismatic structure breaking to weak, medium, subangular blocky; firm; dark-brown (10YR 3/3) clay flows in some channels; common, fine, black (10YR 2/1) oxide concretions; medium acid.

The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2) in color and from 6 to 10 inches in thickness. The A2 horizon ranges from 2 to 6 inches in thickness and from grayish brown (10YR 5/2) to yellowish brown (10YR 5/4). The B21t horizon ranges from brown (7.5YR 4/4) to yellowish red (5YR 5/6). The upper part of the IIB horizon ranges from 42 to 48 percent maximum clay content. The lower part of the B horizon centers on clay loam and ranges from 30 to 36 percent clay. The reaction is medium to very strongly acid in the most acid part.

Armstrong soils are associated with Adair, Gara, Lamoni, Lineville, and Shelby soils. In contrast with Lamoni and Gara soils, they have a stone line, reddish mottles, and a strong-brown maxtrix color in the B horizon. They have an A2 horizon and a thinner A1 horizon than Shelby or Adair soils. They have more clay in the B horizon than Shelby or Gara soils and differ from Lineville soils in having clay within 20 inches of the surface.

Armstrong loam, 5 to 9 percent slopes, moderately eroded (792C2).—This soil is most extensive on the tops and upper sides of ridges in the more strongly dissected areas near the larger streams in the county.

This soil has the profile described as representative of the series. In some places part of the original surface layer has been removed by erosion, and the rest has been mixed with the subsurface layer and part of the former subsoil by plowing. Included in mapping in the center of sloping ridges are areas of Lineville soils, generally less than 2 acres in size. Also included are some areas of Armstrong soils that are not eroded.

Much of this soil is used for permanent pasture or hay. It is moderately suited to row crops. It is generally associated with moderately steep Gara soils that are not suitable for row crops.

Terracing helps in erosion control, but the clayey subsoil, which is poor in tilth and fertility, is exposed in borrow areas. Exposing the subsoil can be avoided by stockpiling the surface soil during construction and replacing it afterward. If this soil is used for row crops, it generally is managed along with the loess soils upslope. The content of organic matter is low. Capability unit IIIe-5; woodland suitability group 5c1.

Armstrong loam, 9 to 14 percent slopes, moderately eroded (792D2).—This soil is on the tops and sides of ridges in the more strongly dissected areas along the larger streams in the county.

This soil has a profile similar to the one described as representative of the series, but in some places the surface layer is slightly thinner and browner. Part of the original surface layer has been removed by erosion. The rest has been mixed with the subsurface layer and part of the former subsoil by plowing. Included in mapping are some areas where this soil is only slightly eroded and a few small areas where it is severely eroded.

This soil is better suited to hay and pasture than to most other uses. It is moderately suited to row crops, but erosion would be excessive if row crops were grown regularly. Moreover, yields of row crops are low. Tilth and fertility of the surface layer become even more unfavorable if erosion is not controlled. If tilled too wet, the soil becomes hard and cloddy when almost dry. This soil is low in organic-matter content. Capability unit IVe-2; woodland suitability group 5c1.

Armstrong soils, 5 to 9 percent slopes, severely eroded (792C3).—These soils are most extensive on the upper parts of side slopes in the more strongly dissected areas near the larger streams in the county.

These soils have a profile similar to the one described as representative of the series, but the surface layer is less than 6 inches thick and is brown loam or clay. The present surface layer consists of less than 3 inches of the original surface layer and subsurface layers mixed with part of the former subsoil by plowing. The rest of the original surface and subsurface layers have been removed by erosion. Included in mapping are a few areas of moderately eroded Armstrong soils and severely eroded Adair soils.

This soil is better suited to hay and pasture than to most other uses. It is moderately suited to row crops. Seedings are difficult to establish because of poor tilth and very low fertility in the surface layer. The surface becomes hard and cloddy when almost dry. It tends to seal over during rain, decreasing infiltration and increasing runoff. Gullies form readily unless this soil is covered by dense vegetation. Capability unit IIIe–5; woodland suitability group 5c1.

Armstrong soils, 9 to 14 percent slopes, severely eroded (792D3).—These soils are on side slopes in the more strongly dissected areas near the larger streams in the county.

These soils have a profile similar to the one described as representative of the series, but the surface layer is less than 6 inches thick, is browner, and is loam to clay. The surface layer consists of less than 3 inches of the original surface layer and subsurface layer mixed with part of the former subsoil by plowing. The rest of the original surface and subsurface layers have been removed by erosion. Included in mapping are a few small areas of moderately eroded Armstrong soils and a few small, moderately sloping areas.

These soils are better suited to hay and pasture than to most other uses. Row crops are not suited to these soils because of the very severe hazard of erosion. Good seedings are difficult to establish because of the strong slopes and the poor tilth and fertility of the surface layer. The surface layer becomes hard and cloddy when almost dry. It tends to seal over during rain, reducing infiltration and increasing runoff. This soil is very low in organic-matter content. Gullies form readily unless this soil is protected by dense vegetation. Capability unit VIe–3; woodland suitability group 5c1.

Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded (993D2).—These are moderately well drained and somewhat poorly drained soils on uplands. They formed in glacial till under grass and trees. This mapping unit occurs throughout the county in coves and on irregular side slopes that are dissected by shallow, crossable drainageways. It is ordinarily downslope from Lamoni and other Armstrong soils and upslope from Colo, Olmitz, and Mystic soils. It is about 60 percent Armstrong soil and 40 percent Gara soil. The Armstrong soil is commonly on convex summits of interfluves, and the Gara soil is downslope.

The Armstrong and Gara soils of this unit have profiles similar to the ones described as representative of their respective series. In most places the original surface layer and subsurface layer have been mixed with part of the former subsoil by plowing.

These soils are moderately suited to row crops. Unless erosion is controlled, the tilth and fertility of the surface layer deteriorate as increasing amounts of the subsoil are mixed into the plow layer. These soils are low in organic-matter content. Much of the acreage is used for hay and pasture. Capability unit IVe–2; woodland suitability group 5c1.

Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded (993E2).—These are moderately well drained to somewhat poorly drained soils on uplands. They formed in glacial till under grass and trees. This mapping unit occurs throughout the county in coves and on irregular side slopes. It is generally downslope from Armstrong soils and upslope from Colo, Vesser, Olmitz, or Mystic soils. It is about 60 percent Armstrong soil and 40 percent Gara soil. The Armstrong soil is commonly on convex summits as narrow bands and is commonly upslope from Gara soil.

The Armstrong and Gara soils of this unit have profiles similar to the ones described as representative of their respective series. The present surface layer is 3 to 6 inches of the original surface layer and subsurface layer that have been mixed with part of the former subsoil by plowing. Included in mapping are a few severely eroded spots and other slightly eroded areas.

These soils are better suited to hay and pasture than to most other uses. Establishing hay or pasture is difficult because tilth is poor and the organic-matter content is low. When pastures are renovated, excessive soil loss can be prevented if part of the old vegetation is maintained while new vegetation is being established. Gullies should be shaped and reseeded as soon as they start to form. Capability unit VIe–2; woodland suitability group 5c1.

Armstrong-Gara complex, 9 to 14 percent slopes, severely eroded (993D3).—These are moderately well drained to somewhat poorly drained soils on uplands. This mapping unit occurs throughout the county and consists of about 60 percent Armstrong soils and about 40 percent Gara soils. The Armstrong soils generally are in the upper part of the mapping unit on convex summits of interfluves and Gara soils are downslope. They are in coves and on irregular side slopes that are dissected by shallow drainageways. They generally are downslope from Lamoni soils and upslope from Colo, Vesser, Olmitz, or Mystic soils.

The Armstrong and Gara soils of this unit have similar profiles to those described as representative of their respective series, but the surface layer is thinner. It consists of less than 3 inches of the original surface layer and subsurface layer mixed with part of the former subsoil by plowing. Texture of the surface layer ranges from loam to clay loam to clay, depending on the amount of surface soil removed by erosion and the texture of the original subsoil. In many places erosion has removed all of the surface soil and the subsoil is exposed. Small rills and gullies occur.

These soils are not suited to row crops. They are better suited to hay and pasture than to most other uses. Good hay and pasture vegetation is difficult to establish and maintain because the surface layer is in poor tilth and is low in fertility. These soils are very low in organic-matter content. Unless these soils are covered by dense vegetation, gullies form readily. They should be shaped and reseeded as soon as they begin to form. Capability unit VIe–3; woodland suitability group 5c1.

Armstrong-Gara complex, 14 to 18 percent slopes, severely eroded (993E3).—This mapping unit is in coves and on irregular side slopes that are dissected by shallow drainageways. It is about 60 percent Armstrong soils and 40 percent Gara soils. Armstrong soils generally are on the upper slopes near the end of convex interfluves and Gara soils are downslope. These are moderately well drained to somewhat poorly drained soils on uplands throughout the county. They are usually downslope from other Armstrong soils and upslope from Colo, Vesser, Olmitz, or Mystic soils.

The Armstrong and Gara soils have profiles similar to the ones described as representative of the series, but the surface layer is thinner. The plow layer ranges from loam or clay loam to clay within short distances. In many places the surface layer is less than 3 inches of the original surface layer and subsurface layers mixed with part of the subsoil through plowing. Near rills and gullies the clay or clay loam subsoil is exposed. Included in mapping are small, moderately eroded areas.

The Armstrong and Gara soils are not suited to row crops. They are better suited to hay, pasture, and wildlife habitat than to most other uses. Seeded hay and pasture are very difficult to establish because the surface layer is in poor tilth and is low in fertility and because slopes are moderately steep. The surface layer tends to seal over during rain, reducing infiltration and increasing runoff. This, in combination with the moderately steep slopes, results in rapid runoff and a severe hazard of further erosion. Unless this complex is protected by dense vegetation, gullies form readily. They should be shaped and reseeded as soon as they begin to form. Some areas are too steep or too eroded for efficient use of farm machinery. Capability unit VIIe–2; woodland suitability group 5c1.

Ashgrove Series

The Ashgrove series consists of poorly drained soils on uplands. These soils formed in weathered glacial till under forest vegetation. The till is gray clay that is commonly called "gumbotil." The gumbotil was the subsoil of a soil on the nearly level drift plain that remained after the Kansan Glacier receded. Later a deposit of loess covered the gumbotil, but geologic erosion has removed the loess in many places and has exposed the old buried soil.

These soils are most extensive at the edge of the timbered areas in the county. They are generally in coves and on side slopes along drainageways that extend back into moderately wide ridges. They are downslope from Weller or Rathbun soils and upslope from Lindley or Keswick soils.

In a representative profile the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is brown silty clay loam about 4 inches thick. The subsoil extends to a depth of about 65 inches or more. The upper 7 inches is brown silty clay. The rest is gray clay.

These soils have a high available water capacity and very slow permeability. They are very low in natural fertility. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low to very low in available phosphorus and potassium, and is poorly aerated. These soils tend to stay wet longer in spring than the adjacent soils. They have a high shrink-swell potential, and deep cracks form when they are dry.

These soils are seldom used for row crops. They are better suited to hay or pasture than to most other uses. Most individual areas are too narrow and irregular in shape or too small in size to be managed as separate units.

Representative profile of Ashgrove silt loam, 5 to 9 percent slopes, moderately eroded, on a southeast aspect where the slope is 7 percent; 600 feet north of the southwest corner of the SE¼SE¼ sec. 26, T. 70 N., R. 17 W.

A1—0 to 4 inches, very dark gray (10YR 3/1) silt loam, very dark grayish brown (10YR 3/2) when kneaded; few, very fine, faint mottles of brown (10YR 5/3), grayish brown (10YR 5/2) when dry; weak, medium, platy structure; friable; very strongly acid; abrupt, smooth boundary.

A2—4 to 8 inches, brown (10YR 5/3) light silty clay loam, pale brown (10YR 6/3) when dry; weak, medium, platy structure; friable; light-gray (10YR 7/1) dry grainy coatings on peds; very strongly acid; gradual, smooth boundary.

IIB1—8 to 15 inches, brown (10YR 4/3) silty clay; few fine faint mottles of yellowish brown (10YR 5/6), brown (10YR 5/3) when dry; moderate, fine, subangular blocky structure; firm; few loose quartz grains; very strongly acid; gradual, smooth boundary.

IIB21tg—15 to 22 inches, gray (10YR 6/1) clay; many, fine, distinct mottles of yellowish brown (10YR 5/6), pale brown (10YR 6/3) when dry; weak, medium, subangular blocky structure; very firm; thin discontinuous clay films on peds; few loose quartz grains; very strongly acid; gradual, smooth boundary.

IIB22tg—22 to 39 inches, gray (10YR 6/1) clay; common, medium, distinct mottles of yellowish brown (10YR 5/6), light gray (10YR 7/1) when dry; weak, medium, subangular blocky structure; very firm; few, thin, discontinuous clay films on peds; few loose quartz grains; very strongly acid; gradual, smooth boundary.

IIB23tg—39 to 54 inches, gray (10YR 6/1) clay; many, medium, distinct mottles of yellowish brown (10YR 5/6) and light brownish gray (10YR 6/2); moderate, medium, subangular blocky structure; very firm; few, thin, discontinuous clay films; few black (N 2/0) oxides; increasing sand content; neutral; gradual, smooth boundary.

IIB3tg—54 to 65 inches, gray (5Y 5/1) clay; common, coarse, distinct mottles of yellowish brown (10YR 5/6 and 5/8); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; very firm; few, thin, discontinuous clay films on vertical peds; few, fine and medium sand grains; neutral.

The A horizon ranges from very dark gray (10YR 3/1) to grayish brown (10YR 4/2). It is mostly silt loam, but ranges to silty clay loam. The A2 horizon is grayish brown (10YR 5/2) or brown (10YR 5/3). The A1 and A2 horizons combined are as much as 11 inches thick. The IIB1 horizon is brown (10YR 5/3) to grayish brown (10YR 5/2). The IIB2 horizon is dominantly gray (10YR 4/1), but in places is dark gray (10YR 3/1) and light gray (10YR 7/1) and has high-chroma mottles. The IIB2t horizon is 45 to 60 percent clay. A yellowish-brown clay loam C horizon is at a depth of 3½ to 7 feet.

Ashgrove soils formed in about the same kind of parent materials as Clarinda soils, and they are associated with Keswick and Lindley soils. They differ from Clarinda soils in having a thinner A1 horizon and a light-colored A2 horizon. They lack the reddish colors in the B horizon and the stone line characteristic of Keswick soils. They have more clay and grayer colors in the B horizon than Lindley soils.

Ashgrove silt loam, 5 to 9 percent slopes, moderately eroded (795C2).—This soil generally is in small areas in coves. It is generally at the edges of the strongly dissected timber areas, downslope from Weller or Rathbun soils and upslope from Lindley soils.

This soil has the profile described as representative of the series. In most places part of the original surface and subsurface layers have been removed by erosion, and the remaining 3 to 6 inches has been mixed with part of the former subsoil by plowing. Included in mapping are small areas where erosion has removed the surface layer and exposed the gray clay subsoil. These severely eroded areas are indicated on the soil map by a special spot symbol.

Although this soil is moderately suited to row crops, most of the acreage is used for pasture or woodland. Unless erosion is controlled, the tilth of the surface layer deteriorates as increasing amounts of the subsoil is mixed into the plow layer. This soil dries slowly because of very slow permeability. The organic-matter content is low. Capability unit IVe–2; woodland suitability group 5w1.

Ashgrove silt loam, 9 to 14 percent slopes, moderately eroded (795D2).—This soil generally is in coves and on side slopes at the edges of the strongly dissected timber areas. It is downslope from Weller or Rathbun soils and upslope from Lindley soils.

This soil has a profile similar to the one described as representative of the series, but the surface layer has been eroded and is thinner. All but 3 to 6 inches of the original surface and subsurface layers have been removed by erosion, and the rest has been mixed with part of the former subsoil by plowing.

Included with this soil in mapping are many areas that have never been plowed and have a thicker surface layer. Also included are some areas where most of the surface layer has been removed by erosion and the gray, clayey subsoil exposed on the surface. These severely eroded areas are shown on the soil map by a special symbol.

This soil is moderately suited to row crops. It is better suited to pasture or woodland than to most other uses. Unless erosion is controlled, tilth of the surface layer deteriorates as increasing amounts of the clayey subsoil are mixed into the plow layer. This soil is low in content of organic matter. Capability unit IVe–2; woodland suitability group 5w1.

Beckwith Series

The Beckwith series consists of poorly drained soils on the narrow, flat ridgetops near the major streams in the northern parts of the county. These soils formed in leached loess under a vegetation of trees. The loess, 6 to 8 feet thick, is underlain by a very slowly permeable, gray clayey soil. Slopes range from 0 to 2 percent.

In a representative profile the surface layer is dark grayish-brown silt loam about 6 inches thick. The subsurface layer is light brownish-gray, friable silt loam about 9 inches thick. The subsoil to a depth of 60 inches is dark grayish-brown, firm silty clay that grades to grayish-brown, firm silty clay loam in the lower part.

Beckwith soils are seasonally wet and occasionally pond water on the surface after periods of heavy rainfall. Available water capacity is moderately high, and permeability is very slow. Natural fertility is very low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low in available phosphorus, is medium in available potassium, and is poorly aerated.

These soils are used for row crops and pasture. They are difficult to manage because of poor drainage and very low fertility. Response is only fair to improved management.

Representative profile of Beckwith silt loam, 80 feet west and 207 feet north of the southeast corner of the NE¼SW¼ sec. 10, T. 70 N., R. 16 W.

Ap—0 to 6 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, very thin, platy structure breaking to weak, fine, granular; friable; few, very fine, dark oxides; very strongly acid; abrupt, smooth boundary.

A2—6 to 15 inches, light brownish-gray (10YR 6/2) silt loam, white (10YR 8/2) when dry; moderate, thin, platy structure; friable; few, fine, dark oxides; very strongly acid; clear, smooth boundary.

AB—15 to 17 inches, pale-brown (10YR 6/3) light silty clay loam, white (10YR 8/2) when dry; few, fine, distinct mottles of yellowish brown (10YR 5/6); weak, fine, subangular blocky structure; friable; thick continuous silt coatings; strongly acid; abrupt, smooth boundary.

B21tg—17 to 21 inches, dark grayish-brown (10YR 4/2) silty clay; faces of peds dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2); few, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, distinct mottles of brown to dark brown (10YR 4/3); strong, fine to medium, subangular blocky structure; very firm; thick, discontinuous, very dark gray (10YR 3/1) clay films; common fine dark oxides; very strongly acid; clear, smooth boundary.

B22tg—21 to 25 inches, dark grayish-brown (2.5Y 4/2) silty clay; common, fine, distinct mottles of brown (10YR 4/3) and yellowish brown (10YR 5/6); strong, medium, subangular blocky structure; very firm; few very dark grayish brown (10YR 3/2) organic coatings on peds; thin nearly continuous clay films; common fine dark oxides; medium acid; gradual, smooth boundary.

B23tg—25 to 31 inches, dark grayish-brown (2.5Y 4/2) silty clay; few, fine, distinct mottles of yellowish brown (10YR 5/4 to 5/6) and few, fine, distinct mottles of strong brown (7.5YR 5/6); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; firm; thin, discontinuous clay films; few discontinuous white (10YR 8/2) silt coatings in vertical streaks; few fine dark oxides; medium acid; gradual, smooth boundary.

B31tg—31 to 39 inches, mixed grayish-brown (2.5Y 5/2) and brown (10YR 4/3) silty clay; common, fine, faint mottles of yellowish brown (10YR 5/6) and dark yellowish brown (10YR 4/4); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; firm; thin discontinuous clay films; common fine dark oxides; very few discontinuous white (10YR 8/2) silt coatings in vertical streaks; medium acid; gradual, smooth boundary.

B32tg—39 to 45 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam; common, fine, distinct mottles of yellowish brown (10YR 5/4 to 5/6); very weak, medium, prismatic structure breaking to weak, medium, subangular blocky; firm; common very dark gray (10YR 3/1) oxide stains on peds; thin discontinuous clay films; few fine hard oxides; medium acid; gradual, smooth boundary.

B33tg—45 to 60 inches, grayish-brown (2.5Y 5/2) medium silty clay loam; common, fine to medium, distinct mottles of yellowish brown (10YR 5/6); some vertical cleavage; firm; few very dark gray (10YR 3/1) oxide stains on vertical faces; very few thin clay coatings in some root channels; slightly acid.

The Ap or A1 horizon ranges from 6 to 9 inches in thickness and from dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). The A2 horizon ranges from 6 to 9 inches in thickness and from dark grayish brown (10YR 4/2) to light brownish gray (10YR 6/2). The B2t horizon ranges from very dark grayish brown (10YR 3/2) to grayish brown (2.5Y 5/2). The B3 horizon ranges from silty clay to clay loam. The B2 horizon ranges from medium acid to very strongly acid in reaction. Clayey glacial till is at a depth of about 7 or 8 feet.

Beckwith soils formed in about the same kind of parent material as Rathbun, Weller, and Belinda soils. They differ from Rathbun and Weller soils in having a lighter colored and thicker, more pronounced A2 horizon. The upper part of the B horizon is darker and more poorly drained than in the Rathbun and Weller soils. They have a thinner, browner A1 horizon, a lighter colored A2 horizon, and are browner in the upper part of the B horizon than Belinda soils.

Beckwith silt loam (0 to 2 percent slopes) (260).—This soil is on the narrow ridgetops on uplands near the major streams in the northern parts of the county.

In some places runoff collects and ponds in shallow depressions because there is no natural drainage outlet. In most places plowing mixes the grayish subsurface layer with the surface layer and gives it an ashy appearance.

This soil is moderately suited to row crops because the subsoil is very slowly permeable and is poorly drained. The subsoil contains large amounts of clay, so tile lines are not suitable for drainage. Shallow ditches, however, remove excess water and improve drainage. This soil puddles if it is worked when wet. In periods of above average rainfall, crops turn yellow and are stunted. This soil is strongly acid and needs additions of lime. The content of organic matter is very low. Capability unit IIIw-3; woodland suitability group 5w3.

Belinda Series

The Belinda series consists of poorly drained soils on benches and on narrow, level ridgetops or uplands near major streams in the county. These soils formed in leached loess 6 to 8 feet thick over a buried, very slowly permeable, gray clayey soil. Slopes range from 0 to 2 percent. The native vegetation was mixed prairie grasses and deciduous trees.

In a representative profile the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is grayish brown, friable silt loam about 10 inches thick. The subsoil to a depth of 62 inches is grayish-brown, very firm silty clay that grades to mottled olive-gray, firm silty clay loam in the lower part.

The Belinda soils are seasonably wet and are occasionally ponded after periods of heavy rainfall. Available water capacity is moderately high, and permeability is very slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low in available phosphorus, is very low in available potassium, and is poorly aerated.

These soils are suited to row crops if they are drained. Meadow and permanent pasture are also grown. Response is good to management.

Representative profile of Belinda silt loam, on an upland ridgetop where the slope is 1 percent; 500 feet east and 280 feet north of the southwest corner of the NW¼NW¼ sec. 2, T. 70 N., R. 17 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; weak, thin, platy structure and weak, very fine, granular; friable; slightly acid; abrupt, smooth boundary.

A21—7 to 13 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/1) when dry; common, fine, faint mottles of dark gray (10YR 4/1); weak, fine to medium, platy structure; friable; few fine manganese-iron concretions; medium acid; clear, smooth boundary.

A22—13 to 17 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/1) when dry; strong, fine, subangular blocky structure; friable; almost continuous light-gray (10YR 7/1) grainy ped coatings; few manganese-iron concretions; strongly acid; clear, wavy boundary.

B1g—17 to 19 inches, grayish-brown (10YR 5/2) and dark-gray (10YR 4/1) heavy silty clay loam; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky; firm; few discontinuous light-gray (10YR 7/1) grainy ped coatings; common manganese-iron concretions; strongly acid; clear, smooth boundary.

B21tg—19 to 28 inches, grayish-brown (2.5Y 5/2) silty clay; few, fine, distinct mottles of yellowish brown (10YR 5/6 and 5/8); moderate, fine, subangular blocky structure; very firm; common thick black (10YR 2/1) clay films; common manganese-iron concretions; medium acid; clear, smooth boundary.

B22tg—28 to 35 inches, grayish-brown (2.5Y 5/2) silty clay; many, fine, distinct mottles of yellowish brown (10YR 5/6 and 5/8) and few, fine, faint mottles of dark gray (10YR 4/1); moderate, medium, subangular blocky structure; very firm; few thick black (10YR 2/1) clay films; common manganese-iron concretions; medium acid; gradual, smooth boundary.

B23tg—35 to 42 inches, olive-gray (5Y 5/2) light to medium silty clay; many, fine, faint mottles of yellowish brown (10YR 5/6 and 5/8) and few, fine, faint mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; few thick black (10YR 2/1) clay films; few manganese-iron concretions; medium acid; gradual, smooth boundary.

B31tg—42 to 52 inches, olive-gray (5Y 5/2) heavy silty clay loam; common, fine, faint mottles of yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm; few clay films; few manganese-iron concretions; slightly acid; gradual, smooth boundary.

B32g—52 to 62 inches, olive-gray (5Y 5/2) medium silty clay loam; few, fine, distinct mottles of dark brown (7.5YR 4/4) and common, fine, faint mottles of yellowish brown (10YR 5/6); massive; firm; neutral.

The Ap or A1 horizon ranges from 6 to 10 inches in thickness and is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from 8 to 12 inches in thickness and from dark gray (10YR 4/1) to grayish brown (10YR 5/2). The B2tg horizon ranges from dark gray (10YR 4/1) to olive gray (5Y 5/2) and from medium to heavy silty clay. Reaction ranges from medium to strongly acid in the upper part of the B2t horizon. Depth to weathered glacial till of clay texture is about 1 to 8 feet.

Belinda soils formed in about the same kind of parent material as Kniffin, Pershing, Edina, Beckwith, Seymour, and Grundy soils. They differ from Kniffin and Pershing soils in having a lighter colored and thicker A2 horizon. They differ from the Edina soils in having a thinner A horizon and a browner B horizon. They have a thicker A1 horizon and are darker colored in the upper part of the B horizon than Beckwith soils. They differ from the Seymour and Grundy soils in having a distinct A2 horizon.

Belinda silt loam (0 to 2 percent slopes) (130).—This soil is on narrow, flat ridgetops on uplands near the major streams in the county. Areas generally are small.

This soil has the profile described as representative of the series. Included in mapping are small areas where runoff collects in shallow depressions, because natural drainage outlets are not available. In some places, plowing mixes the grayish subsurface layer with the surface layer causing ashy appearing spots in the field.

The subsoil of this soil contains large amounts of clay, therefore tile lines are not suitable for drainage. Shallow ditches, however, remove excess water and improve drainage. Where such drainage has been installed, this soil is suited to growing row crops often. In periods of above-average rainfall, crops turn yellow and are stunted. In many places this soil is cultivated along with Pershing and Clarinda soils. Capability unit IIIw-3; woodland suitability group 5w3.

Belinda silt loam, benches (0 to 2 percent slopes) (T130).—This soil is on the more nearly flat parts of benches along the larger streams in the county. Slopes are dominantly less than 1 percent but range from 0 to 2 percent.

This soil has a profile similar to the one described as representative of the series, but the underlying material at a depth of 6 to 8 feet is stratified loamy alluvial sediments. The surface layer is very dark gray silt loam about 8 inches thick. The subsoil is grayish-brown silty clay. Included in mapping are a few small areas of Beckwith soils.

Individual areas of this soil are small, therefore most of them are cropped in the same way as the surrounding soils. If this soil is drained, row crops are moderately suited. Shallow surface ditches remove excess water and improve drainage. The high clay content of the subsoil limits the effective use of tile lines. Seepage and the variable texture of the underlying material can be expected where deep cuts are made on this bench phase of Belinda soil. Capability unit IIIw-3; woodland suitability group 5w3.

Caleb Series

The Caleb series consists of moderately well drained soils along the major stream valleys throughout the county. These soils formed in water-sorted glacial sediments under mixed grass and forest vegetation. Slopes range from 9 to 18 percent.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer is brown, friable silt loam 6 inches thick. The subsoil to a depth of 52 inches is yellowish-brown, firm clay loam in the upper part and grades to light brownish-gray sandy clay loam or fine sandy loam.

Caleb soils are subject to erosion. Natural fertility is very low. Available water capacity is medium, and permeability is moderate. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid and is very low in available phosphorus and potassium.

Most of the acreage is used for pasture or hay. A few strongly sloping areas are occasionally used for row crops. The moderately steep Caleb soils are not suited to row crops.

Caleb soils in Appanoose County are mapped only with Mystic soils.

Representative profile of Caleb loam in an area of Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded, on a northeast aspect where the slope is 11 percent; 120 feet south and 630 feet south of the northwest corner of the SW¼SW¼ sec. 12, T. 68 N., R. 19 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; friable; strongly acid; abrupt, smooth boundary.

A2—8 to 14 inches, brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) when dry; many, fine, faint mottles of yellowish brown (10YR 5/6), brown (10YR 4/3) when kneaded; weak, fine, granular structure; friable; few soft and very dark grayish-brown (10YR 3/2) oxides; strongly acid; gradual, smooth boundary.

B21t—14 to 21 inches, dark yellowish-brown (10YR 4/4) medium clay loam; common, fine, faint mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; firm; few, thin, discontinuous clay films; very strongly acid; gradual, smooth boundary.

B22t—21 to 29 inches, light brownish-gray (10YR 6/2) sandy clay loam, yellowish brown (10YR 5/6) when kneaded; common, medium, distinct mottles of yellowish brown (10YR 5/6); moderate, medium, angular blocky structure; friable; few pinholes; few, thin, discontinuous clay films; light grayish-brown (10YR 6/2) grainy coatings on ped exteriors; very strongly acid; gradual, smooth boundary.

B31—29 to 40 inches, light brownish-gray (10YR 6/2) loam, yellowish brown (10YR 5/4) when kneaded; common, medium, distinct mottles of strong brown (7.5YR 5/6); weak, coarse, prismatic structure; friable; thin dark grayish-brown (10YR 4/2) clay films in root channels; few fine dark reddish-brown (5YR 3/4) oxides; light-gray (10YR 7/2) coatings on prism faces; very strongly acid; gradual, smooth boundary.

B32—40 to 52 inches, light brownish-gray (10YR 6/2) fine sandy loam; common, medium to fine, distinct mottles of strong brown (7.5YR 5/6) and few, fine, faint mottles of yellowish brown (10YR 5/6); weak, coarse, prismatic structure; friable; very strongly acid.

The Ap or A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 6 to 9 inches in thickness. The Ap or A1 horizon is loam or silt loam, but is loam in most places. The A2 horizon generally ranges from dark grayish brown (10YR 4/2) to brown (10YR 5/3) and is 4 to 8 inches thick. The upper part of the B2t horizon typically ranges from dark brown (10YR

4/3) to yellowish brown (10YR 5/6) and has a few yellowish-brown (10YR 5/4 or 5/6) mottles. The B2t horizon ranges from clay loam to sandy clay loam that has thin strata of sandy loam and loamy sand or coarser material in places. Reaction ranges from very strongly acid to medium acid in the B2t horizon. The C horizon ranges from fine sandy loam to sandy clay loam and contains strata of coarse materials in places.

A large part of the Caleb soil mapped in Appanoose County has lower chroma (2 chroma) in the upper 10 inches of the B horizon than is typical of the Caleb series.

Caleb soils are associated with Armstrong, Gara, Lindley, Mystic, and Shelby soils. They differ from the Mystic and Armstrong soils in having less clay in the B horizon and in lacking the reddish colors characteristic of those soils. They have less clay and fewer glacial stones and pebbles in the solum than Gara, Shelby, and Lindley soils.

Cantril Series

The Cantril series consists of somewhat poorly drained soils on stream benches, foot slopes, and alluvial fans. These soils formed in silty alluvium under hardwood trees and tall prairie grass vegetation. They are slightly upslope from Chequest and Carlow soils.

In a representative profile the surface layer is very dark gray and dark grayish-brown loam about 12 inches thick. The subsurface layer is dark grayish-brown friable loam about 9 inches thick. The subsoil extends to a depth of 55 inches. It is firm, brown heavy loam in the upper part, light brownish gray to grayish brown loam in the middle part, and grayish-brown and strong-brown sandy loam in the lower part.

Cantril soils are subject to occasional flooding in places. Available water capacity is moderate, and permeability is moderate to moderately slow. Natural fertility is low. The surface or subsurface layer is acid and responds to additions of lime. The subsoil is slightly acid to neutral in reaction, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

Cantril soils are used for row crops. Occasional flooding and soil loss from erosion are major concerns in management.

Representative profile of Cantril loam, 2 to 5 percent slopes, where the slope is 2 percent; 200 feet west and 525 feet north of the southeast corner of the NE¼SE¼ sec. 27, T. 69 N., R. 17 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) when dry; weak, fine, granular structure; friable; common worm casts; neutral; clear, smooth boundary.

A12—8 to 12 inches, dark grayish-brown (10YR 4/2) loam, grayish brown (10YR 5/2) when dry; weak, thin, platy structure breaking to weak, fine, granular; friable; common soft oxides; common gray to light gray (10YR 6/1), when dry, grainy ped coatings; common fine pores; medium acid; clear, smooth boundary.

A2—12 to 21 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) when dry; moderate, thin and very thin, platy structure; friable; common soft oxides; upper side of plates somewhat lighter colored and less mottled than under side; common fine pores; medium acid; clear, smooth boundary.

AB—21 to 29 inches, mixed dark grayish-brown (10YR 4/2) and brown (10YR 5/3) loam: many, fine, distinct mottles of dark brown (7.5YR 3/2), light gray (10YR 7/1 and 7/2) when dry; weak, medium, subangular blocky structure; friable; nearly continuous light-gray (10YR 7/1) vertical ped coatings; common soft oxides and concretions; common fine pores; slightly acid; clear, smooth boundary.

B21t—29 to 33 inches, brown (10YR 4/3) and yellowish-brown (10YR 5/6) heavy loam; faces of peds are dark grayish brown (10YR 4/2); moderate, medium, subangular blocky structure; firm; common grainy ped coatings; many fine concretions and soft oxides; thin discontinuous clay films; neutral; clear, smooth boundary.

B22t—33 to 41 inches, light brownish-gray (10YR 6/2) and yellowish-brown (10YR 5/6) heavy loam; weak, fine, prismatic structure breaking to weak, medium, subangular blocky; firm; few grainy ped coatings; many fine concretions and yellowish-red (5YR 5/6) soft oxides; thin discontinuous clay films mostly in root channels; neutral; gradual, smooth boundary.

B3t—41 to 55 inches, mixed grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) sandy loam; common, fine, prominent mottles of yellowish red (5YR 4/6); weak, medium, prismatic structure; firm; few, thin, discontinuous clay films in root channels; common concretions and soft oxides; neutral.

The A1 or Ap horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is dominantly loam, but ranges to silt loam. The A2 horizon is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). The AB horizon is typically dark grayish brown (10YR 4/2), brown (10YR 5/3), or grayish brown (10YR 5/2). Clay content of the B2t horizon ranges from heavy loam to medium clay loam. Depth to the C horizon ranges from 42 to 60 inches. Reaction is medium acid to strongly acid in the most acid part of the solum, but the B horizon generally is less acid than is typical of Cantril soils.

Cantril soils are associated with Olmitz, Chequest, Colo, Vesser, and Coppock soils. They have a lighter colored A horizon than Olmitz soils. They contain more sand in the B horizon than Chequest, Colo, Vesser, and Coppock soils.

Cantril loam, 2 to 5 percent slopes (56B).—This soil is on alluvial fans, foot slopes, and stream benches. Most areas are within the Chariton River Valley.

Included with this soil in mapping are small areas where the slope is about 1 percent. Also included are areas where the surface layer is slightly thicker and the lower parts of the subsoil and substratum contain more sand. Areas that have recent deposition of loamy sediments are indicated by a special symbol on the soil map.

This soil is well suited to row crops. Most areas are narrow or small and are better farmed in the same manner as adjacent soils than separately. Unless runoff from uplands is controlled, this soil is damaged by sheet and gully erosion. The organic-matter content is low to medium. Capability unit IIe-2; woodland suitability group 5w2.

Carlow Series

The Carlow series consists of very poorly drained soils in level to slightly depressional slack-water areas on the flood plain, generally away from the natural stream channel. These soils formed in silty alluvium. The soils are likely to be flooded before the surrounding bottom land because they are generally in slightly lower positions in the landscape. These soils are minor in extent.

In a representative profile the surface layer is black to very dark gray silty clay about 18 inches thick. The subsoil to a depth of 55 inches is dark-gray, firm silty clay.

Carlow soils are subject to flooding, and the water table is seasonally at or near the surface. Adequate drainage is difficult to provide. Available water capacity is moderately high, and permeability is very slow. The shrink-swell potential is high. Natural fertility is low to medium. The surface layer is acid, and lime is needed. The subsoil is acid, is low to very low in available phosphorus and potassium, and is very poorly aerated.

Carlow soils are used for crops or pasture. The choice of crops on these soils is limited because of high water table and flooding. These soils are difficult to farm.

Representative profile of Carlow silty clay, 225 feet west and 375 feet north of the southeast corner of the SW¼SE¼ sec. 25, T. 68 N., R. 17 W.

A11—0 to 9 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) when dry; few, fine, distinct mottles of yellowish red (5YR 4/6); (compacted) weak, fine, granular structure; friable to firm; few fine soft oxides; very strongly acid; clear, smooth boundary.

A12—9 to 13 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) when dry; few, fine, faint mottles of dark reddish brown (5YR 3/3); weak to moderate, very fine, subangular blocky structure; firm; few soft oxides; very strongly acid; clear, smooth boundary.

A3—13 to 18 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) when dry; common, fine, distinct mottles of dark reddish brown (5YR 3/4); moderate, very fine, subangular blocky structure; firm; few soft oxides; very strongly acid; clear, smooth boundary.

B21g—18 to 24 inches, dark-gray (10YR 4/1) silty clay, gray to light gray (10YR 6/1) when dry; common, fine, distinct mottles of dark reddish brown (5YR 3/4); moderate, fine to medium, subangular blocky structure; firm; common fine soft oxides; common grainy light-gray (10YR 7/1) ped coatings when dry and common black (10YR 2/1) and very dark gray (10YR 3/1) deposits on vertical ped faces; very strongly acid; clear, smooth boundary.

B22tg—24 to 30 inches, dark-brown to brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) silty clay; faces of peds dark gray (10YR 4/1); moderate, fine, prismatic structure breaking to moderate, medium, subangular blocky; firm; thick discontinuous black (10YR 2/1) and very dark gray (10YR 3/1) clay films; few light-gray (10YR 7/1) grainy ped coatings when dry; few fine soft oxides; strongly acid; gradual, smooth boundary.

B23tg—30 to 37 inches, dark-brown to brown (7.5YR 4/4) and yellowish-brown (10YR 5/6) silty clay; faces of peds dark gray (10YR 4/1); weak, fine to medium, prismatic structure breaking to moderate, fine, subangular blocky; firm; thick nearly continuous very dark gray (10YR 3/1) clay films; strongly acid; gradual, smooth boundary.

B3tg—37 to 55 inches, dark-gray (10YR 4/1) silty clay; common, fine, distinct mottles of dark reddish brown (5YR 3/4) and reddish brown (5YR 4/4); weak, medium, prismatic structure; firm; thick continuous clay films; few concretions and soft oxides; strongly acid.

The A horizon ranges from 10 to 20 inches in thickness and from black (10YR 2/1) to very dark gray (10YR 3/1). The B horizon ranges from mottled gray to very dark gray in 10YR to 5Y hue. It is heavy silty clay or clay that ranges from about 48 to 60 percent clay. Reaction of the B horizon ranges from medium acid to very strongly acid.

Carlow soils are associated with Chequest, Colo, Zook, Humeston, and Wabash soils. They contain more clay in the B horizon than Chequest, Colo, and Zook soils. They do not have the A2 horizon characteristic of Humeston soils. They are similar to Wabash soils, but they have a mottled, grayer, more acid B horizon.

Carlow silty clay (0 to 2 percent slopes) (534).—This soil is on bottom lands. It formed in low areas where floodwater often stands long enough for the clay in it to settle out. Individual areas range from 5 to 50 acres in size.

Included with this soil in mapping are a few areas that have an overwash of less clayey sediments. These areas are indicated by a special symbol on the soil map.

This very poorly drained soil is silty clay throughout. As it dries, it becomes extremely hard, and many cracks form and extend from the surface into the subsoil. This soil then absorbs rainfall at a moderate rate for a short time, and when it becomes saturated the cracks seal. After the cracks seal, the surface soil is slowly permeable and the subsoil is very slowly permeable.

This soil is moderately suited to row crops if it is properly drained and managed. Soybeans are often grown instead of corn. This soil is ponded after heavy rains. Excess water generally delays field operations in spring and fall. Sometimes excess water can be reduced by a system of open ditches and shallow surface drains. Tile drains are not suitable because the subsoil is very slowly permeable. Seedbeds are very difficult to prepare because the soil puddles easily. Capability unit IIIw–2; woodland suitability group 5w3.

Chequest Series

The Chequest series consists of poorly drained soils on bottom land in and along old abandoned stream channels and bayous. These soils formed in moderately fine textured silty alluvium. They are not extensive in the county, but individual areas are large and the soils are fairly good for farming.

In a representative profile the surface layer is very dark gray silty clay loam about 12 inches thick. The subsoil to a depth of 50 inches or more is dark-gray to black, friable to firm silty clay loam that has brownish mottles in places.

Chequest soils are subject to flooding and have a seasonal high water table. Available water capacity is high, and permeability is moderately slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the last few years. The subsoil is acid, is medium or low in available phosphorus, is low or very low in available potassium, and is poorly aerated.

Use of Chequest soils is limited by poor drainage and occasional flooding. Most areas are in cultivated crops. Artificial drainage is needed in cropped areas. Some undrained areas are in pasture.

Representative profile of Chequest silty clay loam in a cultivated field 350 feet west and 35 feet north of the southeast corner of the NW¼NE¼ sec. 13, T. 68 N., R. 17 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) when dry, very dark gray (10YR 3/1) when kneaded; weak, fine, granular structure; friable, numerous pores; slightly acid; abrupt, smooth boundary.

A12—7 to 12 inches, very dark gray (10YR 3/1) medium silty clay loam, dark gray (10YR 4/1) when dry, very dark gray (10YR 3/1) when kneaded; moderate, very fine, subangular blocky structure; firm; numerous roots and pores; slightly acid; gradual, smooth boundary.

B21g—12 to 18 inches, dark-gray (10YR 4/1) heavy silty clay loam, gray (10YR 6/1) when dry; common, fine, distinct mottles of dark brown (7.5YR 3/2); moderate, fine, subangular blocky structure; firm; few, thin, discontinuous very dark gray (10YR 3/1) to black (10YR 2/1) clay coatings; common fine roots and pores; few discontinuous silty ped coatings; medium acid; gradual, smooth boundary.

B22g—18 to 25 inches, dark-gray (10YR 4/1) heavy silty clay loam, gray (10YR 6/1) when dry; many, medium, distinct mottles of dark brown (7.5YR 3/2) and few, fine, distinct mottles of dark brown to brown (7.5YR 4/2); moderate, fine to medium, subangular blocky structure; firm; few gray (10YR 6/1, when dry) ped coatings; few, black (10YR 2/1), thick, grainy, discontinuous clay coatings; common fine roots and pores; few soft oxides; medium acid; gradual, smooth boundary.

B23g—25 to 35 inches, mixed black (10YR 2/1), very dark gray (10YR 3/1), and dark-gray (10YR 4/1) heavy silty clay loam; many, fine, distinct mottles of olive brown (2.5Y 4/4) and common, fine, distinct mottles of dark brown (7.5YR 3/2) and dark brown to brown (7.5YR 4/2); moderate, fine to medium, subangular blocky structure; firm; common fine black (10YR 2/1) soft oxides; thick black (N 2/0 to 10YR 2/1) discontinuous clay coatings; few grainy ped coatings; common fine roots; strongly acid; gradual, smooth boundary.

B24g—35 to 43 inches, mixed very dark gray (10YR 3/1) and gray (N 5/0 and 10YR 6/1) medium silty clay loam; many, medium, distinct mottles of olive brown (2.5Y 4/4); weak, medium, subangular blocky structure; firm; common, fine, black (10YR 2/1), soft oxides; thick, black (N 2/0 to 10YR 2/1), discontinuous clay coatings, mostly on root channels; common fine roots; strongly acid; gradual, smooth boundary.

B3g—43 to 53 inches, mixed dark-gray (10YR 4/1) and gray (5Y 5/1) medium silty clay loam; common, fine, distinct mottles of dark brown to brown (7.5YR 4/4) and dark brown (7.5YR 4/2) and few, fine, distinct mottles of olive brown (2.5Y 4/4); weak, medium, subangular blocky structure; firm; thick, black (N 2/0 to 10YR 2/1), discontinuous clay films on root channels, pores, and cleavage planes; medium acid.

In most places the Ap or A1 horizon is very dark gray (10YR 3/1) or black (10YR 2/1) and ranges from 8 to 12 inches in thickness. The B horizon centers on chroma of 1. The B2 horizon generally is heavy silty clay loam, but the clay content ranges from 30 to 55 percent. The B horizon ranges from medium acid to strongly acid and is typically strongly acid in the most acid part.

Chequest soils are associated with Vesser, Amana, Colo, and Kennebec soils. They have more clay in the A horizon and more mottles in the B horizon than Vesser soils. They have a thinner A horizon and a grayer B horizon than Amana and Colo soils. They have more clay throughout than Kennebec soils.

Chequest silty clay loam (0 to 2 percent slopes) (587).—This soil is on the wider bottom lands in the county. It formed in bayous or low areas where sediment is deposited during floods and where floodwater often stands or the water table is generally high.

Included with this soil in mapping are small areas, indicated by a spot symbol on the soil map, that have an overwash of loamy sediments and some places where the surface layer is slightly thinner than in the profile described. Also included are a few small low wet areas that are indicated by a marsh spot symbol on the soil map.

This poorly drained soil is generally farmed along with soils that are better suited to cultivated crops. If artificially drained, it can be planted to row crops often, but it is only moderately suited to row crops. It is generally in poor tilth and puddles if worked when wet. Poor drainage and occasional flooding are the main limitations. If outlets can be established, open ditches or tile drains should be installed in cultivated areas. In undrained areas this soil is better suited to pasture than to row crops. Capability unit IIw-1; woodland suitability group 5w3.

Clanton Series

The Clanton series consists of moderately well drained to somewhat poorly drained soils that formed in residuum derived from shale under grass and forest vegetation. These soils are on convex, moderately sloping to steep lower side slopes along the Cooper, Walnut, and Shoal Creeks and along the southwestern side of the Chariton River.

In a representative profile the surface layer is very dark gray silty clay loam about 7 inches thick. The subsurface layer is dark grayish-brown, friable silty clay loam about 4 inches thick. The subsoil is reddish-brown to dark reddish-brown firm clay 39 inches thick. The underlying material is olive and dusky red clay that contains a few calcium carbonate concretions.

Erosion on Clanton soils is the principal limitation to use and management. Available water capacity is high, and permeability is very slow. Natural fertility is very low. The surface layer is slightly acid to neutral. The subsoil is acid, is very low in available phosphorus, is low to very low in available potassium, and is poorly aerated.

These soils are better suited to hay and pasture than to most other uses.

In this survey area, Clanton soils are mapped only as part of the Gosport-Clanton silt loams or the Sogn-Gosport-Clanton complex.

Representative profile of Clanton silty clay loam, in an area of Gosport-Clanton silt loams, 9 to 14 percent slopes, moderately eroded, where the slope is 11 percent and faces north; 340 feet north and 50 feet west of the southeast corner of the SW1/4 sec. 24, T. 69 N., R. 18 W.

A1—0 to 7 inches, very dark gray (10YR 3/1) light silty clay loam, dark gray (10YR 4/1) when dry; few, fine, faint, dark grayish-brown (10YR 4/2) mottles; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—7 to 11 inches, dark grayish-brown (10YR 4/2) light silty clay loam, light brownish gray (10YR 6/2 when dry; weak, medium, platy structure breaking to weak, medium, subangular blocky; friable; few very dark gray (10YR 3/1) worm casts; medium acid; gradual, smooth boundary.

AB—11 to 13 inches, dark grayish-brown (10YR 4/2) silty clay loam, grayish brown (10YR 5/2) when dry; moderate, very fine, subangular blocky structure; friable; light gray (10YR 7/1) grainy coatings; medium acid; clear, smooth boundary.

B21t—13 to 18 inches, reddish-brown (5YR 4/3) clay, reddish brown (5YR 5/3) when dry; moderate, fine, subangular blocky structure; firm; thin continuous clay films; few iron-manganese concretions; medium acid; clear, smooth boundary.

B22t—18 to 28 inches, dark reddish-brown (5YR 3/3) clay, reddish brown (5YR 4/3) when dry; moderate, fine, subangular blocky structure; firm; common iron-manganese concretions, few, thin, discontinuous clay films on ped faces; medium acid; clear, smooth boundary.

B3—28 to 50 inches, reddish-brown (5YR 4/3) clay, reddish brown (5YR 5/4) when dry; weak, fine, subangular blocky structure; firm; common calcium carbonate concretions; many iron-manganese concretions; neutral; gradual, smooth boundary.

IIC—50 to 60 inches, olive (5Y 5/3) and dusky red (2.5YR 3/2) clay; few, fine, faint, olive-yellow (2.5Y 6/6) mottles; weak, fine, subangular blocky structure; firm; few calcium carbonate concretions; neutral.

The A horizon, where not eroded, ranges from 6 to 10 inches in thickness and from very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). The A2 horizon ranges from 2 to 4 inches in thickness and from dark grayish brown (10YR 4/2) to light yellowish brown (10YR 6/4). Where these soils have been plowed, the A1 and A2 horizons are mixed together into the plow layer. The B2t horizon ranges from strongly acid to neutral and is most acid in the upper part. The B2t horizon is normally reddish brown, but layers of olive-colored material are often below a depth of 36 inches. Maximum clay content of the B2t horizon ranges from 45 to 60 percent or more.

Clanton soils are associated with Armstrong, Mystic, and Sogn soils and formed in parent material similar to that of Gosport soils. They have a B horizon high in kaolinitic clay minerals that is redder than that of Armstrong and Mystic soils. They have a thicker B horizon than Sogn and are underlain by shale and clay rather than the limestone bedrock that typically underlies Sogn soils. They differ from Gosport soils in having a reddish-brown B horizon.

Clarinda Series

The Clarinda series consists of poorly drained soils on uplands. These soils formed in weathered glacial till under grass vegetation. The till is gray clay that is commonly called "gumbotil." The gumbotil was the subsoil of a soil on the nearly level drift plain that remained after the Kansan Glacier receded. Later, a deposit of loess covered the gumbotil, but geologic erosion has removed the loess in many places and has exposed the old buried soil.

These soils are most extensive in the moderately sloping areas near the major interstream divides in the county. They often form a continuous band of about the same elevation just downslope from Seymour or Grundy soils on broad divides and just upslope from Lamoni, Adair, or Shelby soils. Farther away from the major divides, they occur only in small areas in the coves downslope from Seymour, Grundy, Kniffin, or Pershing soils and upslope from Armstrong or Gara soils.

In a representative profile the surface layer is very dark gray silty clay loam about 10 inches thick. The subsoil to a depth of 60 inches or more is mottled dark-gray to light brownish-gray, firm and very firm silty clay and clay.

Clarinda soils tend to stay wet longer in spring than the soils around them, and field operations are often delayed. Clarinda soils in Appanoose County, however, are generally not so wet as Clarinda soils in other parts of Iowa that are overlain by more permeable loess soils. Available water capacity is high, and permeability is very slow. The shrink-swell potential is high, and the soils crack deeply as they dry. Natural fertility is low to very low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus and potassium, and is poorly aerated.

Most of the acreage is used for pasture or hay. Some of the less sloping areas are row cropped along with more suitable adjacent soils.

Representative profile of Clarinda silty clay loam, 5 to 9 percent slopes, on a north aspect where the slope is 7 percent; 520 feet east and 330 feet north of the southwest corner of the SE¼SW¼ sec. 17, T. 69 N., R. 19 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) light silty clay loam, dark gray (10YR 4/1) when dry; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—7 to 10 inches, very dark gray (10YR 3/1) light silty clay loam; few, fine, faint mottles of dark grayish brown (10YR 4/2); moderate, fine, granular structure; friable; slightly acid; gradual, smooth boundary.

A3—10 to 13 inches, dark grayish-brown (10YR 4/2) light silty clay; few, fine, faint mottles of very dark gray (10YR 3/1); moderate, fine, granular structure; friable; medium acid; gradual, smooth boundary.

IIB1g—13 to 18 inches, dark-gray (10YR 4/1) light silty clay; few, fine, faint mottles of dark grayish brown (10YR 4/2) and common, fine, distinct mottles of strong brown (7.5YR 5/6); moderate, fine, subangular blocky structure; firm; medium acid; gradual, smooth boundary.

IIB21tg—18 to 23 inches, grayish-brown and dark-gray (10YR 5/2 and 10YR 4/1) clay; common, fine, distinct mottles of yellowish brown (10YR 5/6 to 5/8); moderate, fine, subangular blocky structure; very firm; few, thin, discontinuous clay films; medium acid; gradual, smooth boundary.

IIB22tg—23 to 31 inches, dark-gray (10YR 4/1) clay; common, medium, distinct mottles of yellowish brown (10YR 5/6 and 5/8); moderate, fine, subangular blocky structure; very firm; thick continuous clay films; medium acid; gradual boundary.

IIB23tg—31 to 40 inches, light brownish-gray and olive-gray (2.5Y 6/2 and 5Y 5/2) clay; many, medium, distinct mottles of brown and yellowish brown (10YR 5/3 and 5/4); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; very firm; clay films on cleavage plains; slightly acid; gradual boundary.

IIB3tg—40 to 60 inches, light brownish-gray (2.5Y 6/2) light silty clay; few, fine, faint mottles of olive yellow (2.5Y 6/5); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; clay films on cleavage plains; slightly acid.

In uneroded areas the A horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1) in color and from 10 to 14 inches in thickness. It generally is light silty clay loam, but ranges to silt loam in places. The A horizon formed in loess of silty sediments that are high in sand. In many places the loess in the upper part of the Clarinda soils ranges from 6 to 16 inches in thickness. The B2t horizon ranges from dark gray (10YR 3/1) to olive gray (5Y 5/2) and from silty clay to clay in texture. The mottles in the B horizon generally are yellowish brown (10YR 5/6) to strong brown (7.5YR 5/6).

Clarinda soils formed in parent materials similar to those of Ashgrove soils and are associated with Adair, Armstrong and Lamoni soils. They differ from Ashgrove soils in having a thicker, darker A1 horizon and in not having a light-colored A2 horizon. They have a grayer B horizon than Adair and Armstrong soils and do not have the pebbles and stones that are common in those soils. They have more clay in the B horizon than Lamoni soils.

Figure 8.—**Road cut exposing the buried soil in which Clarinda soils formed.**

Clarinda silty clay loam, 5 to 9 percent slopes (222C). —This soil is most extensive in the coves of shallow drainageways that extend far back into upland flats. It is downslope from Seymour or Grundy soils.

This soil has the profile described as representative of the series (fig. 8).

Included with this soil in mapping are small areas of soils that have 4 to 6 percent slopes near the heads of drainageways where the dark surface layer has been thickened by local alluvium. Seepy spots are on the uphill side of many of these areas where they border soils that formed in loess.

Most of this soil is used for permanent pasture or crops. The fine-textured subsoil and moderate slopes make this soil highly susceptible to erosion in cultivated areas. If terracing is used to control erosion, the clayey subsoil that has poor tilth is exposed in borrow areas. This problem can be minimized by stockpiling the surface soil during construction and replacing it afterward. In many places this soil stays wet for periods in spring and after heavy rainfall. Tile drains should not be placed in this soil, but interceptor tile drains can be installed in the adjacent loess-derived soils upslope. This tile helps to prevent seepage and reduce surface wetness. The organic-matter content is medium. Capability unit IVw–1; woodland suitability group 5w1.

Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded (222C2).—This soil generally is in bands about 200 feet wide and is downslope from Seymour or Grundy soils or in places is downslope from Kniffin or Pershing soils. It is one of the most extensive soils in the county, and individual areas are generally large.

This soil has a profile similar to the one described as representative of the series, but part of the surface layer has been removed by erosion, leaving it thinner and somewhat lighter in color. The surface layer is about 7 inches thick and is very dark gray in color. It consists of 3 to 6 inches of the original surface layer that has been mixed with part of the original subsoil by plowing.

Included with this soil in mapping are small areas on the upper slopes or in the center of rounded side slopes between drains where the grayish subsoil has been exposed by erosion. Also included are a few small areas of Lamoni soils.

This soil is moderately suited to row crops, and many areas are used for pasture. If terracing is used to control erosion, the clayey subsoil that has poor tilth is exposed in borrow areas. Unless erosion is controlled, the tilth and fertility of the surface layer continue to deteriorate as increasing amounts of the subsoil are mixed into the plower layer. The organic-matter content is low.

Tile drains should not be placed in this soil, but interceptor tile drains can be installed in adjacent loess-derived soils upslope to reduce seepage and surface wetness. This soil dries slowly because it is very slowly permeable. Growth of row crops is generally poor because of wetness. Capability unit IVw–1; woodland suitability group 5w1.

Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded (222D2).—This soil is in bands in coves at the heads of drainageways and extends to the shoulder of the side slopes. It is downslope from Seymour and Grundy soils. In places this soil occupies entire short side slopes and is adjacent to drainageways that dissect broad uplands. Generally, areas are larger than 10 acres in size.

This soil has a profile similar to the one described as representative of the series, but part of the original surface layer has been removed by erosion and the remaining material is thinner and somewhat lighter in color. The surface layer is about 7 inches thick and very dark gray in color. It consists of 3 to 6 inches of the original surface layer that has been mixed with part of the former subsoil by plowing. Included in mapping are small areas on the upper part of the side slope where the grayish subsoil has been exposed by erosion.

This soil is better suited to hay and pasture than to most other uses. The strong slopes and clay subsoil make it extremely erodible and difficult to manage. Unless erosion is controlled, the tilth and fertility of the surface layer continue to deteriorate as increasing amounts of the former subsoil are mixed into the plow layer. When the surrounding more sloping soils are ready for cultivation, this soil may still be too wet to work. Tile drains can be installed in some of the loess-derived soils upslope to intercept seepage water, reduce surface wetness, and allow earlier cultivation. The surface of this soil is very hard and cloddy when dry. Capability unit IVe–2; woodland suitability group 5w1.

Clarinda soils, 5 to 9 percent slopes, severely eroded (222C3).—These soils generally are in coves and on upper parts of side slopes just downslope from Seymour or Grundy soils, but in places they are downslope from Kniffin or Pershing soils. Individual areas are generally less than 10 acres in size.

These soils have profiles similar to the one described as representative of the series, but most of the original surface layer has been removed by erosion and the remaining material is thinner, lighter in color, and higher in clay content. The surface layer is silty clay loam or clay about 5 inches thick and dark gray in color. It consists of less than 3 inches of the original surface layer that has been mixed with part of the former subsoil by plowing. In some places the dark-gray subsoil is exposed. Included in mapping are some small areas that are only moderately eroded and a few areas of severely eroded Lamoni soils.

These soils are generally used for hay and pasture or are left idle. They are not suited to cultivated crops. Erosion and wetness are the main concerns of management. The surface layer hardens and cracks severely as it dries. It puddles readily and absorbs moisture very slowly. In some places a practical way to reduce surface wetness is placing interceptor tile in the loess-derived soils upslope. The deep, active gullies that have formed in places should be shaped and planted to grass to prevent further erosion. Short, temporary diversion terraces placed upslope from these gullied areas help to prevent erosion until a seedbed is established. Birdsfoot trefoil is tolerant of the wetness and poor fertility of this soil and does well when it has been established. Capability unit VIe–3; woodland suitability group 5w1.

Colo Series

The Colo series consists of poorly drained soils on bottom lands and foot slopes. These soils formed in moderately fine textured silty alluvium under wetland grass vegetation. They are on the larger flood plains and in gently sloping areas near drainageways and large streams. Areas that are drained and protected from flooding are among the most productive in the county. Colo soils are not extensive, but individual areas are as large as 80 acres.

In a representative profile the surface layer is black silty clay loam about 30 inches thick. The subsoil to a depth of 60 inches is black to grayish-brown, firm silty clay loam that commonly has a few mottles in the lower part.

Colo soils are seasonally wet because of the high seasonal water table and flooding. Available water capacity is high, and permeability is moderately slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is medium in available phosphorus, is very low in available potassium, and is poorly aerated.

If Colo soils are drained and protected from flooding, they can be used intensively for row crops. These are desirable soils for farming, and they respond favorably to good management.

Representative profile of Colo silty clay loam, 0 to 2 percent slopes, where the slope is 1 percent; 90 feet south and 150 feet west of the northeast corner of the SW¼SW¼ sec. 4, T. 68 N., R. 18 W.

Ap—0 to 8 inches, black (10YR 2/1) light silty clay loam; weak, fine, granular structure; friable; neutral; gradual, smooth boundary.

A12—8 to 14 inches, black (10YR 2/1) light silty clay loam; moderate, fine, granular structure; friable; neutral; gradual smooth boundary.

A13—14 to 24 inches, black (10YR 2/1) light silty clay loam; moderate, very fine, subangular blocky structure and moderate, fine, granular; friable; slightly acid; gradual, smooth boundary.

A14—24 to 30 inches, black (10YR 2/1) medium silty clay loam; moderate, fine and very fine, angular and subangular blocky structure; friable; few fine concretions and oxides; slightly acid; gradual, smooth boundary.

B21—30 to 42 inches, very dark gray (10YR 3/1) medium silty clay loam; few, fine, faint mottles of very dark grayish brown (10YR 3/2); weak, fine, subangular blocky structure; firm; few fine concretions and oxides; slightly acid; gradual, smooth boundary.

B22—42 to 60 inches, grayish-brown (10YR 5/2) medium silty clay loam; few, fine, faint, very dark grayish-brown (10YR 3/2) mottles; weak, fine, prismatic structure breaking to weak, fine, subangular blocky; firm; few fine concretions and oxides; slightly acid.

The A horizon ranges from very dark gray (10YR 3/1) to black (10YR 2/1, N 2/0), except where alluvium has been recently deposited. In most places the A horizon is 24 inches or more thick. On the surface of overwashed soils is 8 to 18 inches of stratified, very dark gray (10YR 3/1), dark grayish-brown (10YR 4/2), and very dark grayish-brown (10YR 3/2) silt loam. The upper part of the B horizon ranges from very dark gray (10YR 3/1) to black 10YR 2/1, N 2/0). The clay content ranges from 28 to 38 percent, but averages less than 35 percent in the upper 40 inches. Reaction ranges from neutral to medium acid in the B horizon.

Colo soils are associated with Zook, Wabash, Nodaway, and Kennebec soils. They are less clayey than the Zook and Wabash soils. They are not stratified and are higher in clay than Nodaway soils. They are higher in clay and have more grayish colors in the B horizon than Kennebec soils.

Colo silt loam, overwash (0 to 2 percent slopes) (133+).—Most of this soil is on flood plains of the Chariton River. This soil formed in silty sediments that were deposited by adjacent rivers or by small, secondary drains of the uplands. Areas generally are small.

This soil has a profile similar to the one described as representative of the series, but it has 8 to 20 inches of stratified very dark gray, dark grayish-brown, and very dark grayish-brown silt loam overwash on the surface. This sediment has been deposited by recent floods.

Although this soil is occasionally flooded, row crops are grown frequently. It is well suited to cultivated crops if artificially drained and protected from flooding. This soil can be managed in the same way as Colo silty clay loam, but because of the texture of the surface layer, plowing is easier and the seedbed preparation is less difficult. Although this soil generally is not so wet as Colo silty clay loam, most areas benefit from artificial drainage if suitable outlets are available. Diversions on adjacent soils upslope are needed to intercept runoff and prevent siltation in areas at the base of steep slopes. Capability unit IIw–1; woodland suitability group 5w3.

Colo silty clay loam, 0 to 2 percent slopes (133A).—This soil is commonly on the bottom lands of the smaller stream valleys, and it occupies the entire width of these valleys. It is also on wider, more stable bottom lands. In many places this soil is between Kennebec, Coppock, or Vesser soils and the more clayey Zook soils. Individual areas are as much as 80 acres in size.

This soil has the profile described as representative of the series. Included in mapping are a few small areas of Kennebec, Coppock, Vesser, and Zook soils.

Much of the acreage is used for cultivated crops, even though the soil is flooded occasionally. It is well suited to cultivated crops if artificially drained and protected from flooding. Cultivation is often delayed unless this poorly drained soil is artificially drained. Tile drains work satisfactorily, although the subsoil is moderately slow in permeability. This soil has a high content of organic matter and is generally in good tilth. In many areas use of farm machinery is impeded by small, uncrossable streams. Capability unit IIw–1; woodland suitability group 5w3.

Colo silty clay loam, 2 to 5 percent slopes (133B).—This soil formed in dark-colored sediments that washed from adjacent soils on uplands. It is on even to slightly concave foot slopes downslope from the Shelby and Gara soils and it fans out to bottom lands. Slopes are 3 percent or less in most places, and erosion is not a serious hazard.

The dark-colored surface layer of this soil is typically silty clay loam about 24 inches thick. In some places the surface layer is clay loam. Included in mapping are a few small areas where 10 to 19 inches of dark grayish-brown and very dark grayish-brown silt loam overwash has been recently deposited.

This soil is farmed in a manner similar to that of adjacent soils on first bottoms. Row crops are well suited in drained, well-managed areas. This soil is often wet because it receives excessive runoff and seepage from adjacent uplands. In many places diversion terraces have been built in adjacent soils upslope to divert runoff. The subsoil has moderately slow permeability and normally absorbs most of the rainfall. Capability unit IIw–1; woodland suitability group 5w3.

Coppock Series

The Coppock series consists of somewhat poorly drained soils on wide bottom lands. These soils formed in alluvium under mixed forest and prairie grass vegetation. Individual areas generally are large.

In a representative profile the surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsurface layer is dark grayish-brown to grayish-brown, friable silt loam 17 inches or more thick. The subsoil to a depth of 60 inches or more is mottled grayish-brown, friable silty clay loam.

Coppock soils are subject to flooding and have a seasonally high water table. Available water capacity is high, and permeability is moderate. Natural fertility is medium. The surface soil is acid unless it has been limed within the past few years. The subsoil is acid, is low to medium in available potassium and phosphorus, and is poorly aerated.

A large acreage of the Coppock soils is cultivated. Occasional flooding and poor drainage are the main concerns in management.

Representative profile of Coppock silt loam, 600 feet east and 910 feet north of the southwest corner of sec. 25, T. 68 N., R. 17 W.

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

A21—8 to 14 inches, dark grayish-brown (10YR 4/2) and very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry, dark grayish brown (10YR 4/2) when kneaded; weak, thin, platy structure breaking to weak, fine, granular; friable; few, fine, dark grayish-brown (10YR 4/2) soft oxides; neutral; clear, smooth boundary.

A22—14 to 20 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, medium, platy structure breaking to weak, fine, subangular blocky; friable; few concretions of dark reddish-brown soft oxides; few very dark grayish-brown (10YR 3/2) coatings on plates; slightly acid; clear, smooth boundary.

A23—20 to 25 inches, grayish-brown (10YR 5/2) heavy silt loam, light brownish gray (10YR 6/2) to light gray (10YR 7/2) when dry; weak, medium, platy structure breaking to weak, fine, subangular blocky; friable; few, fine, dark reddish-brown (5YR 3/2) soft oxides; discontinuous light brownish-gray silt coatings on blocky peds; medium acid; clear, smooth boundary.

B1g—25 to 32 inches, grayish-brown (10YR 5/2) light silty clay loam, light gray (10YR 7/2) when dry; few, fine, distinct mottles of brown (7.5YR 4/4); moderate, medium, subangular blocky structure; friable; common, fine, dark reddish-brown (5YR 3/2) soft oxides; common discontinuous silt coatings on all peds; strongly acid; gradual, smooth boundary.

B21tg—32 to 37 inches, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) light silty clay loam, light gray (10YR 7/1 and 7/2) when dry; common, fine, distinct mottles of brown (7.5YR 4/4); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; friable; thin discontinuous clay films; common, fine, dark reddish-brown (5YR 3/2) soft oxides; common discontinuous light-gray silt coatings on prism faces; strongly acid; gradual, smooth boundary.

B22tg—37 to 43 inches, grayish-brown (10YR 5/2) and light brownish-gray (10YR 6/2) light to medium silty clay loam; common, fine to medium, distinct mottles of reddish brown (5YR 4/4) to yellowish red (5YR 4/6); weak to moderate, medium, prismatic structure breaking to weak, medium, subangular blocky; friable; thin discontinuous clay films; common, fine, dark reddish-brown (5YR 3/2) soft oxides; nearly continuous light-gray silt coatings on prism faces in upper part of horizon; strongly acid; gradual, smooth boundary.

B3g—43 to 60 inches, grayish-brown (10YR 5/2) light to medium silty clay loam; common, medium, distinct mottles of reddish brown (5YR 4/4) and yellowish red (5YR 4/6); weak, medium, prismatic structure; friable; common, fine, dark reddish-brown (5YR 3/2) soft oxides; few discontinuous dark-gray ped coatings and discontinuous light-gray silt coatings on prism faces; strongly acid.

The Ap horizon ranges from 7 to 10 inches in thickness and is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from 14 to 20 inches in thickness and from dark grayish brown (10YR 4/2) to light brownish gray (10YR 6/2). The B2t horizon ranges from light brownish gray or gray to grayish brown in hue of 10YR or 2.5Y and in clay content from 27 to 35 percent.

Coppock soil are associated with Nodaway, Colo, Humeston, Tuskeego, Vesser, and Amana soils. They differ from the Nodaway and Colo soils in having a thick, grayish A2 horizon. They have less clay in the B horizon than Humeston and Tuskeego soils and more clay than Amana soils. They differ from Vesser soils in having a lighter colored, thinner A horizon and a browner A2 horizon.

Coppock silt loam (0 to 2 percent slopes) (520).—This soil is on flats along streams or old meander belts. Individual areas generally are large.

This soil is flooded occasionally, but most of the acreage is used for cultivated crops. Areas that are flooded more frequently or are inaccessible are in pasture or are wooded. If this soil is protected from overflow and is artificially drained, it is well suited to row crops. Natural drainage is poor to somewhat poor, and cultivation is occasionally delayed unless the soil is artificially drained. Tile lines work well because permeability is moderate in the subsoil. The organic-matter content is low to medium. Capability unit IIw-1; woodland suitability group 5w3.

Edina Series

The Edina series consists of poorly drained soils on the broad upland flats and narrow, flat ridgetops. These soils formed in leached loess 6 to 8 feet thick over a buried, very slowly permeable, gray clayey soil. Slopes range from 0 to 2 percent and are occasionally depressional. Except in the extreme northeastern section of the county, the Edina soils are extensive.

In a representative profile the surface layer is very dark gray silt loam about 10 inches thick. The subsurface layer is very dark gray and dark-gray, friable silt loam about 9 inches thick. The subsoil, about 45 inches thick, is black and dark-gray, very firm silty clay that grades to mottled, olive-gray firm silty clay loam in the lower part.

Edina soils are seasonally wet and are frequently ponded after heavy rainfall. Available water capacity is high, and permeability is very slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus, is very low to low in available potassium, is poorly aerated, and has high shrink-swell potential.

Most of the acreage of Edina soils is cultivated. Corn, soybeans, or small grain are the main crops. A few small areas are in pasture. Drainage is needed to remove ponded water so that crops do not drown.

Representative profile of Edina silt loam, on a nearly level upland divide, 20 feet north and 75 feet west of the southeast corner of the NE¼NW¼ sec. 9, T. 68 N., R. 16 W.

A1—0 to 10 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—10 to 19 inches, very dark gray (10YR 3/1) and dark-gray (10YR 4/1) silt loam, gray (10YR 5/1) when dry on bottom of plates and light gray (10YR 7/1) when dry on top of plates; moderate to strong, medium, platy structure; friable; few soft dark-brown (7.5YR 3/2) oxides; medium acid; clear, wavy boundary.

B1t—19 to 21 inches, mixed dark-gray (10YR 4/1) and gray (10YR 5/1) light silty clay loam; moderate, fine, subangular blocky structure; friable; thick discontinuous clay films; few discontinuous grainy ped coatings; few dark-brown (7.5YR 3/2) soft oxides; medium acid; abrupt, smooth boundary.

B21t—21 to 25 inches, black (10YR 2/1) and very dark gray (10YR 3/1) silty clay; common, medium, distinct mottles of yellowish brown (10YR 5/6 and 5/8); weak, medium, subangular blocky structure; very firm; thick continuous clay films; many fine hard manganese-iron concretions; medium acid; gradual, smooth boundary.

B22tg—25 to 31 inches, dark-gray (10YR 4/1) silty clay; common, medium, distinct mottles of yellowish brown (10YR 5/6) and common, medium, faint mottles of gray (10YR 5/1); weak, medium, subangular blocky structure; very firm; thin continuous clay films; common black (10YR 2/1) coatings on pores; few fine hard manganese-iron concretions; medium acid; gradual, smooth boundary.

B23tg—31 to 37 inches, dark-gray (10YR 4/1) to grayish-brown (2.5Y 5/2) silty clay; few, fine, distinct mottles of yellowish brown (10 YR 5/6); moderate, medium, subangular blocky structure; firm; continuous clay films mostly on horizontal ped faces; few, fine, hard manganese-iron concretions; few black (10YR 2/1) clay-filled pores; slightly acid; gradual, smooth boundary.

B31tg—37 to 46 inches, grayish-brown (2.5Y 5/2) light silty clay to heavy silty clay loam; common, coarse, prominent mottles of yellowish brown (10YR 5/8) and yellowish red (5YR 4/8); weak, medium, prismatic structure breaking to weak, medium, subangular blocky; firm; thin discontinuous clay films on prism faces; slightly acid; gradual, smooth boundary.

B32tg—46 to 57 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam; common, coarse, distinct mottles of strong brown (7.5YR 5/8) and dark brown to brown (10YR 4/3); weak, coarse, prismatic structure breaking to weak, coarse, subangular blocky; firm; thin discontinuous clay films on prism faces; slightly acid; gradual, smooth boundary.

B33tg—57 to 64 inches, olive-gray (5YR 5/2) heavy silty clay loam; common, coarse, distinct mottles of strong brown (7.5YR 5/8); very weak, coarse, subangular blocky structure; firm; thin discontinuous clay films; neutral; gumbotil at a depth of 84 inches.

The A1 horizon ranges from 8 to 12 inches in thickness and is black (10YR 2/1) or very dark gray (10YR 3/1). The A2 horizon ranges from 6 to 10 inches in thickness and from very dark gray (10YR 3/1) to gray (10YR 5/1). The B2t horizon ranges from black (10YR 2/1) in the upper part to grayish brown (2.5Y 5/2) in the lower part and from heavy silty clay to clay. Depth to the B2t horizon ranges from 16 to 22 inches. Reaction in the B1 horizon ranges from medium acid to slightly acid. Depth to glacial till of clay texture is about 8 feet.

Edina soils are associated with Seymour, Grundy, Haig, Kniffin, and Belinda. They have a gray silty A2 horizon that Seymour, Grundy, and Haig soils do not have. They have a B horizon that is more clayey than that of Grundy and Haig soils and is grayer than that of Grundy and Seymour soils. They have a thicker, more distinct A2 horizon and a grayer B horizon than Kniffin soils. They have a thicker A1 horizon and a darker B horizon than Belinda soils.

Edina silt loam (0 to 1 percent slopes) (211).—This soil is on broad divides on uplands in most of the townships.

In some plowed areas ashy spots appear on the surface because the grayish subsurface layer has been mixed with the surface layer (fig. 9). The subsoil is plastic and sticky when wet. For lack of natural outlets, runoff water collects and forms ponds in shallow depressions.

Where surface drains have been installed in this soil, row crops are moderately suited. This soil puddles if it is worked when wet. The subsoil contains a large amount of clay, and tile drains are unsatisfactory. Crops planted in undrained areas are occasionally drowned. When rainfall is above average, some crops turn yellow and are stunted. Improved drainage is the principal management need. Water erosion is not a problem. Capability unit IIIw-3; woodland suitability group 5w3.

Figure 9.—**Profile of Edina silt loam showing light-colored A2 horizon and abrupt boundary with the clayey subsoil.**

Gara Series

The Gara series consists of moderately well drained soils that formed in slightly weathered glacial till on uplands under mixed forest and prairie grass vegetation. These soils are on rounded ends of narrow ridgetops and irregular, complex side slopes along all large streams and rivers in the county. They cover a large total acreage. Slopes range from 9 to 24 percent.

In a representative profile the surface layer is very dark gray loam about 8 inches thick. The subsurface layer, about 6 inches thick, is dark grayish-brown, friable loam. The subsoil, about 28 inches thick, is brown to dark yellowish-brown, firm clay loam. The substratum is mottled yellowish-brown, firm clay loam.

Gara soils are highly susceptible to erosion if used for row crops. Available water capacity is high, and permeability is moderately slow. Natural fertility is low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

Only the strongly sloping Gara soils are suited to rows crops. Severely eroded and moderately steep or steep Gara soils are used mainly for pasture. A large acreage has been cleared of native vegetation. Most of these soils are suitable sites for farm ponds.

Representative profile of Gara loam, 14 to 18 percent slopes, on a southwest aspect where the slope is 15 percent; 275 feet south and 375 feet west of the northeast corner of the NW¼NW¼ sec. 15, T. 70 N., R. 17 W.

A1—0 to 8 inches, very dark gray (10YR 3/1) loam, gray (10YR 5/1) when dry; weak, very fine, granular structure; friable; neutral; clear, smooth boundary.

A2—8 to 14 inches, dark grayish-brown (10YR 4/2) light loam, light brownish gray (10YR 6/2) when dry; moderate, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

B1—14 to 18 inches, brown (10YR 4/3) light to medium clay loam; some interiors of peds dark yellowish brown (10YR 4/4); moderate to strong, fine, subangular blocky structure; friable; some grainy ped coatings; strongly acid; clear, smooth boundary.

B21t—18 to 25 inches, yellowish-brown (10YR 5/4) medium clay loam; faces of peds brown (10YR 4/3); moderate, fine, subangular blocky structure; firm; thin discontinuous clay films; few fine iron-manganese concretions; strongly acid; gradual, smooth boundary.

B22t—25 to 33 inches, dark yellowish-brown (10YR 4/4) medium clay loam; common, fine, distinct mottles of grayish brown (10YR 5/2) and few, fine, faint mottles of yellowish brown (10YR 5/4); weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; firm; thin discontinuous clay films; medium acid; gradual, smooth boundary.

B3t—33 to 42 inches, dark yellowish-brown (10YR 4/4) medium clay loam; faces of peds yellowish brown (10YR 5/4); common, fine, distinct mottles of grayish brown (2.5Y 5/2); weak, medium, prismatic structure breaking to weak, medium to coarse, subangular blocky; firm; few, thin, discontinuous clay films; slightly acid; gradual, smooth boundary.

C—42 to 60 inches, yellowish-brown (10YR 5/6) medium clay loam; many, medium, prominent grayish-brown (2.5Y 5/2) mottles; massive with vertical cleavage; firm; mildly alkaline.

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and is 6 to 10 inches thick. The A2 horizon ranges from 2 to 6 inches in thickness and from very dark grayish brown (10YR 3/2) to grayish brown (10YR 5/2). The B2t horizon ranges from dark brown (10YR 4/3) to yellowish brown (10YR 5/4) and averages 32 to 35 percent clay. Reaction in the most acid part of the B horizon ranges from strongly acid to medium acid. The matrix of the C horizon is commonly calcareous at a depth of 30 to 48 inches. Depth to calcareous material depends on the position of Gara soils in the landscape.

Gara soils are associated with Shelby, Lindley, and Caleb soils. They have a thinner dark-colored A horizon and typically are more acid in the B horizon than Shelby soils. They have a thicker A horizon than Lindley soils. They have more gravel-size material in the B horizon than Caleb soils and have a calcareous C horizon that Caleb soils do not have.

Gara loam, 9 to 14 percent slopes, moderately eroded (179D2).—This soil generally is in bands on rounded side slopes. It formed in slightly weathered glacial till that has been exposed by geologic erosion. It is downslope from Lamoni and Armstrong soils and upslope from soils on bottom lands and along small drainageways. Individual areas are as large as 80 acres in size.

This soil has a profile similar to that described as representative of the series, but it has a very dark gray loam surface layer about 6 inches thick underlain by a thin, leached layer.

Included with this soil in mapping are areas of soils that have a 9-inch surface layer. Also included are small severely eroded areas where all of the surface layer has been removed and the subsoil is exposed. The surface layer and thin underlying layer are mixed where this soil has been plowed.

Much of the acreage has been cleared of its native oak, hickory, and elm. This soil is moderately suited to row crops. Row crops generally are planted only when pasture is renovated. The surface layer contains only a small amount of organic matter and, in many places, is cloddy and hard when dry. Runoff is rapid because this soil has strong slopes and moderately slow permeability. Gullies that are uncrossable with farm machinery have formed in a few areas. Capability unit IVe–1; woodland suitability group 2o1.

Gara loam, 14 to 18 percent slopes (179E).—This soil has rounded slopes and is downslope from Armstrong soils and upslope from bottom-land soils or soils along narrow drainageways. Where it is adjacent to the valleys of major streams, this soil grades to Olmitz or to Colo soils in many places. Individual areas are large in places.

This soil has the profile described as representative of the series. Included in mapping are a few small areas that have a thinner surface layer.

Most of the acreage is in pasture or is wooded. Many areas are still in oak, hickory, and elm trees. Under good management these areas probably would be valuable as woodland. Cleared areas are better suited to pasture than to woodland. Rapid runoff causes erosion in places and makes the soil unsuitable for row crops. Areas that have been cleared for pasture should be seeded as soon as possible after clearing. This soil is low in content of organic matter. Capability unit VIe–1; woodland suitability group 2o1.

Gara loam, 14 to 18 percent slopes, moderately eroded (179E2).—This soil is dissected by small sidehill drains. It is downslope from Armstrong soils and upslope from soils on bottom lands and along small drainageways. This is the most extensive Gara soil in the county. Individual areas are as large as 80 acres in size.

This soil has a profile similar to that described as representative of the series, but it has a thinner surface layer. The surface layer, about 6 inches thick, is very dark grayish-brown to brown loam that is underlain by a thin, leached subsurface layer. Erosion has been uneven, and the remaining surface layer is mostly loam, but includes clay loam in the more eroded spots. The loss of organic matter and mixing of the surface layer with the subsurface layer or subsoil make the present surface layer appear browner.

Included with this soil in mapping are some severely eroded areas that have rounded slopes and an exposed subsoil. Also included are a few areas where gullies that cannot be crossed with farm machinery have formed.

This soil is not suited to row crops, but it is well suited to pasture under good management. Much of the acreage has been cleared of its native oak, hickory, and elm. Runoff is rapid because this soil is moderately steep and has slopes that are dissected by many small drains. This soil is acid in the upper part. Capability unit VIe–1; woodland suitability group 2o1.

Gara loam, 18 to 24 percent slopes, moderately eroded (179F2).—This soil is on side slopes downslope from Adair soils and upslope from bottom-land soils and soils in narrow drainageways. Areas are commonly on the nose of short ridges. Individual areas are generally 10 to 30 acres in size.

This soil has a profile similar to the one described as representative of the series, but the surface layer and subsoil are thinner. The surface layer, about 6 inches thick, is very dark grayish-brown or brown loam that is underlain in most places by a thin, leached, grayish subsurface layer. The subsoil is thin enough that in some places the calcareous substratum is within 24 inches of the surface. Included in mapping are some areas on the lower parts of side slopes where the surface layer is about 8 inches thick.

Some areas of this soil have been partly cleared of timber and are in pasture that provides only limited grazing. Depleted pasture should be renovated without destroying the existing grass, but pasture renovation is difficult. The use of equipment is dangerous in places because this soil is steep and gullied. In places where oak and hickory trees grow, this soil, under good management, could be used for wood crops. Capability unit VIIe–1; woodland suitability group 3r1.

Gara soils, 9 to 14 percent slopes, severely eroded (179D3).—These soils are on rounded side slopes and in coves. They are downslope from Clarinda, Lamoni, or Armstrong soils and upslope from soils in narrow drainageways. Individual areas are small.

These soils have had most of the original surface layer removed by erosion. The present surface layer is very dark grayish-brown to brown clay loam or loam.

These soils are very erodible. Runoff is rapid because of strong slopes, the very thin surface layer, moderately slow permeability, and the sparse vegetation. Although they are suited to pasture, these soils cannot support much grazing except under a high level of management. Overgrazing has caused erosion, and deep gullies have formed in many places. Small rills and gullies are common. Some areas should be reshaped and the gullies filled before seedings are established. Seeded pasture should be protected from grazing until plants are well established. Areas of these soils not used for pasture are suitable for wildlife habitat. Capability unit VIe–3; woodland suitability group 2o1.

Gara soils, 14 to 18 percent slopes, severely eroded (179E3).—These soils are on the shoulders of rounded side slopes and are dissected by gullies and waterways. Individual areas are mostly 5 to 15 acres in size.

These soils have had most of their original surface layer removed by erosion. The remaining surface layer is dark-brown or brown to dark grayish-brown loam or clay loam. In most places the surface layer consists of former subsoil.

These soils are better suited to pasture than to most other uses, but grazing is limited unless the level of management is high. Erosion has caused small rills and uncrossable gullies to form. These soils are susceptible to further erosion anl gullying because slopes are strong, the surface layer is very thin, permeability is moderately slow, and the plant cover is sparse. Reseeding is needed in eroded, gullied areas, but these areas should be reshaped and the gullies filled before seeding. In reshaping, care must be taken to avoid removing more of the existing vegetation than is necessary. Areas of these soils not used for pasture are suitable for wildlife habitat. Capability unit VIIe–2; woodland suitability group 2o1.

Gosport Series

The Gosport series consists of moderately well drained and somewhat poorly drained soils that formed in residuum derived from shale under grass and forest vegetation. These soils are moderately sloping to steep and are on convex lower side slopes along Cooper, Walnut, and Shoal Creeks and along the southwest side of the Chariton River. They are downslope from Armstrong, Keswick, Rathbun, Kniffin, Gara, and Lindley soils.

In a representative profile the surface layer is very dark grayish-brown silt loam about 7 inches thick. The subsoil is grayish-brown to light olive-brown clay 23 inches thick. Yellowish-brown mottles are common in the lower part of the subsoil. The substratum, beginning at a depth of about 30 inches, is gray clay. Reaction in the upper part of the subsoil is very strongly acid, but the substratum is less acid than is typical for Gosport soils.

Available water capacity is high, and permeability is very slow. Erosion is the main limitation to use and management. Natural fertility is very low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus, is low to very low in available potassium, and is poorly aerated.

Some of these soils can be row cropped occasionally, but most of them are better suited to hay and pasture than to most other uses.

Gosport soils in Appanoose County are mapped only in a complex with Clanton or Sogn soils.

Representative profile of Gosport silt loam in an area of Gosport-Clanton silt loams, 9 to 14 percent slopes, moderately eroded, on a north aspect where the slope is 9 percent; 960 feet north and 100 feet west of the center of sec. 30, T. 69 N., R. 17 W.

A1—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) when dry; weak medium, platy structure breaking to moderate, fine, granular; friable; many roots; few loose sand grains on ped faces; slightly acid; abrupt, smooth boundary.

IIB1—7 to 11 inches, grayish-brown (10YR 5/2) clay, light gray (10YR 7/2) when dry; moderate, medium, subangular blocky structure; firm; many fine roots; common fine pores; strongly acid; gradual, smooth boundary.

IIB21—11 to 18 inches, light olive-brown (2.5Y 5/4) clay; faces of peds olive brown (2.5Y 4/4); few, fine, distinct mottles of yellowish brown (10YR 5/6); weak, fine, subangular blocky structure; very firm; common fine roots; common fine pores; some dark grayish-brown (10YR 4/2) coatings on ped faces in upper part; very strongly acid; gradual, smooth boundary.

IIB22—18 to 21 inches, light olive-brown (2.5Y 5/4) clay; many, fine, faint mottles of olive (5Y 5/3) and few, fine, faint mottles of yellowish brown (10YR 5/8); weak, medium, angular blocky structure; firm; common fine roots; common fine pores; common fine iron-manganese concretions; neutral; gradual, smooth boundary.

IIB23—21 to 30 inches, light olive-brown (2.5Y 5/4) clay; common, fine, faint mottles of yellowish brown (10YR 5/8); weak, medium, angular blocky structure; slightly firm; few fine roots; common fine pores; common fine iron-manganese concretions; many very dark brown (10YR 2/2) organic deposits; neutral; gradual, smooth boundary.

IIC—30 to 60 inches, gray (2.5Y 6/1) clay; many, medium, distinct mottles of yellowish brown (10YR 5/8); weak, medium, platy structure; slightly firm; very few roots; many fine pores; few, fine, distinct very dark brown (10YR 2/2) organic stains; few dark grayish-brown (10YR 5/2) deposits in old root channels; few large carbonate concretions below a depth of 39 inches; neutral.

The A horizon ranges from 3 to 8 inches in thickness, where not eroded, and from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A2 horizon, where present, ranges from 2 to 4 inches in thickness and from dark grayish brown (10YR 4/2) to light yellowish brown (10YR 6/4). Where these soils have been plowed, the A2 and A1 horizons have been mixed together to form the plow layer. The B2 horizon ranges from gray (10YR 5/1) to olive (5Y 5/6). Clay content of the B2 horizon ranges from 45 to 60 percent or more. The B2 horizon is most acid in the upper part, and reaction ranges from very strongly acid to strongly acid.

Gosport soils are associated with Mystic, Clanton, and Sogn soils. Gosport soils have a thinner solum and have more olive colors and more kaolinitic and illitic clay minerals in the B horizon than Mystic soils. They have an olive-brown matrix color in the B horizon in contrast to the reddish-brown B horizon of Clanton soils. They overlie shale and clay rather than the shallow limestone bedrock that is typical of Sogn soils.

Gosport-Clanton silt loams, 9 to 14 percent slopes, moderately eroded (313D2).—This mapping unit is most extensive on the lower parts of side slopes either adjacent to alluvial soils in the stream valleys or separated from them by a band of Sogn soils. It is about 55 percent Gosport soils and 45 percent Clanton soils.

Included with these soils in mapping are a few small areas that are only slightly eroded or are severely eroded. Also included are a few areas that are dominantly either Gosport or Clanton soils.

These soils are better suited to pasture or hay than to most other uses. The stony slopes cause excessive erosion in areas row cropped on a regular basis. Unless erosion is controlled, tilth and fertility of the surface layer deteriorate as increasing amounts of the subsoil are mixed into the plow layer. These soils are low in organic-matter content and are droughty. Capability unit VIe–4; woodland suitability group 5w1.

Gosport-Clanton silt loams, 14 to 18 percent slopes, moderately eroded (313E2).—This mapping unit is most extensive on the lower parts of side slopes along narrow, deeply entrenched drainageways. It is about 55 percent Gosport soils and 45 percent Clanton soils, but in some places Gosport soils make up nearly all of the area.

These soils have profiles similar to those described as representative of their respective series, but in many places the surface layer is thinner. Included in mapping are small, severely eroded areas where the surface layer and part of the subsoil have been mostly or entirely eroded away.

These soils are better suited to pasture or hay than to most other uses, but some are in timber or brush. The hazard of further erosion is severe on these soils because of the moderately steep slopes. Unless erosion is controlled, tilth and fertility of the surface layer deteriorate. Farm machinery can be used in places for renovating pastures, but present grass vegetation should not be entirely destroyed or gullies will form. These soils are low in organic-matter content. They are droughty, and pasture generally is poor. Capability unit VIe–4; woodland suitability group 5w1.

Gosport-Clanton silt loams, 18 to 24 percent slopes, moderately eroded (313F2).—This mapping unit is most extensive on lower parts of side slopes along deeply entrenched drainageways. It is about 55 percent Gosport soils and about 45 percent Clanton soils. Included in mapping are a few slightly eroded areas and some areas that are largely Gosport soils.

These soils are better suited to pasture, woodland, or wildlife habitat than to most other uses. These soils are not used for row crops because of the steep slopes, the very severe hazard of further erosion, and droughtiness. Farm equipment can be used in some areas when renovating pasture, but maintaining present grass vegetation reduces gullying. These soils are low in organic-matter content. Capability unit VIIe–3; woodland suitability group 5w1.

Grundy Series

The Grundy series consists of somewhat poorly drained soils on uplands. These soils formed in leached loess 80 to 100 inches thick over a buried, very slowly permeable clayey soil. These gently sloping soils are on ridgetops surrounding the nearly level upland flats. They are downslope from Haig soils and upslope from Clarinda soils. Slopes range from 2 to 5 percent and are mostly short and convex. These soils are fairly extensive in the north-central part of the county. The native vegetation was prairie grasses.

In a representative profile the surface layer is black and very dark gray silty clay loam about 18 inches thick. The subsoil to a depth of 60 inches is mottled grayish-brown, yellowish-brown, and light olive-brown, firm silty clay in the upper part that grades to mottled olive-gray or light olive-gray, firm silty clay loam in the lower part.

The hazard of erosion is slight. Available water capacity is high, and permeability is slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus, is low in available potassium, and is somewhat poorly aerated.

Grundy soils are used intensively for cultivated crops and are well suited to corn, soybeans, small grain, and legumes.

Representative profile of Grundy silt loam, 2 to 5 percent slopes, where the slope is 3 percent; 570 feet west and 50 feet north of the southeast corner of the SW¼ sec. 16, T. 70 N., R. 17 W.

Ap—0 to 8 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) when dry, black (10YR 2/1) when kneaded; (slightly compacted) weak, fine, granular structure; friable; many roots; neutral; clear, smooth boundary.

A12—8 to 14 inches, black (10YR 2/1) light silty clay loam, dark gray (10YR 4/1) when dry; moderate, very fine, granular structure; friable; many roots; few fine pores; medium acid; clear, smooth boundary.

A3—14 to 18 inches, dark grayish-brown (10YR 3/2) light silty clay loam; faces of peds very dark gray (10YR 3/1), gray (10YR 5/1), and light brownish gray (10YR 6/2) when dry; few, fine, faint mottles of dark yellowish brown (10YR 4/4) mostly on ped interiors; moderate, fine, granular and subangular blocky structure; friable; many roots; common pores; medium acid; clear, smooth boundary.

B1—18 to 22 inches, dark grayish-brown (10YR 4/2) heavy silty clay loam; faces of peds dark gray (10YR 4/1); some ped exteriors gray to light gray (10YR 6/1) and grayish brown (10YR 5/2) when dry; common, fine, distinct mottles of yellowish brown (10YR 5/6 and 5/8); moderate, very fine, subangular and angular blocky structure; firm; common fine pores; medium acid; clear, smooth boundary.

B21t—22 to 30 inches, yellowish-brown (10YR 5/4 and 5/6) medium silty clay; faces of peds very dark gray (10YR 3/1) and dark gray (10YR 4/1); moderate, fine and medium, subangular blocky structure; firm; nearly continuous clay films; few concretions and soft oxides; medium acid; gradual, smooth boundary.

B22t—30 to 36 inches, grayish-brown (2.5Y 5/2) medium silty clay; common, medium, prominent mottles of strong brown (7.5YR 5/6) and yellowish brown (10YR 5/4 and 5/6); weak to moderate, medium, subangular blocky structure; firm; common discontinuous clay films; common fine concretions and soft oxides; medium acid; gradual, smooth boundary.

B23t—36 to 41 inches, olive-gray (5Y 5/2) light silty clay; common, fine and medium, distinct, yellowish-brown (10YR 5/4 and 5/6) mottles and few, medium, prominent mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; many fine concretions and soft oxides; few discontinuous very dark gray (10YR 3/1) clay films mostly on root channels and vertical faces; slightly acid; gradual, smooth boundary.

B3t—41 to 60 inches, light olive-gray (5Y 6/2) heavy silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/6) mottles and few, medium, prominent mottles of strong brown (7.5YR 5/6) and dark brown to brown (7.5YR 4/4); massive; few cleavages; firm; very dark gray (10YR 3/1) clay fills in root channels and pores; slightly acid.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in color and from 10 to 19 inches in thickness. The A horizon is mainly silty clay loam, but the A1 or Ap horizon ranges from silty clay loam to silt loam. The B21t horizon ranges from very dark gray (10YR 3/1) to grayish brown (2.5Y 5/2) and from light to medium silty clay. Content of clay ranges from about 42 to 48 percent in the zone of maximum accumulation. Reaction in the B2 horizon ranges from medium acid to slightly acid. The depth to glacial till of clayey texture ranges from 4 to 8 feet and depends on topographic position.

Grundy soils are associated with Haig, Clarinda, and Pershing soils and formed in about the same kind of parent material as Edina and Seymour soils. Grundy soils are browner in their B horizon than Haig soils. They are not so gray as Clarinda and Edina soils and have less clay in the B horizon than those soils. They have a thicker, darker A horizon than Pershing soils, but they do not have the grayish A2 horizon that is typical of those soils. They have less clay in their B horizon than Seymour soils.

Grundy silty clay loam, 2 to 5 percent slopes (364B).—This soil is on short, slightly convex side slopes and ridgetops near broad upland flats. It is upslope from the moderately sloping Clarinda soils and is adjacent to Haig soils.

Included with this soil in mapping are small areas that have a silt loam surface layer. Also included are some slightly eroded areas that have a thinner surface layer and small areas where the slope is about 6 percent.

This soil is well suited to row crops. Most of the acreage is used for cultivated crops. This soil is high in organic-matter content and is generally in good tilth. Capability unit IIe-1; woodland suitability group 4w1.

Haig Series

The Haig series consists of poorly drained soils on nearly level, broad uplands. These soils formed in leached loess 7½ to 9 feet thick under prairie grass vegetation.

In a representative profile the surface layer is black silty clay loam about 13 inches thick. The subsoil to a depth of 60 inches or more is black that grades to gray, firm silty clay in the upper part and grayish-brown to olive-gray, firm silty clay loam in the lower part.

Haig soils are seasonally wet because of a high water table. Available water capacity is high, and permeability is very slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low in available phosphorus, is medium in available potassium, and is poorly aerated.

Most of the acreage is in row crops. Corn and soybeans are the main crops. A drainage system is needed for optimum plant growth. Haig soils dry out more slowly than the associated Grundy soils.

Representative profile of Haig silty clay loam where the slope is 1 percent; 550 feet south and 60 feet west of the northeast corner of sec. 21, T. 70 N., R. 17 W.

A11—0 to 7 inches, black (10YR 2/1) silty clay loam, gray (10YR 5/1) when dry, very dark gray (10YR 3/1) when kneaded; moderate, fine, granular structure; friable; neutral; gradual, smooth boundary.

A12—7 to 13 inches, black (10YR 2/1) light silty clay loam, very dark gray (10YR 3/1) when dry; moderate, fine and very fine, granular structure; friable; few grainy ped coatings; few fine pores; neutral; clear, smooth boundary.

B1t—13 to 19 inches, black (10YR 2/1) light silty clay, very dark gray (10YR 3/1) when dry; few, fine, distinct mottles of yellowish brown (10YR 5/4); moderate, very fine, subangular blocky structure; firm; few fine iron-manganese concretions; slightly acid; abrupt, smooth boundary.

B21t—19 to 23 inches, very dark gray (10YR 3/1) medium silty clay; common, fine, distinct mottles of yellowish brown (10YR 5/6 and 5/8); moderate, fine, subangular blocky structure; firm; many fine soft concretions; black (N 2/0) clay films on root channels; common fine pores; slightly acid; gradual, smooth boundary.

B22tg—23 to 29 inches, gray (5Y 5/1) and olive-gray (5Y 5/2) medium silty clay; few, fine, distinct mottles of strong brown (7.5YR 5/6 and 5/8) and many, fine, distinct mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; firm; common fine soft concretions; few discontinuous very dark gray (10YR 3/1) clay films; common fine pores; neutral; gradual, smooth boundary.

B23tg—29 to 35 inches, gray (5Y 5/1) and olive-gray (5Y 5/2) light silty clay; few, fine, prominent mottles of strong brown (7.5YR 5/6) and yellowish brown (10YR 5/4); moderate, medium, subangular blocky structure; firm; common fine soft concretions; few discontinuous very dark gray (10YR 3/1) clay films; neutral; gradual, smooth boundary.

B31tg—35 to 42 minutes, olive-gray (5Y 5/2) heavy silty clay loam to light silty clay; few, fine, prominent mottles of strong brown (7.5YR 5/6) and yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm; few fine soft concretions; few discontinuous very dark gray (10YR 3/1) clay films; neutral; gradual, smooth boundary.

B32tg—42 to 60 inches, olive-gray (5Y 5(2) medium silty clay loam; few, fine, prominent mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; few fine soft concretions; few discontinuous very dark gray (10YR 3/1) clay films; neutral.

The A horizon ranges from black (10YR 2/1) to a very dark gray (10YR 3/1) in color and from 10 to 18 inches in thickness. The A horizon is dominantly silty clay loam, but ranges to silt loam. The B2t horizon ranges from very dark gray to grayish brown in hues of 10YR to 5Y and from light to medium silty clay. Content of clay ranges from 42 to 48 percent in the zone of maximum accumulation. Reaction in the B horizon ranges from medium acid to slightly acid in the upper part and from slightly acid to neutral in the lower part. Depth to glacial till is about 7 to 8 feet.

Haig soils are associated with Edina and Grundy soils. They have a thicker darker A horizon than Edina soils, but they do not have the A2 horizon that is typical of Edina soils. They have poorer drainage than the adjacent sloping Grundy soils, and their B2tg horizon is grayer and more mottled than that of Grundy soils.

Haig silty clay loam (0 to 2 percent slopes) (362).—This soil is on broad upland divides in the northwestern and north-central parts of the county.

Included with this soil in mapping are a few small areas on high benches. Also included are areas where the surface layer is silt loam.

This soil is well suited to the row crops commonly grown in the county. It is commonly farmed along with the surrounding Grundy soils. The soil dries out more slowly after rains and warms up more slowly in spring than the Grundy soils, but it is suitable for intensive row cropping if it is drained. Because surface drainage is poor and permeability is very slow in the subsoil, shallow ditches are needed in places to remove surface water during wet periods. Tile drains do not work well on this soil. Capability unit IIw–2; woodland suitability group 5w3.

Humeston Series

The Humeston series consists of nearly level soils on bottom lands and gently sloping soils near the drainageways and larger streams in the county. These soils are poorly drained to very poorly drained. They formed in alluvium under wetland grass vegetation. These soils are minor in extent in Appanoose County. Areas range from 5 to 20 acres in size.

In a representative profile the surface layer is very dark gray silt loam about 12 inches thick. The subsurface layer is dark-gray or very dark gray, friable silt loam about 12 inches thick. The subsoil to a depth of 60 inches or more is black to dark-gray, firm silty clay that grades to firm silty clay loam in the lower part.

Humeston soils are seasonally wet because of the high water table and flooding. Drainage and flood protection are needed. Available water capacity is high, and permeability is very slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus and potassium, and is poorly aerated.

Humestone soils are used for selected row crops. Corn growth is stunted in wet years and planting may be delayed in spring because of excessive wetness. Pasture is the main use for these soils in some areas.

Representative profile of Humeston silt loam, 0 to 2 percent slopes, where the slope is 1 percent; 65 feet west and 600 feet south of the northeast corner of the SW¼NE¼ sec. 32, T. 69 N., R. 19 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) when dry; moderate, fine, granular structure; friable; many roots; few fine pores; neutral; abrupt, smooth boundary.

A12—8 to 12 inches, very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) to gray (10YR 5/1) when dry; weak, fine, subangular blocky structure breaking to weak, fine, granular; friable; many roots; few fine pores; medium acid; clear, smooth boundary.

A21—12 to 17 inches, very dark gray (10YR 3/1) silt loam, gray to light gray (10YR 6/1) when dry; moderate, thin, platy structure; friable; many roots; few fine concretions and soft oxides; nearly continuous grainy ped coatings when dry; medium acid; clear, smooth boundary.

A22—17 to 24 inches, light silty clay loam that is dark gray (10YR 4/1) on top of plates and very dark gray (10YR 3/1) and dark gray (10YR 4/1) on under side of plates, light gray (10YR 7/1) when dry on top of plates and gray (10YR 5/1) and light gray (10YR 7/1) when dry on under side of plates; moderate, medium, platy structure breaking to weak, fine, subangular blocky; friable; few roots and fine pores; common fine concretions and soft oxides; medium acid; clear, smooth boundary.

Blt—24 to 27 inches, mixed very dark gray (10YR 3/1) and black (10YR 2/1) heavy silty clay loam; moderate, fine, subangular blocky structure; firm; common light-gray (10YR 7/1) when dry grainy ped coatings; few thin clay films; few roots; common concretions and soft oxides; medium acid; clear, smooth boundary.

B21t—27 to 32 inches, black (N 2/0 to 10YR 2/1) light silty clay; moderate, fine, subangular blocky structure; firm; few fine pores; few patches of grainy ped coatings when dry; thick discontinuous clay films; few concretions; slightly acid; gradual, smooth boundary.

B22t—32 to 38 inches, black (N 2/0 to 10YR 2/1) light silty clay; moderate, fine to medium, subangular blocky structure; firm; few small patches of grainy ped coatings when dry; thick discontinuous clay films; few fine pores; common concretions; common sand grains; slightly acid; gradual, smooth boundary.

B23t—38 to 44 inches, black (10YR 2/1) light silty clay; moderate, medium, subangular blocky structure; firm; thick discontinuous black (N 2/0) clay films; common concretions; common fine pores and sand grains; slightly acid; gradual, smooth boundary.

B3t—44 to 60 inches, black (10YR 2/1) to very dark gray (10YR 3/1) heavy silty clay loam; weak, medium, subangular blocky structure to moderate, fine, prismatic; firm; thick discontinuous black (N 2/0) clay films; common concretions; common fine pores and sand grains; neutral.

The A1 horizon is black (10YR 2/1) or very dark gray (10YR 3/1) and ranges from 10 to 14 inches in thickness. The A2 horizon ranges from very dark gray (10YR 3/1) to gray (10YR 5/1) and from 10 to 14 inches in thickness.

The B horizon is black (N 2/0) to very dark gray (10YR 3/1) in the upper part, but it grades to dark gray (10YR 4/1) or gray (10YR 5/1) with increasing depth. The clay content of the B2 horizon ranges from 38 to 48 percent. The B3 horizon typically grades from heavy silty clay loam in the upper part to medium silty clay loam in the lower part.

Humeston soils are associated with Colo, Zook, Wabash, Vesser, and Coppock soils. They have a gray silt loam A2 horizon that Colo, Zook, and Wabash soils do not have. They have a thinner B horizon than Colo soils. They have a thinner A2 horizon and a more clayey B horizon than Vesser soils. They have a B horizon that contains more clay than that of Coppock soils.

Humeston silt loam, 0 to 2 percent slopes (269A).—This soil is generally wet, and many areas are flooded occasionally.

This soil has the profile described as representative of the series (fig. 10). Included in mapping are some areas that have an overwash of more recent loamy sediments.

Drainage is needed on this wet soil. Excess surface water can be drained by open ditches, but even in drained areas these soils are difficult to work and they puddle readily. Tile drains do not work well because the subsoil is very slowly permeable. The content of organic matter is medium.

This soil is moderately suited to row crops. It dries slowly in spring and after rains, occasionally delaying planting and cultivation. This soil is well suited to some pasture plants, and in undrained areas it is better suited to pasture than to most other uses. Capability unit IIIw-1; woodland suitability group 5w3.

Humeston silt loam, 2 to 5 percent slopes (269B).—This soil is on foot slopes along the valleys of the major streams. Most of this soil slopes 3 percent or less. Included in mapping are a few areas that have an overwash of loamy colluvial sediments.

Row crops are moderately suited to this soil if contour cultivation is used. This soil is often wet, because it receives excessive runoff and some seepage from adjacent uplands. In many places diversion terraces are built in the adjacent soils upslope to divert water from the uplands. Erosion is not a serious hazard on this soil. Tile drains do not work well because the subsoil is very slowly permeable, but excessive surface water can be removed by open ditches. Capability unit IIIw-1; woodland suitability group 5w3.

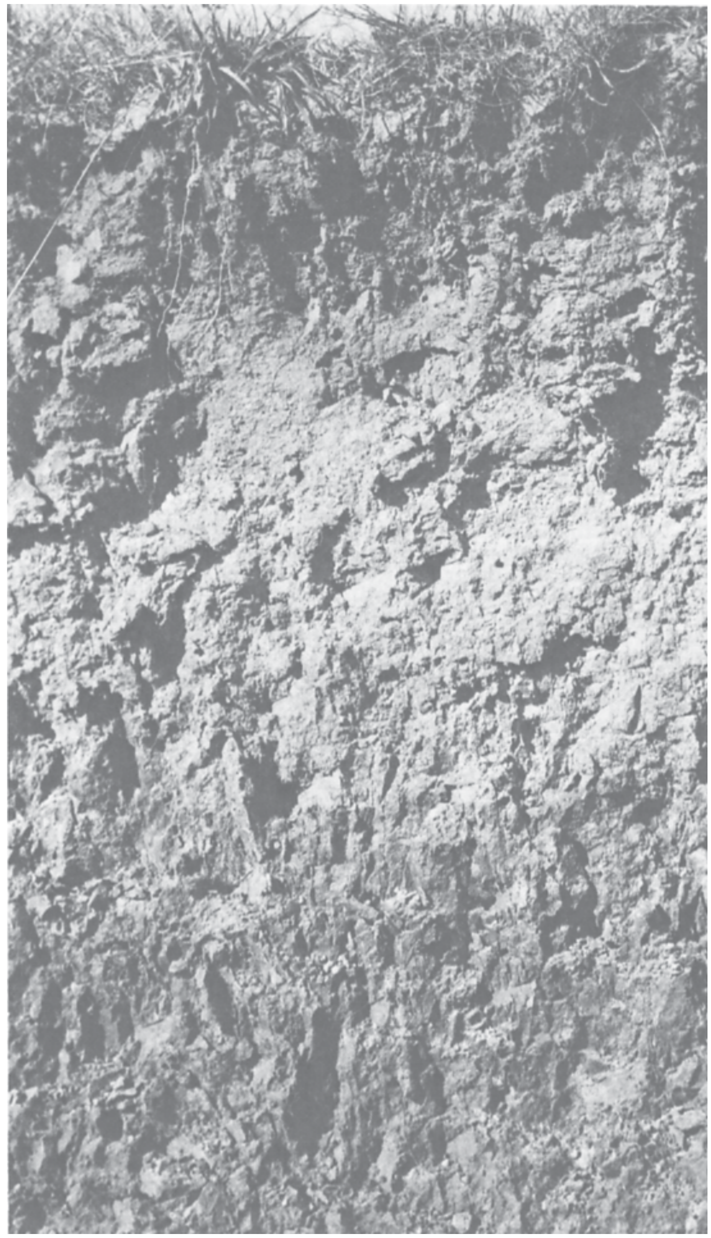

Figure 10.—**Profile of Humeston soil showing thick, light-colored A2 horizon. Dark-colored clayey subsoil is at a depth of about 24 inches.**

Kennebec Series

The Kennebec series consists of moderately well drained soils on first bottoms near the natural stream channels. These soils formed in silty alluvium under grass vegetation. In periods of heavy rainfall they are likely to be flooded and receive deposits of medium-textured materials. Slopes range from 0 to 2 percent and are more undulating than those of some other bottom land soils in the county. The undulating slopes are often remnants of old meandering streams.

In a representative profile the surface layer is very dark gray silt loam 33 inches thick. The subsoil to a depth of 60 inches or more is very dark gray and very dark grayish-brown, friable silt loam.

These soils are occasionally flooded. Available water capacity is high, and permeability is moderate. Natural fertility is high. The surface layer is neutral and generally does not need liming. The subsoil is acid, is low to medium in available phosphorus and potassium, and is somewhat poorly aerated.

Kennebec soils can be used intensively for row crops if flooding is controlled. Most larger areas are cultivated to corn or soybeans. Many small areas near stream channels are pastured or wooded.

Kennebec soils in Appanoose County are mapped only with Amana soils.

Representative profile of Kennebec silt loam that has a 1 percent slope; in an area of Kennebec-Amana silt loams, 180 feet west and 180 feet north of the southeast corner of the SW¼NE¼ sec. 32, T. 69 N., R. 19 W.

A11—0 to 8 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry, very dark grayish brown (10YR 3/2) when kneaded; moderate, fine, granular structure; friable; common pores and roots; slightly acid; gradual, smooth boundary.

A12—8 to 15 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry, very dark grayish brown (10YR 3/2) when kneaded; moderate, fine, subangular blocky structure breaking to moderate, fine, granular; friable; common pores and roots; slightly acid; gradual, smooth boundary.

A13—15 to 21 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) to grayish brown (10YR 5/2) when dry, very dark grayish brown (10YR 3/2) when kneaded; weak, fine, subangular blocky structure; friable; common pores; few roots; increasing sand grains with increasing depth; slightly acid; gradual, smooth boundary.

A14—21 to 26 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) gritty silt loam, gray (10YR 5/1) to grayish brown (10YR 5/2) when dry; weak, fine, subangular blocky structure; friable; few thin sand strata; common fine pores; few roots; medium acid; gradual, smooth boundary.

A3—26 to 33 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) gritty silt loam, grayish brown (10YR 5/2) when dry; weak to moderate, fine, subangular blocky structure; friable; few short oxides; many fine pores; few thin sand strata; few roots; medium acid; gradual, smooth boundary.

B2—33 to 43 inches, very dark gray (10YR 3/1) gritty silt loam; weak, fine to medium, subangular blocky structure; friable; very fine sand; few soft oxides; many fine pores; few roots; strongly acid; gradual, smooth boundary.

B3—43 to 60 inches, very dark grayish-brown (10YR 3/2) silt loam; weak, fine to medium, subangular blocky structure; friable; few soft oxides; many fine pores; medium acid.

The A horizon ranges from 18 to 36 inches in thickness and from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The B horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). The silt loam texture extends from the surface to a depth of 42 to 60 inches. In some places sand grains are in the profile; some layers are as much as 20 percent sand, with fine and very fine sand dominant. Reaction ranges from slightly acid to medium acid in the upper part of the solum and medium acid to strongly acid in the lower part of the B horizon. The Kennebec soils in this county are more acid below a depth of 24 inches than is typical of the Kennebec series.

Kennebec soils are associated with Colo, Zook, Chequest, Vesser, Coppock, and Nodaway soils. They are not so fine textured in the B horizon as Colo, Zook, or Chequest soils and are better drained. They do not have the A2 horizon that is typical of Vesser and Coppock soils. They do not have stratified layers of different textures and colors of alluvium that are typical of Nodaway soils.

Kennebec-Amana silt loams (0 to 2 percent slopes) (406).—This mapping unit is on wide first bottoms. It is about 70 percent Kennebec soils (fig. 11) and 30 percent Amana soils. Some areas are slightly undulating and include narrow noncrossable streams. The undulating slopes generally are remnants of old meandering streams. Individual areas are generally large. Included in mapping are small areas near the stream channels that have high sand content in the surface layer. These are indicated by a standard sand spot symbol on the soil map.

These Kennebec and Amana soils are well suited to row crops. Much of the acreage is cultivated, but occasional flooding is a hazard. Pasture and woodland are flooded more frequently than cultivated fields because they generally are next to the main river channel or smaller streams. Instead of artificial drainage, protection from stream overflow is needed. Tilth is usually not a problem. Organic-matter content is medium to high. These soils warm up quickly and can be worked earlier in spring than soils that have a more developed profile. Capability unit I–1; woodland suitability group 5w2.

***Figure 11.*—Profile of deep, dark-colored Kennebec soils showing good distribution of roots.**

Keswick Series

The Keswick series consists of somewhat poorly drained and moderately well drained soils on uplands. These soils formed in previously weathered glacial till under forest vegetation. They are most extensive on narrow, sloping ridgetops downslope from Weller, Rathbun, and Ashgrove soils and upslope from moderately steep to steep Lindley soils. These soils are typically in the most strongly dissected areas along the major streams of the county.

In a representative profile the surface layer is dark grayish-brown loam about 3 inches thick. The subsurface layer is brown, friable loam 7 inches thick. The subsoil is 42 inches thick. The upper part is strong-brown or reddish-brown, firm clay that has reddish mottles. A distinct stone line is in the upper 4 inches. The lower part is reddish-yellow clay loam.

These soils tend to stay wet longer in spring than those soils that have more permeable subsoils. Available water capacity is high, and permeability is slow. Natural fertility is very low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus, is low in available potassium, and is somewhat poorly aerated.

Most of the acreage is used for pasture, meadow, or is wooded. Some of the less sloping areas are moderately suited to row crops. Potential use and management of these soils are limited by the erosion hazard and the high clay content in the subsoil and influenced by the associated steep Lindley soils that are not suited to row crops.

Representative profile of Keswick loam, 5 to 9 percent slopes, on a north aspect where the slope is 7 percent; 1,100 feet east and 480 feet north of the southwest corner of the NW¼NE¼ sec. 25, T. 70 N., R. 17 W.

A1—0 to 3 inches, dark grayish-brown (10YR 4/2) loam, light brownish gray (10YR 6/2) when dry; few, fine, faint mottles of yellowish red (5YR 5/8); moderate; thin, platy structure breaking to weak, fine, granular; friable; strongly acid; abrupt, smooth boundary.

A2—3 to 10 inches, brown (10YR 5/3) loam, very pale brown (10YR 7/3) when dry; common, moderate, distinct mottles of dark gray (10YR 4/1); moderate, medium, platy structure; friable; very strongly acid; clear, smooth boundary.

IIB1—10 to 14 inches, strong-brown (7.5YR 5/6) light clay loam, very pale brown (10YR 7/4) when dry; common, medium, distinct mottles of yellowish red (5YR 5/8); moderate, medium, subangular blocky structure; distinct stone line at top of horizon; friable; very strongly acid; clear, smooth boundary.

IIB21t—14 to 20 inches, reddish-brown (5YR 4/4) clay with enough sand to have a gritty feel; many, medium, distinct mottles of yellowish red (5YR 4/6) and few, fine, faint mottles of grayish brown (10YR 5/2); weak, fine, subangular blocky structure; very firm; thin discontinuous clay films; very strongly acid; gradual, smooth boundary.

IIB22t—20 to 27 inches, reddish-yellow (7.5YR 6/6) heavy clay loam; few, fine, faint mottles of yellowish red (5YR 5/6) and grayish brown (10YR 5/2); weak, medium, subangular blocky structure; firm; thin discontinuous clay films; very strongly acid; gradual, smooth boundary.

IIB31t—27 to 34 inches, reddish-yellow (7.5YR 6/6) medium to heavy clay loam; common, medium, faint mottles of very pale brown (10YR 7/4); weak, fine, prismatic structure; firm; few, thin, discontinuous clay films; very strongly acid; gradual, smooth boundary.

IIB32—34 to 52 inches, reddish-yellow (7.5YR 6/6) light clay loam; common, medium, distinct mottles of light gray (10YR 7/1); weak, medium, prismatic structure; firm; common black (10YR 2/1) oxide stains; strongly acid.

The A1 horizon ranges from 2 to 5 inches in thickness, where not eroded, and from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). The A2 horizon ranges from 4 to 8 inches in thickness and is brown (10YR 5/3) or pale brown (10YR 6/3). The B2t horizon commonly ranges from dark reddish brown (5YR 4/3) to reddish yellow (7.5YR 6/6). Depth to the B horizon ranges from 8 to 17 inches. The B2t horizon is heavy clay loam or clay containing 38 to 48 percent clay. A stone line generally occurs in the upper part of the B horizon. The solum is very strongly acid to medium acid.

Keswick soils are associated with Armstrong, Mystic, Lindley, and Ashgrove soils. They have a thinner A horizon and a more pronounced A2 horizon than Armstrong and Mystic soils. They do not have stratification, which typically occurs in the lower part of the B horizon of Mystic soils. Their B horizon contains more clay and is redder than that of Lindley soils. The B horizon has redder colors than in Ashgrove soils, but the clay part is not so thick.

Keswick loam, 5 to 9 percent slopes (425C).—This soil is most extensive on narrow ridgetops in the most strongly dissected areas along the major streams in the county. This soil generally is in small, irregularly shaped areas. It has the profile described as representative of the series.

Included with this soil in mapping are a few small areas of Ashgrove, Weller, and Rathbun soils, generally less than 2 acres in size, on the centers of ridges. Also included are a few small areas of Keswick silt loam, 5 to 9 percent slopes, moderately eroded.

This soil is moderately suited to row crops, but most of the acreage is used for pasture, hay, or is wooded. A large acreage now has a stand of low-value timber on it. Terracing helps in erosion control, but if borrow areas are terraced the clayey subsoil, which is poor in tilth, is exposed. Exposing the subsoil can be avoided by stockpiling the surface soil during construction and replacing it afterward. This soil is low in organic-matter content. Capability unit IIIe–5; woodland suitability group 5c1.

Keswick loam, 5 to 9 percent slopes, moderately eroded (425C2).—This soil is most extensive on narrow ridgetops in the most strongly dissected areas along the major streams in the county. Areas are small and irregular in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is lighter in color and the subsurface layer generally is missing. Part of the surface layer has been removed by erosion and the remainder has been mixed with the subsurface layer and part of the subsoil by plowing.

Included with this soil in mapping are a few small areas of severely eroded Keswick soils that are indicated by a severe erosion spot symbol on the soil map. Also included are a few small areas of Ashgrove silt loam, moderately eroded.

This soil is moderately suited to row crops, but most of the acreage is used for pasture or hay. Terraces help in erosion control, but where they are used in borrow areas the clayey subsoil, which is poor in tilth, is exposed. Exposing the subsoil can be overcome by stockpiling the surface soil during construction and replacing it afterward. This soil is very low in organic-matter content. Tilth of the surface layer is poor in many places; it becomes hard and cloddy when almost dry if it is tilled too wet. Unless erosion is controlled, tilth of the surface layer continues to deteriorate as increasing amounts of the subsoil are mixed into it. Capability unit IIIe-5; woodland suitability group 5c1.

Keswick loam, 9 to 14 percent slopes (425D).—This soil is most extensive on the ridgetops in the most strongly dissected areas along the major streams in the county. It generally is in narrow bands on convex side slopes.

Included with this soil in mapping are some areas where part of the surface layer and subsurface layer have been removed by erosion and the rest has been mixed with part of the subsoil through plowing.

This soil is better suited to hay, pasture, or wood crops than to most other uses. Much of the acreage now has a stand of low-value timber that must be cleared if it is to be used for productive pasture. This soil is low in organic-matter content. Capability unit IVe-2; woodland suitability group 5c1.

Keswick loam, 9 to 14 percent slopes, moderately eroded (425D2).—This soil is most extensive on the ridgetops in the most strongly dissected areas along the major streams in the county. In places it occupies entire short side slopes.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner and lighter in color. In some areas the soil has no subsurface layer. In many places part of the original surface layer has been removed by erosion, and the rest has been mixed with the subsurface layer and part of the subsoil by plowing to form the present surface layer. The surface layer generally contains more clay than is typical for Keswick soil. Included in mapping are a few small areas of Lindley loam.

This soil is better suited to hay, pasture, or wood crops than to most other uses. Much of the acreage now has a stand of low-quality timber that must be cleared if it is to be used for productive pasture. The organic-matter content of this soil is low. Capability unit IVe-2; woodland suitability group 5c1.

Keswick soils, 9 to 14 percent slopes, severely eroded (425D3).—This soil is most extensive on ridgetops in the most strongly dissected areas along the major streams in the county. It is commonly dissected by gullies and waterways.

This soil has a profile similar to that described as representative of the series, but the surface layer is higher in content of clay and it has no subsurface layer. All but 3 inches or less of the original surface layer and subsurface layer have been removed through erosion, and the rest has been mixed with part of the former subsoil by plowing to form the present surface layer. This surface layer ranges from loam to clay loam or clay. In some places the clay subsoil is exposed. Included in mapping are some areas where erosion has been less severe and 3 to 6 inches of the original surface and subsurface layers remain.

This soil is not suitable for cultivation. It is better suited to hay and pasture than to most other uses. The hazard of further erosion is severe. Seeded pasture is difficult to establish because of strong slopes and because the surface layer is in poor tilth and becomes hard and cloddy when almost dry. The surface tends to seal over during rainfall, thus reducing infiltration and increasing runoff. Shaping and seeding gullies and waterways help to prevent soil loss. Control of grazing is necessary because the carrying capacity of pasture is somewhat low. Capability unit VIe-3; woodland suitability group 5c1.

Kniffin Series

The Kniffin series consists of somewhat poorly drained soils on uplands. These soils formed in leached loess about 48 to 80 inches thick over a buried, very slowly permeable, clayey soil. The native vegetation was a mixture of grass and trees. Slopes range from 2 to 9 percent and are mostly short and convex. Kniffin soils are on narrow ridgetops upslope from Armstrong, Clarinda, Lamoni, and Gara soils. They are in most parts of the county except the north-central parts. Individual areas range from 5 to 30 acres in size.

In a representative profile the surface layer is very dark gray silt loam about 6 inches thick. The subsurface layer is dark grayish-brown and grayish-brown, friable silt loam and silty clay loam about 7 inches thick. The subsoil to a depth of 60 inches or more is mottled dark grayish-brown, firm and very firm silty clay that grades to silty clay loam in the lower part.

Kniffin soils are subject to erosion, particularly when planted to row crops. Available water capacity is moderately high, and permeability is very slow. Natural fertility is low to medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low to very low in available phosphorus and potassium, and is somewhat poorly aerated.

Kniffin soils are used mainly for cultivated crops or pasture.

Representative profile of Kniffin silt loam, 2 to 5 percent slopes, in a cultivated field, the southwest aspect of a stable ridgetop where the slope is 3 percent; 457 feet west of the southeast corner of the NE¼SE¼ sec. 35, T. 67 N., R. 19 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) when dry; weak, thin, platy structure breaking to weak, fine, granular; friable; slightly acid; abrupt, smooth boundary.

A21—6 to 9 inches, dark grayish-brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) when dry; weak, thin, platy structure; friable; few very dark gray (10YR 3/1) fills in worm voids; strongly acid; clear, smooth boundary.

A22—9 to 13 inches, grayish-brown (10YR 5/2) medium silty clay loam; few, very fine, faint mottles of strong brown (7.5YR 5/6), very pale brown (10YR 7/3) when dry; weak, fine, subangular blocky structure; friable; strongly acid; clear, smooth boundary.

AB—13 to 16 inches, brown (10YR 5/3) light to medium silty clay; common, very fine, faint mottles of strong brown (7.5YR 5/6); moderate, fine, subangular blocky structure; friable; thin light-gray (10YR 7/2) grainy ped coatings; medium acid; clear, smooth boundary.

B21t—16 to 23 inches, dark grayish-brown (10YR 4/2) medium silty clay; common, fine, distinct mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; very firm; thin discontinuous clay films; medium acid; gradual, smooth boundary.

B22t—23 to 30 inches, grayish-brown (10YR 5/2) heavy silty clay loam; many, medium, distinct mottles of strong brown (7.5YR 5/6); moderate, medium, subangular blocky structure; very firm; few fine iron-manganese concretions; few, thin, discontinuous clay films; medium acid; gradual boundary.

B31t—30 to 37 inches, grayish-brown (2.5Y 5/2) medium silty clay loam; common, medium, distinct mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; common fine iron-manganese concretions; thin discontinuous clay films in root channels; medium acid; gradual, smooth boundary.

B32t—37 to 60 inches, light brownish-gray (2.5Y 6/2) light silty clay loam; many, medium, distinct mottles of yellowish brown (10YR 5/6); weak, coarse, prismatic structure; firm; common fine iron-manganese concretions; thin discontinuous dark grayish-brown (10YR 4/2) clay films in root channels; neutral.

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 6 to 9 inches in thickness. The A2 horizon generally is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2) and ranges from 2 to 7 inches in thickness. The B2t horizon ranges from grayish brown (2.5Y 5/2) to dark grayish brown (10YR 4/2), and the B3t horizon ranges from grayish brown (2.5Y 5/2) to light olive gray (5Y 6/2). Mottles in the B horizon are commonly yellowish brown (10YR 5/6 and 5/8) and strong brown (7.5YR 5/6). The grayish colors are relict and are related to a deoxidized and leached weathering zone. Clay makes up 48 to 56 percent of the zone of maximum clay accumulation, which occurs at a depth of about 20 inches. The most acid part of the B horizon is medium acid to very strongly acid. Depth to the glacial till of clay texture ranges from 48 to 80 inches.

Kniffin soils are associated with Grundy, Rathbun, Lamoni, and Gara soils. They differ from Grundy soils in having a thinner A1 horizon and an A2 horizon. They have a thicker A1 horizon than Rathbun soils. They have less sand and fewer pebbles and stones than Lamoni and Gara soils that were derived from till.

Kniffin silt loam, 2 to 5 percent slopes (531B).—This soil is on somewhat rounded ridgetops and on short, slightly convex side slopes. This soil is generally surrounded by moderately sloping Kniffin soils. The individual areas are generally large.

This soil has the profile described as representative of the series. Included in mapping are a few moderately eroded areas.

Crops grow moderately well on this soil under good management. If terracing and contour tillage are used, row crops are moderately suited. This soil erodes readily because the silty surface layer contains only a medium amount of organic matter and is generally not well granulated. Loss of the surface layer increases the hazard of exposing the very firm clayey subsoil. This soil is strongly acid and needs additions of lime. Capability unit IIIe-3; woodland suitability group 4w1.

Kniffin silt loam, 5 to 9 percent slopes (531C).—This soil is most extensive on rounded ridgetops, but it is on slightly convex side slopes in places. The ridgetops extend toward broader divides, and near them this soil is generally associated with Seymour soils. Downslope are moderately sloping Clarinda and Armstrong soils. Some areas of this Kniffin soil are very large.

The soil has a profile similar to that described as representative of the series, but the surface layer is very dark gray silt loam 6 to 8 inches thick over a very thin subsurface layer that becomes quite gray as it dries. The subsoil is very firm and clayey. Included in mapping are a few moderately eroded areas.

Much of the acreage is cropped, and many areas are farmed separately from other soils. This soil is moderately well suited to row crops. It is very erodible because of rapid runoff. Loss of the surface layer increases the hazard of exposing the very firm clayey subsoil. This soil contains a medium amount of organic matter. It is acid and needs additions of lime. Capability unit IIIe-4; woodland suitability group 4w1.

Kniffin silt loam, 5 to 9 percent slopes, moderately eroded (531C2).—This soil is in bands on short, slightly convex side slopes and on rounded ridgetops upslope from soils derived from till. The individual areas of this soil are generally 5 to 15 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is very dark gray to very dark grayish-brown silt loam 3 to 7 inches thick and overlies a very thin grayish subsurface layer. The subsoil is very firm and clayey. In many places the plow layer is noticeably lighter colored when dry because the thin grayish layer has been mixed into it through plowing. Plowing exposes the subsoil at the edge of some slope shoulders and at the heads of some waterways on sidehills. Included in mapping are a few severely eroded areas that are indicated by a severe erosion spot symbol on the soil map.

This soil is mostly used for crops. If it is terraced and tilled on the contour, it is moderately suited to row crops. The surface layer is low in organic-matter content, and tilth is generally poor. After rains the soil surface tends to crust. This soil is acid and needs additions of lime. Capability unit IIIe-4; woodland suitability group 4w1.

Lamoni Series

The Lamoni series consists of somewhat poorly drained soils on uplands. These soils formed in a thin layer of weathered glacial till that is gray clay commonly called gumbotil." The gumbotil was the subsoil of a soil on the nearly level drift plain that remained after the Kansan Glacier receded. Later a deposit of loess covered the gumbotil, but geologic erosion removed the loess and much of the gumbotil in many places. These soils are mostly on side slopes where the once-buried soil has been modified by geologic erosion and is exposed. Since these soils have been exposed, the native vegetation has been prairie grasses.

These soils are most extensive in coves and on adjacent side slopes downslope from Clarinda or Appanoose soils. Shelby, Adair, and Armstrong soils generally are on the lower parts of side slopes and nose slopes downslope from Lamoni soils.

In a representative profile the surface layer is very dark gray silty clay loam and clay loam 10 inches thick. The subsoil is about 46 inches thick. It is dark grayish-brown clay loam in the upper part and grades to grayish-brown to olive-gray, firm clay that has yellowish-brown and strong-brown mottles in the middle part. The lower 20 inches is olive-gray clay loam.

The Lamoni soils on hillsides are seasonally wet from seepage. They are subject to erosion, particularly where they are row cropped. Available water capacity is high, and permeability is very slow. Natural fertility is low to very low. The soils have a high shrink-swell potential and crack readily upon drying. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

Some of the Lamoni soils are suitable for occasional cultivation; others are better suited to pasture or hay than to most other uses.

Representative profile of Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded, on a west aspect where the slope is 10 percent; 980 feet north and 280 feet east of the southwest corner of the SE¼SW¼ sec. 17, T. 69 N., R. 19 W.

Ap—0 to 5 inches, very dark gray (10YR 3/1) light silty clay loam; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A3—5 to 10 inches, mixed very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) heavy clay loam; weak, fine, granular structure; slightly firm; neutral; gradual, smooth boundary.

IIB1—10 to 14 inches, dark grayish-brown (10YR 4/2) heavy clay loam; few, fine, distinct mottles of strong brown (7.5YR 5/6 and 5/8) and few, medium, distinct mottles of dark gray (10YR 4/1); moderate, fine, subangular blocky structure; firm; medium acid; gradual, smooth boundary.

IIB2t—14 to 23 inches, grayish-brown (2.5Y 5/2) clay; common, fine, distinct mottles of strong brown (7.5YR 5/6 and 5/8); weak, fine, columnar structure breaking to weak, medium, subangular blocky; firm; thick continuous clay films; few visible pores; sand content increases with increasing depth; medium acid; gradual, smooth boundary.

IIB31t—23 to 36 inches, olive-gray (5Y 5/2) light clay; common, medium, distinct mottles of strong brown (7.5YR 5/6 and 5/8); weak, medium, subangular blocky structure; firm; thin discontinuous clay films; sand content increases with increasing depth; medium acid; gradual, smooth boundary.

IIB32t—36 to 56 inches, olive-gray (5Y 5/2) heavy clay loam; many, coarse, distinct mottles of strong brown (7.5YR 5/8); weak, coarse, prismatic structure; firm; thin discontinuous clay films; few gravel-size particles; sand content increases with increasing depth; slightly acid.

The A horizon ranges from 10 to 14 inches in thickness. The IIB2t horizon ranges from dark grayish brown (10YR 4/2) to light brownish gray (2.5Y 6/2) and has common strong-brown (7.5YR 5/6) and yellowish-brown (10YR 5/4 to 5/8) mottles. It typically ranges from 12 to 24 inches in thickness, and in clay maximum from 40 to 50 percent. The gleyed colors of the IIB2t horizon are inherited from the Yarmouth-Sangamon B horizon. The IIB3t and IIC horizons generally are mottled olive-gray (5Y 5/2) to yellowish-brown (10YR 5/6) clay loam. Carbonates are commonly leached to depths below 48 inches.

Lamoni soils are associated with Shelby, Gara, Clarinda, and Adair soils. They have higher clay content and a grayer B horizon than Shelby and Gara soils. They have a thinner and more mottled B horizon than Clarinda soils. They have a grayish colored B horizon, whereas the B horizon of Adair soils is reddish in color.

Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded (822D2).—This soil is near the heads of drainageways, generally downslope from Clarinda soils. In places it is in bands at the shoulders of side slopes upslope from Shelby soils. This soil has the profile described as representative of the series.

Included with this soil in mapping are small areas where the gray clay subsoil has been exposed at the surface through erosion. Also included are some areas that are only slightly eroded. In places the surface layer is thinner and slightly browner because it has been partly removed by erosion.

The clay subsoil and strong slopes make this soil erodible in cultivated areas and hard to manage. The soil is better suited to hay and pasture than to most other uses. It has low organic-matter content. When other soils in the field are ready for cultivation, this soil may still be too wet to work. Unless erosion is controlled, tilth and fertility of the surface layer continue to deteriorate as increasing amounts of the subsoil are mixed into the plow layer. Capability unit IVe-2; woodland suitability group 5w1.

Lamoni soils, 9 to 14 percent slopes, severely eroded (822D3).—These soils are on side slopes or in coves downslope from Clarinda soils.

These soils have a profile similar to that described as representative of the series, but most of the surface layer has been removed through erosion and the remaining surface layer is thinner, lighter in color, and higher in clay. The plow layer is dark-gray silty clay loam or clay about 5 inches thick. It is less than 3 inches of the surface layer mixed with part of the subsoil. The surface layer in areas near small gullies and rills generally is clay. It is hard and cloddy when almost dry and sticky when wet. The surface tends to seal over during rain, increasing runoff and erosion.

Included with these soils in mapping are some areas that are only moderately eroded. Also included are small areas of severely eroded Clarinda soils.

These soils are not suitable for row crops. They are better suited to hay and pasture than to most other uses. Establishing and maintaining good hay or pasture vegetation is very difficult because the surface layer is in poor tilth and is low in fertility. The hazard of erosion is severe. Most legumes are subject to winterkill. These soils are very low in organic-matter content. Unless they are protected by dense vegetation, gullies form readily. Capability unit VIe-3; woodland suitability group 5w1.

Landes Variant

The Landes variant consists of moderately well drained soils that have formed on first bottoms in stratified sandy alluvium. Vegetation has not influenced soil formation. These soils are commonly flooded in periods of heavy rainfall and receive deposits of coarse-textured materials. These soils typically have a dark silty clay loam buried horizon below a depth of 40 inches.

In a representative profile the surface layer is very dark grayish-brown fine sandy loam about 10 inches thick. The next 16 inches is stratified layers of dominantly dark-gray, grayish-brown and light brownish-gray fine sandy loam, loamy sand, and sand. Beneath this is 14 inches of grayish-brown silt loam that is underlain by black silty clay loam.

Landes soils are subject to flooding. Available water capacity and permeability are moderate. Natural fertility is low. The surface layer is neutral and does not need additions of lime. The subsoil is acid, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

Most of the acreage is cultivated. The soils respond well to good management.

Representative profile of Landes fine sandy loam, heavy subsoil variant, along straightened stream channel of Chariton River, 100 feet north and 100 feet east of the southwest corner of the NW¼NW¼ sec. 13, T. 68 N., R. 17 W.

Ap—0 to 10 inches, very dark grayish-brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) when dry; few streaks of very dark grayish brown (10YR 3/2) and grayish brown (10YR 5/2); weak, fine, granular structure; very friable; neutral; clear, smooth boundary.

C1—10 to 13 inches, stratified dark-gray (10YR 4/1), grayish-brown (10YR 5/2), and light brownish-gray (10YR 6/2) fine sandy loam that has thin strata of loamy sand and sand; common, fine, distinct mottles of dark brown (7.5YR 3/2); weak, fine, granular structure; very friable; neutral; clear, smooth boundary.

C2—13 to 18 inches, stratified dark-gray (10YR 4/1) and gray (10YR 5/1) fine sandy loam; common, fine, distinct mottles of dark brown (7.5YR 3/2); weak, medium, granular structure; very friable; few, thin, grayish-brown (10YR 5/2) sand strata; slightly acid; clear, smooth boundary.

C3—18 to 22 inches, dark-gray (10YR 4/1) and light brownish-gray (10YR 6/2) fine sandy loam; common, fine, distinct mottles of yellowish brown (10YR 5/6), dark brown (7.5YR 3/2), and dark brown to brown (7.5YR 4/4); weak, medium, granular structure; friable; colors of matrix are stratified; slightly acid; clear, smooth boundary.

C4—22 to 26 inches, dark-gray (10YR 4/1) and light brownish-gray (10YR 6/2) very fine sandy loam; common, fine, distinct mottles of yellowish brown (10YR 5/6), dark brown (7.5YR 3/2), and dark brown to brown (7.5YR 4/4); weak, medium, granular structure; friable; colors of matrix are stratified; slightly acid; clear, smooth boundary.

C5—26 to 40 inches, grayish-brown (2.5Y 5/2) silt loam; few, fine, faint mottles of yellowish brown (10YR 5/4) and dark brown to brown (7.5YR 4/4); weak, medium, granular structure; friable; few dark-gray (10YR 4/1) root channels; few fine sand strata; slightly acid; clear, smooth boundary.

IIA1b—40 to 60 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay loam; many, fine, distinct mottles of yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm; few hard concretions; medium acid.

The Landes soils are highly stratified in the upper 3 or 4 feet in colors that range from dark gray (10YR 3/1) to light brownish gray (10YR 6/2). The A horizon and upper part of the C horizon to a depth of 20 inches are typically fine sandy loam, but range from sandy loam to loam. Silt loam textures of the C horizon usually occur at depths of 20 to 40 inches. Thin strata of coarser or finer textured soil material occur in the upper 40 inches in places. Depth to the underlying silty clay loam buried soil is more than 40 inches. The Landes soils in this county contain more clay below a depth of 40 inches that is typical of the Landes series.

Landes soils are associated with Vesser, Coppock, Kennebec, Amana, Nodaway, and Radford soils. They have stratified soil material of higher sand content below the A horizon than Vesser, Coppock, Kennebec, and Amana soils. They have more sand in the solum than Nodaway soils. They are deeper over the dark buried soil and contain more sand than Radford soils.

Landes fine sandy loam, heavy subsoil variant (208).—This soil is on first bottoms adjacent to stream channels of the Chariton River, Soap Creek, and South Soap Creek. Slopes range from 0 to 2 percent and are more undulating than those of other soils on bottom land.

Included with this soil in mapping are small areas of Nodaway soils. Also included are some areas that have the dark silty clay loam buried soil at a depth of 35 to 40 inches. The underlying material commonly has brown mottles, but the color of the mottles varies with the frequency of flooding.

If this soil is protected from overflow, it is suited to growing row crops often. Most of this soil is cultivated, but flooding is a hazard. This soil is low in organic-matter content. Tilth generally is not a problem. This soil warms up quickly and can be worked earlier in spring than soils that have more developed profiles. Except after damaging floods, crops grow well on this soil. Capability unit IIw–1; woodland suitability group 5w2.

Lindley Series

The Lindley series consists of moderately well drained soils in landscape positions that range from the rounded ends of narrow ridgetops to irregular, complex side slopes, on uplands. These soils formed in slightly weathered glacial till under forest vegetation. Slopes range from 14 to 40 percent. These soils generally are downslope from Keswick soils and are adjacent to Mystic or Gara soils. Lindley soils are extensive in the northeastern and south-central parts of the county.

In a representative profile the surface layer is very dark gray loam about 3 inches thick. The subsurface layer is yellowish-brown, friable loam about 5 inches thick. The subsoil, about 36 inches thick, is dominantly yellowish-brown, firm clay loam that is strongly acid and very strongly acid. The underlying material is calcareous and has about the same color and texture as the subsoil.

Lindley soils are subject to erosion if they are cropped. Available water capacity is high, and permeability is moderately slow. Natural fertility is very low. The surface layer is acid unless it has been limed within the last few years. The subsoil is acid, is very low in available phosphorus, is medium to high in available potassium, and is somewhat poorly aerated.

Lindley soils erode readily if cultivated and generally are better suited to pasture or woods than to most other uses. Many cleared areas have been cultivated at one time, but most of these areas have been allowed to revert to permanent vegetation because of very low fertility and the very severe hazard of erosion. Suitable sites for farm ponds are common.

Representative profile of Lindley loam, 18 to 24 percent slopes, on a north-facing side slope where slope is 20 percent; 600 feet north and 1,100 feet east of the southwest corner of the NW¼NE¼ sec. 25, T. 70 N., R. 17 W.

A1—0 to 3 inches, very dark gray (10YR 3/1) loam, grayish brown (10YR 5/2) and light gray (10YR 7/2) when dry, very dark grayish brown (10YR 3/2) when kneaded; moderate, medium, platy structure; friable; neutral; abrupt, smooth boundary.

A2—3 to 8 inches, yellowish-brown (10YR 5/4) loam; few, fine mottles of dark grayish brown (10YR 4/2), very pale brown (10YR 7/3) when dry; weak, medium, platy structure; friable; slightly acid; clear, smooth boundary.

B1—8 to 14 inches, yellowish-brown (10YR 5/4) light clay loam that contains some pebbles; few, medium, faint mottles of strong brown (7.5YR 5/6); weak, fine, subangular blocky structure; friable; very strongly acid; clear, smooth boundary.

B21t—14 to 20 inches, yellowish-brown (10YR 5/6) heavy clay loam; moderate, fine, subangular blocky structure; firm; few thin clay films; very strongly acid; gradual, smooth boundary.

B22t—20 to 24 inches, yellowish-brown (10YR 5/6) medium clay loam; faces of peds yellowish brown (10YR 5/4); moderate, medium, subangular blocky structure; firm; few thin clay films; very strongly acid; gradual, smooth boundary.

B31—24 to 34 inches, yellowish-brown (10YR 5/6) medium clay loam; few, very fine, distinct mottles of light gray (10YR 7/2); weak, medium, subangular blocky structure; firm; few thin clay films; few brown (10YR 4/3) coatings on ped faces; strongly acid; gradual, smooth boundary.

B32—34 to 44 inches, brown (10YR 5/3) light clay loam; few, fine, faint mottles of light brownish gray (10YR 6/2); weak, medium, prismatic structure; firm; few black (N 2/0) organic stains; neutral; gradual, smooth boundary.

C—44 to 60 inches, brown (10YR 5/3) light clay loam; few, fine, faint mottles of light brownish gray (10YR 6/2); massive; firm; few black (N 2/0) organic stains; numerous carbonate concretions; neutral.

In cultivated or eroded areas, the A1 horizon commonly is very dark gray (10YR 3/1) or dark grayish brown (10YR 4/2). The A2 horizon ranges from yellowish brown (10YR 5/4) to pale brown (10YR 6/2) in color and from 4 to 8 inches in thickness. The A1 and A2 horizons range from loam to silt loam that is high in sand. The B2t horizon is dark-brown or brown (10YR 4/3) to yellowish-brown (10YR 5/6) clay loam and has grayish mottles in the lower part. Content of clay in the B2t horizon ranges from 32 to 38 percent, but averages less than 35 percent in the upper 20 inches. The depth to carbonates is about 30 to 48 inches. These soils range from very strongly acid to strongly acid in the most acid part of the solum.

Lindley soils are associated with Keswick, Gara, and Caleb soils. They have less clay in the B2t horizon than Keswick soils, and they do not have the reddish colors typical of Keswick soils. They have a thinner dark-colored A horizon than Gara soils. They have more uniform, finer textures in the lower part of the B horizon than Caleb soils.

Lindley loam, 14 to 18 percent slopes, moderately eroded (65E2).—This soil is most extensive on convex side slopes that are dissected by many small V-shaped drains. It generally is downslope from the moderately sloping and strongly sloping Keswick soils and upslope from the foot slopes or bottom lands.

This soil has a profile similar to that described as representative of the series, but the surface layer is lighter in color and the soil generally does not have a subsurface layer. Part of the surface layer has been removed through erosion, and plowing has mixed the rest with the subsurface layer and part of the subsoil. Included in mapping are a few uneroded areas in forest.

Runoff is very rapid on this soil. Most of the acreage is pastured or wooded. It is better suited to permanent pasture than to most other uses, and it produces fair pasture if managed properly. If this soil is cleared for pasture, it should be seeded as soon as possible after the trees are removed so that severe erosion does not occur. This soil is very low in organic-matter content. Capability unit VIe-1; woodland suitability group 2o1.

Lindley loam, 18 to 24 percent slopes (65F).—This soil is in timbered areas on convex side slopes that are dissected by many small V-shaped drains. They generally are downslope from the moderately sloping and strongly sloping Keswick soils and upslope from the soils of the foot slopes or bottom lands. This soil has the profile described as representative of the series. Free lime or carbonates are closer to the surface than in less sloping Lindley soils.

Most of the acreage is in trees, but a few areas are cleared and are in permanent pasture. This soil is unsuited to row crops because of low yield potential, steep slopes, and a very severe hazard of erosion. It is better suited to permanent pasture or wood crops than to most other uses. The organic-matter content is very low. Capability unit VIIe-1; woodland suitability group 3r1.

Lindley loam, 18 to 24 percent slopes, moderately eroded (65F2).—This soil is on abrupt, steep side slopes. It is downslope from the Weller, Rathbun, and Keswick soils and is upslope from the bottom-land soils. Individual areas are as large as 30 acres, but in most places are smaller.

The surface layer is dark gray in most places and is underlain by a leached, grayish-brown subsurface layer. In a few places the dark-brown to brown clay loam subsoil is exposed on the surface. The subsoil commonly contains lime at a depth of 30 inches.

Most of the acreage is in trees, mostly oak, hickory, and some elm. Some areas are used for very limited grazing, but it generally is not practical to clear the soil and seed pasture. This soil is better suited to wood crops than to most other uses. Capability unit VIIe-1; woodland suitability group 3r1.

Lindley loam, 24 to 40 percent slopes, moderately eroded (65G2).—This soil is most extensive on convex side slopes that are dissected by many small V-shaped drains. It generally is downslope from the strongly sloping Keswick soils and upslope from the soils of the foot slopes or bottom lands.

This soil has a profile similar to that described as representative of the series, but it has a thinner surface layer and less depth to the substratum. This soil has a very dark grayish-brown surface layer about 3 inches thick and a dark grayish-brown subsurface layer about 3 inches thick. The subsoil generally is yellowish-brown clay loam.

Included with this soil in mapping are some noneroded Lindley soils. Also included are a few areas of Gara soils and soils of the Sogn-Gosport-Clanton complex. A few shale or limestone outcrops are indicated by a limestone or shale outcrop symbol on the soil map. Some small severely eroded areas are indicated by a severe erosion spot symbol on the soil map.

Most of the acreage is in trees, but a few areas are in permanent pasture. The steep slopes limit this soil to use as pasture, forest, or wildlife habitat. Capability unit VIIe-1; woodland suitability group 3r1.

Lindley soils, 14 to 18 percent slopes, severely eroded (65E3).—These soils are most extensive on irregular convex side slopes that are dissected by many small V-shaped drains. They generally are downslope from the moderately sloping Keswick soils and upslope from the soils of the foot slopes or bottom lands. Individual areas generally are not large.

These soils have a profile similar to the one described as representative of the series, but erosion has been so severe that in most places the surface layer is firm, brown to yellowish-brown clay loam that is mostly subsoil mixed by tillage with a small amount of the remaining surface and subsurface layers. Many small gullies have formed. In a few areas near waterways or at the base of slopes, the surface layer is a few inches of moderately dark colored loam.

These soils are not suited to row crops because of moderately steep slopes and the severe hazard of further erosion. They are mainly used for permanent pasture or idle areas within cultivated fields. They have a low yield potential, and organic-matter content is very low. They are better suited to permanent pasture or trees than to most other uses. Establishing a stand of either generally is difficult because the soils are in poor tilth and are low in fertility. Tree growth is slow. Capability unit VIIe–2; woodland suitability group 2o1.

Lindley soils, 18 to 24 percent slopes, severely eroded (65F3).—These soils are most extensive on convex side slopes that are dissected by many small V-shaped drains. They are generally downslope from Keswick soils and upslope from soils of the foot slopes or bottom lands. In some areas many small gullies have formed.

These soils have a profile similar to the one described as representative of the series, but the surface layer and the subsoil are thinner. They have a brown to yellowish-brown plow layer that is mostly subsoil mixed with a small amount of the remaining surface layer and subsurface layer. The surface layer ranges from loam to clay loam. The subsoil is exposed in many places.

These soils are chiefly in permanent pasture. A few areas are within cultivated fields and are left idle. These soils are not suited to row crops. The hazard of further erosion is very severe. The soils are better suited to permanent pasture, trees, or wildlife habitat than to most other uses. Establishing a stand of either pasture or trees generally is difficult because the soils are in poor tilth and are low in fertility. These soils are very low in organic-matter content. Capability unit VIIe–2; woodland suitability group 3r1.

Lineville Series

The Lineville series consists of moderately well drained and somewhat poorly drained soils on uplands. These soils formed in leached loess, 10 to 20 inches thick, over water-sorted sediments and weathered glacial till, under forest and grass vegetation. They are underlain by very slowly permeable, clayey materials that are similar to the materials underlying Adair and Clarinda soils. These soils are on the narrow ridgetops upslope from Armstrong soils and downslope from Kniffin and Pershing soils. Slopes range from 2 to 9 percent and are mostly on convex ridgetops. Individual areas generally are small. These soils are adjacent to the larger valleys in most parts of the county.

In a representative profile the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is brown, friable light silty clay loam about 6 inches thick. The subsoil extends to a depth of 60 inches or more. It is mottled brown to grayish-brown, firm clay loam and silty clay loam in the upper part and is mottled brown and yellowish-brown, firm heavy clay loam or clay in the lower part.

Lineville soils erode readily if they are cultivated. Available water capacity is high, and permeability is moderately slow in the upper part of the subsoil and very slow in the lower part. These soils are low in natural fertility. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low to very low in available phosphorus, is very low in available potassium, and is somewhat poorly aerated.

Most of the acreage is in pasture, meadow, or trees, although row crops are moderately well suited. Corn, soybeans, and small grain are the main crops.

Representative profile of Lineville silt loam, 5 to 9 percent slopes, on a southeast-facing ridgetop where the slope is 5 percent; 600 feet south and 220 feet east of the northwest corner of the NE¼ sec. 34, T. 69 N., R. 19 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A2—7 to 13 inches, brown (10YR 5/3) light silty clay loam, pale brown (10YR 6/3) when dry; weak, fine, granular structure; friable; few very dark gray (10YR 3/1) fills in wormholes; slightly acid; gradual, smooth boundary.

IIB21t—13 to 19 inches, brown (10YR 5/3) silty clay loam, pale brown (10YR 6/3) when dry; few, fine, faint mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; friable; few light-gray (10YR 7/2) grainy coatings on ped faces; very few, thin, discontinuous clay films; few, fine, iron-manganese concretions; strongly acid; gradual, smooth boundary.

IIB22t—19 to 25 inches, mottled brown and grayish-brown (10YR 4/3 and 5/2) clay loam; few, fine, faint mottles of dark yellowish brown (10YR 4/4); moderate, medium, subangular blocky structure; firm; common light-gray (10YR 7/2) grainy coatings on ped faces; few discontinuous dark grayish-brown (10YR 4/2) clay films; few, fine, iron-manganese concretions; increase in sand content in this horizon; strongly acid; clear, smooth boundary.

IIB23t—25 to 29 inches, grayish-brown (2.5Y 5/2) light clay loam; common, fine and medium, distinct mottles of dark yellowish brown (10YR 4/4) and few, medium, distinct mottles of gray to light gray (10YR 6/1); moderate, medium, subangular blocky structure; firm; thin continuous clay films; few, fine, iron-manganese concretions; medium acid; gradual, smooth boundary.

IIB24t—29 to 39 inches, mottled yellowish-brown (10YR 5/6) and grayish-brown (10YR 5/2) light clay loam; common, fine and medium mottles of strong brown (7.5YR 5/6 and 5/8) and dark yellowish brown (10YR 4/4); weak, fine, subangular blocky structure; light-gray (10YR 7/1) dry grainy silt coatings; slightly firm; thin discontinuous clay films; few iron-manganese concretions; medium acid; abrupt, smooth boundary.

IIIB25t—39 to 46 inches, strong-brown (7.5YR 5/6) clay; few, fine, distinct mottles of dark red (10R 3/6) and reddish brown (5YR 4/4) and few, fine, faint mottles of light brownish gray (2.5Y 6/2); weak, fine, subangular blocky structure; very firm; thin discontinuous clay films; few, fine, iron-manganese concretions; medium acid; gradual, smooth boundary.

IIIB2tt—46 to 60 inches, yellowish-brown (10YR 5/6) heavy clay; few, fine, faint mottles of grayish brown (10YR 5/2) and strong brown (7.5YR 5/6) and common, fine, distinct mottles of dark red (10R 3/6); weak, fine, subangular blocky structure; very firm; few fine black (10YR 2/1) streaks; few discontinuous clay films; slightly acid.

The A1 or Ap horizon ranges from very dark brown (10YR 2/2) to very dark gray (10YR 3/1) in color and from 6 to 9 inches in thickness. The A2 horizon ranges from 3 to 6 inches in thickness and from dark grayish brown (10YR 4/2) to brown (10YR 5/3). The IIB21t horizon ranges from dark brown or brown (10YR 4/3) to dark grayish brown (10YR 4/2). It has a maximum accumulation of clay of 28 to 35 percent and is 30 to 40 percent fine and medium sand. The upper part of the IIB22t horizon ranges from grayish brown (2.5Y 5/2) to strong brown (7.5YR 5/6). The IIB horizon ranges from 18 to 30 inches in thickness. The IIIB horizon is at a depth of 24 to 50 inches and is 35 to 50 percent clay. The B horizon ranges from medium acid to strongly acid in the most acid part and no carbonates are within a depth of 60 inches.

Lineville soils are associated with Armstrong, Kniffin, Pershing and Lineville dark variant soils. They are less clayey and are more permeable in the upper part of the B horizon than Armstrong soils. They contain more sand in the lower part of the B horizon than Kniffin and Pershing soils.

Lineville silt loam, 2 to 5 percent slopes (452B).—This soil is on rounded ridgetops. Upslope from this soil, toward the broader ridgetops, are areas of Kniffin and Pershing soils. Downslope are moderately sloping Armstrong soils. Most areas of this soil are small.

The surface layer is very dark gray over a thin subsurface layer that is nearly gray when it dries. The upper part of the subsoil is clay loam. A reddish clayey material that is similar to the subsoil of Armstrong soils is at a depth of 30 to 48 inches.

Much of this soil is in pasture, although row crops are moderately suited under good management. Water runs off rapidly and causes erosion in cultivated fields unless they are tilled on the contour. This soil generally has a perched water table near the surface in wet seasons. This soil contains only a medium amount of organic matter. Capability unit IIIe-3; woodland suitability group 5c1.

Lineville silt loam, 5 to 9 percent slopes (452C).—This soil is mostly on rounded ridgetops. Upslope from this soil, toward the broader ridgetops, are areas of Kniffin and Seymour soils. Downslope are moderately sloping Armstrong soils. Most areas of this soil are small. This soil has the profile described as representative of the series.

Included with this soil in mapping are areas of a soil in which the clayey underlying layer is at a depth of 24 to 42 inches and is very slowly permeable. Also included are a few small moderately eroded areas.

Much of this soil is in pasture. Row crops are moderately suited if this soil is terraced. Generally a perched water table is near the surface in wet seasons. The silty surface layer is medium in organic-matter content. This soil is medium acid to strongly acid and needs additions of lime. Capability unit IIIe-4; woodland suitability group 5c1.

Lineville silt loam, 5 to 9 percent slopes, moderately eroded (452C2).—This soil is mostly on rounded ridgetops. The total acreage is small, and individual areas are generally small.

This soil has a profile similar to the one described as representative of the series, but part of the original surface layer has been removed through erosion. The surface layer is very dark gray to very dark grayish-brown silt loam 3 to 6 inches thick. In many places the thin, grayish to brownish subsurface layer has been mixed with the surface layer through tillage and the plow layer is noticeably lighter colored when dry. The surface layer is light silty clay loam in a few eroded areas near drainageways.

Much of this soil is cropped, and the rest is wooded or pastured. It is moderately suited to row crops. The surface layer generally is in poor tilth and is low in organic-matter content. This soil generally has a perched water table near the surface in wet seasons. After heavy rains the surface tends to crust. Capability unit IIIe-4; woodland suitability group 5c1.

Lineville Variant

The Lineville variant consists of somewhat poorly drained soils on uplands. These soils formed under prairie vegetation in water-sorted sediments over previously weathered glacial till. They are on sloping ridgetops and upper parts of side slopes downslope from Seymour or Grundy soils and upslope from Lamoni or Clarinda soils. They are most extensive near the broad divides in the west-central part of the county.

In a representative profile the surface layer is very dark gray silt loam and light silty clay loam about 11 inches thick. The subsoil extends to a depth of 60 inches or more. The upper part is dark grayish-brown, friable silty clay loam; the middle part is dark grayish-brown to yellowish-brown, firm silty clay loam that contains more sand than the upper part; and below a depth of 56 inches is mottled gray silty clay.

The hazard of erosion is the main limitation to use and management of these soils. Available water capacity is high, and permeability is moderately slow. These soils are low in natural fertility. The surface layer is acid unless it has been limed within the last few years. The subsoil is acid, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

These soils are suitable for occasional corn or soybean crops. Individual areas generally are too narrow and irregular in shape or too small in size to be managed separately, but they should be considered when managing areas that include them.

Representative profile of Lineville silt loam, dark variant, 5 to 9 percent slopes, 225 feet north and 300 feet east of the southwest corner of the NW¼NW¼ sec. 27, T. 69 N., R. 18 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam; few, fine, faint mottles of dark brown to brown (7.5YR 4/4) and gray (10YR 5/1) to grayish brown (10YR 5/2) when dry; weak, fine, granular structure; friable; common roots; medium acid; abrupt, smooth boundary.

A3—7 to 11 inches, very dark gray (10YR 3/1) light silty clay loam, grayish brown (10YR 5/2) when dry; moderate, fine, granular structure; friable; common roots and pores; few sand grains; medium acid; clear, smooth boundary.

B1—11 to 17 inches, dark grayish-brown (10YR 4/2) silty clay loam; few, fine, faint mottles of yellowish brown (10YR 5/6), brown (10YR 5/3) when dry; moderate, very fine, subangular blocky structure; friable; common pores and roots; thin grainy ped coatings when dry; medium acid; clear, smooth boundary.

IIB21t—17 to 23 inches, yellowish-brown (10YR 5/4) silty clay loam high in content of sand; common, fine, faint mottles of yellowish brown (10YR 5/6 and 5/8), light brownish gray (10YR 6/2) when dry; moderate, fine, subangular blocky structure; firm; thin discontinuous clay films on peds; common fine pores; few fine concretions and soft oxides; nearly continuous grainy ped coatings when dry; medium acid; clear, smooth boundary.

IIB22t—23 to 27 inches, yellowish-brown (10YR 5/4) silty clay loam high in content of sand; faces of peds grayish brown (10YR 5/2); common, fine, faint mottles of dark brown to brown (7.5YR 4/4) and strong brown (7.5YR 5/6); weak, coarse, prismatic structure breaking to moderate, fine to medium, subangular blocky; firm; few, thin, discontinuous clay films on peds; continuous light-gray (10YR 7/2) grainy ped coatings when dry; few fine concretions and soft oxides; slightly acid; gradual, smooth boundary.

IIB23t—27 to 33 inches, yellowish-brown (10YR 5/4 and 5/6) clay loam; faces of peds gray (10YR 5/1) and dark gray (10YR 4/1); common, fine, faint mottles of dark brown to brown (7.5YR 4/4) and yellowish brown (10YR 5/6); weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; firm; few, thin, discontinuous clay films; few small pebbles; few fine soft oxides; discontinuous light-gray (10YR 7/1) grainy ped coatings when dry; slightly acid; gradual, smooth boundary.

IIB24t—33 to 42 inches, yellowish-brown (10YR 5/4 and 5/6) silty clay loam high in content of sand; faces of peds gray (10YR 5/1); common, fine, faint mottles of dark brown to brown (7.5YR 4/4) and strong brown (7.5YR 5/6); weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; firm; few small pebbles; few soft oxides; some discontinuous light-gray (10YR 7/2) ped coatings when dry; neutral; gradual, smooth boundary.

IIB31t—42 to 50 inches, mottled gray (5Y 5/1), yellowish-brown (10YR 5/4 and 5/6), and dark-brown to brown (7.5YR 4/4) heavy silty clay loam high in content of sand; weak, medium, subangular blocky to massive; firm; black (10YR 2/1) organic coatings in root channels; few grainy coatings when dry; neutral; gradual, smooth boundary.

IIB32t—50 to 56 inches, mottled gray (5Y 5/1) to light-gray (10YR 6/1), yellowish-brown (10YR 5/4 and 5/6), and brown (7.5YR 5/4) heavy silty clay loam high in content of sand; weak, medium, subangular blocky structure; firm; black (10YR 2/1) organic coatings in root channels; few grainy ped coatings when dry; neutral; gradual, smooth boundary.

IIIB33t—56 to 65 inches, mottled gray (5Y 5/1), light-gray (10YR 6/1), and yellowish-brown (10YR 5/6 and 5/8) silty clay; weak, medium, prismatic structure breaking to moderate, medium, subangular blocky; very firm; organic clay films on peds and in channels; few fine and medium sand grains; fine, generally rounded black concretions; neutral.

The Al or Ap horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) and is dominantly silt loam, but ranges to clay loam in places. The B horizon is mottled and ranges from gray to dark grayish brown or yellowish brown. The average clay content in the upper 20 inches of the B horizon is less than 35 percent. A mottled gray silty clay horizon is at a depth generally of more than 48 inches.

Lineville soils, dark variant, are associated with Seymour, Grundy, Clarinda, Lamoni, and Lineville soils. They differ from Seymour, Grundy, Clarinda, and Lamoni soils in having a grayish-brown clay loam B horizon. They do not have the grayish A2 horizon that is typical of Lineville soils.

Lineville silt loam, dark variant, 5 to 9 percent slopes (752C).—This soil generally is on ridgetops downslope from and adjacent to Seymour soils. This soil is most extensive near the broad divides in the west-central part of the county.

This soil has a profile similar to the one described as representative of the series, but it has a thicker, darker surface layer, a less acid surface layer and subsoil, and the depth to weathered glacial till of clay texture is typically greater. The surface layer is very dark gray silt loam about 11 inches thick. The subsoil, to a depth of 17 inches, is dark grayish-brown silty clay loam. Below a depth of 17 inches is dark grayish-brown to yellowish-brown silty clay loam that contains more sand than the upper 6 inches of the subsoil. Below a depth of 56 inches is mottled gray silty clay. Included in mapping are many small areas of Clarinda soils that make up about 20 percent of the total area.

The hazard of erosion is the main limitation to use and management of this soil. This soil is medium in organic-matter content. Capability unit IIIe–4; woodland suitability group 5c1.

Lineville silt loam, dark variant, 5 to 9 percent slopes, moderately eroded (752C2).—This soil is on the upper parts of side slopes downslope from Seymour soils in the west-central part of the county.

This soil has a profile similar to the one described as representative of the series, but it has a darker, thicker surface layer, is less acid, and does not have the light-colored subsurface layer that is typical of Lineville soils. Part of the original surface layer has been removed through erosion. The remaining surface layer is very dark grayish-brown silt loam about 8 inches thick. The subsoil is silty clay loam that is high in content of sand. At a depth of 40 to 60 inches is mottled gray clay or silty clay. Included in mapping are many small areas of Clarinda soils that make up about 20 percent of the total area. A few severely eroded spots are indicated by a special symbol on the soil map.

The hazard of further erosion is the main limitation to use and management of this soil. Capability unit IIIe–4; woodland suitability group 5c1.

Marsh

Marsh (354) consists of depressions covered by 1 to 3 feet of water during part of the year. Most areas are oxbows or old depressed stream channels of the Chariton River or its tributaries. In summer or during periods of low rainfall, the water area decreases in size or disappears. Dense swamp vegetation grows around the perimeter of the Marsh. Cattails and swampgrasses are dominant where water is shallow. These areas are periodically flooded.

The basin of the depressions is dark-colored silty or clayey alluvial sediment. Around the rim of the depression, the surface layer is 6 to 18 inches of muck or partly decayed plant residue.

Marsh is not artificially drained. In places open ditches outlet into the Marsh. This Marsh land is well suited to wildlife habitat. Capability unit VIIw-1; not assigned to a woodland suitability group.

Mystic Series

The Mystic series consists of somewhat poorly drained soils that formed in water-sorted glacial sediments under grass and forest vegetation. These moderately fine to fine textured sediments were deposited as alluvium during an earlier geologic period. The soils may have been partly buried by loess at one time, but were later exposed by geologic erosion. They generally do not have a stone line in the solum. They are in major stream valleys throughout the county. Slopes range from 5 to 18 percent.

In a representative profile the surface layer is very dark grayish-brown silt loam about 6 inches thick. The subsurface layer is dark grayish-brown, friable silt loam about 4 inches thick. The subsoil, about 35 inches thick, is dark grayish-brown and dark-brown to strong-brown and reddish-brown, friable or firm silty clay loam, clay, and clay loam that in most places is mottled with shades of brown. The substratum is brown and light brownish-gray clay loam.

Mystic soils are seasonally wet and seepy and are susceptible to erosion if cultivated. Available water capacity is high, and permeability is very slow. Natural fertility is low to very low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus and potassium, and is somewhat poorly aerated.

A large acreage of Mystic soils is used for pasture, but less sloping areas are cultivated. These soils are severely eroded in places and are difficult to manage. Suitable sites for dams are difficult to locate because the seepage potential from the stratified underlying material is high.

Representative profile of Mystic silt loam, 5 to 9 percent slopes, moderately eroded, on a ridgetop where the slope is 7 percent; 550 feet south and 150 feet east of the northwest corner of sec. 27, T. 70 N., R. 16 W.

Ap—0 to 6 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry, very dark grayish brown (10YR 3/2) when kneaded; weak, fine, granular structure; friable; slightly acid; clear, smooth boundary.

A2—6 to 10 inches, dark grayish-brown (10YR 4/2) silt loam; few fine, faint mottles of yellowish brown (10YR 5/4) that are grayish brown (10YR 5/2) and pale brown (10YR 6/3) when dry; moderate, fine, subangular blocky and granular structure; friable; common light brownish-gray (10YR 6/2) grainy ped coatings; slightly acid; clear, smooth boundary.

B1—10 to 13 inches, dark grayish-brown (10YR 4/2) light silty clay loam; few, fine, faint mottles of very dark grayish brown (10YR 3/2) and strong brown (7.5YR 5/6); moderate, fine, subangular blocky structure; friable; few light-gray (10YR 7/2) grainy ped coatings; medium acid; clear, smooth boundary.

B21t—13 to 20 inches, brown (7.5YR 4/2) and reddish-brown (5YR 4/4) clay; few, fine, distinct mottles of reddish brown (5YR 4/4); moderate to strong, fine, subangular blocky structure; firm; few, thin, discontinuous clay films; strongly acid; clear, smooth boundary.

B22t—20 to 26 inches, strong-brown (7.5YR 5/6) and grayish-brown (2.5Y 5/2) clay; few, fine, distinct mottles of red (2.5YR 4/6); moderate, fine, subangular blocky structure; firm; few, thin, discontinuous clay films on ped faces and in root channels; medium acid; gradual, smooth boundary.

B23t—26 to 34 inches, brown (7.5YR 4/4) and grayish-brown (2.5Y 5/2) heavy clay loam; few, medium, faint mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; few, thin, discontinuous clay films on ped faces and in root channels; medium acid; gradual, smooth boundary.

B3t—34 to 45 inches, brown (7.5YR 4/4) and light brownish-gray (2.5Y 6/2) light to medium clay loam; few, medium, faint mottles of strong brown (7.5YR 5/6); weak, medium, subangular blocky structure; firm; dark-gray (5Y 4/1) clay deposits in root channels; medium acid; gradual, smooth boundary.

C—45 to 65 inches, brown (7.5YR 4/4) and light brownish-gray (2.5Y 6/2) light to medium clay loam; few, medium, faint mottles of strong brown (7.5YR 5/6); weak, medium, prismatic structure to massive; firm; dark-gray (5Y 4/1) clay deposits in root channels; slightly acid.

The A1 or Ap horizon ranges from very dark gray (10YR 3/1) to very dark brown (10YR 2/2) and from 6 to 10 inches in thickness. It is mostly silt loam, but ranges from loam to light clay loam. The A2 horizon ranges from dark grayish brown (10YR 4/2) to dark brown or brown (7.5YR 4/2) and from 3 to 6 inches in thickness. The B2t horizon typically is dark reddish brown (5YR 3/4) to brown (7.5YR 5/4) and ranges from heavy clay loam to clay. In the B3 and C horizons the clay content is extremely variable; it ranges from fine sandy loam to clay loam within short distances. Reaction ranges from medium acid to very strongly acid in the most acid part of the solum. Carbonates are leached to a depth of 6 to 8 feet or more.

Mystic soils are associated with Adair, Armstrong, and Keswick soils, and are closely associated with Caleb soils. They have a more variable texture in the lower part of the B horizon than Adair, Armstrong, and Keswick soils, and they do not have the prominent stone line characteristic of those soils. They are finer textured and more reddish in the B horizon than Caleb soils.

Mystic silt loam, 5 to 9 percent slopes, moderately eroded (592C2).—In many places this soil is near the ends of ridgetops. It extends down onto the high stream benches and is generally at lower elevations than other soils on surrounding ridges. Because of its position on the landscape, each area generally is less than 8 acres in size.

This soil has the profile described as representative of the series. Because the subsoil is firm, contains a large amount of clay, and takes in water slowly, runoff is rapid and the hazard of erosion is severe. In some places plowing mixes the clayey subsoil with the surface layer. Included in mapping are some areas where the surface layer is thicker than in the profile described.

This soil is moderately suited to row crops, but is better suited to hay and pasture. It is low in organic-matter content. Unless erosion is controlled, tilth and fertility of the surface layer continue to deteriorate as increasing amounts of subsoil are mixed into the plow layer. This soil receives varying amounts of seepage from the underlying material, but artificial drainage is not practical in most places. Areas in row crops generally are farmed along with upslope soils. Capability unit IIIe–5; woodland suitability group 5c1.

Mystic silt loam, 9 to 14 percent slopes, moderately eroded (592D2).—This soil is on the sides of high bench terraces along the larger streams in the county. In a few places where large benches have not formed, it is adjacent to the Gara or Shelby soils upslope.

Included with this soil in mapping are areas that have a dark surface layer about 9 inches thick. Plowing has mixed the surface layer and subsurface layer over much of the acreage, and in places the subsoil is exposed.

Because runoff is rapid and the hazard of further erosion is severe, much of the acreage is used for permanent pasture or hay. If this soil is used for row crops regularly, it erodes excessively. Unless further erosion is controlled, tilth and fertility of the surface layer become even more unfavorable. If tilled too wet, this soil becomes hard and cloddy when dry. It is low in organic-matter content. It receives varying amounts of seepage, but in most places artificial drainage is not practical. Capability unit IVe–2; woodland suitability group 5c1.

Mystic soils, 5 to 9 percent slopes, severely eroded (592C3).—These soils are above the soils on foot slopes and bottom land and below the Pershing and Weller soils on high benches.

These soils have a profile similar to that described as representative of the series, but the surface layer is thinner and ranges from silt loam to clay within short distances, depending on the degree of erosion. The plow layer is less than 3 inches of the surface layer and subsurface layer mixed with part of the subsoil. Small rills and gullies are common, and in places all of the surface layer has been lost through erosion and the clayey subsoil is exposed.

Because these soils are poorly suited to row crops, much of the acreage is used for permanent pasture. Seeded pasture is difficult to establish because the surface layer is in poor tilth and is low in fertility. The surface layer becomes hard and cloddy when dry. The soils are very low in organic-matter content. Unless they are covered with dense vegetation, gullies form readily. Capability unit IIIe–5; woodland suitability group 5c1.

Mystic soils, 9 to 14 percent slopes, severely eroded (592D3).—These soils are on the sides of high bench terraces along the larger streams in the county.

These soils have a profile similar to that described as representative of the series, but in most places the surface layer is thinner. The surface layer ranges from silt loam to clay within short distances. Where erosion is more severe, it is clay loam or clay. The soil has no subsurface layer. Part of what was once the subsoil has been mixed with the surface layer through plowing. Small rills and gullies are common along drainageways.

These soils are suited to permanent pasture or hay. The carrying capacity of pasture is low, however, and controlled grazing is needed. The surface layer is in poor tilth and is very low in fertility. For this reason, a good seeded pasture is difficult to establish. The surface layer becomes hard and cloddy when dry. It tends to seal over during rains, which reduces infiltration and increases runoff. Unless these soils are protected by dense vegetation, gullies form readily. Capability unit VIe–3; woodland suitability group 5c1.

Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded (94D2).—This mapping unit is on the sides of high bench terraces along the larger streams of the county. It is about 60 percent Mystic soil and 40 percent Caleb soil. These soils are generally downslope from the Pershing and other Mystic soils and upslope from the soils of the foot slopes and bottom land. In many places the Mystic soil is at higher elevations than the Caleb soil.

The surface layer ranges from loam to clay loam except in a few eroded spots where clay is exposed at the surface. The subsoil of the Mystic soil is typically reddish-brown silty clay, and the subsoil of the Caleb soil is yellowish-brown clay loam.

Included with these soils in mapping are a few severely eroded areas, some short steep slopes, and a few small areas that are largely Caleb soils.

These soils are best suited to hay and pasture. If erosion is controlled and fertility is improved, they are moderately suited to row crops. The tilth of the surface layer is somewhat unfavorable. The soils receive varying amounts of seepage, but in most places artificial drainage is not practical. Capability unit IVe–2; woodland suitability group 5c1.

Mystic-Caleb complex, 9 to 14 percent slopes, severely eroded (94D3).—This mapping unit is on the sides of high bench terraces along the larger streams in the county. It is about 60 percent Mystic soil and 40 percent Caleb soil. These soils are generally downslope from the Pershing and other Mystic soils and upslope from the soils of the foot slopes and bottom land. In many places the Mystic soil is at slightly higher elevations than the Caleb soil.

These soils have profiles similar to those described as representative of their respective series, but the surface layer is thinner. The surface layer is less than 3 inches of the original surface layer and subsurface layer mixed with part of the original subsoil through plowing. Small rills and gullies have formed in places.

These Mystic and Caleb soils are suited to limited grazing, woodland, and wildlife habitat. They are not suited to row crops. Because the surface layer is in poor tilth and is low in fertility, seeded pasture is very difficult to establish. The soils are very low in organic-matter content. They receive varying amounts of seepage, but in most places artificial drainage is not practical. Capability unit VIe–3; woodland suitability group 5c1.

Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded (94E2).—This mapping unit is on the sides of high bench terraces along the larger streams of the county. It is about 60 percent Mystic soil and 40 percent Caleb soil. These soils are generally downslope from other Mystic soils and upslope from soils on the foot slopes and bottom land (fig. 12).

In many places the plow layer is the surface layer and part of the original subsoil. The clay or clay loam subsoil is exposed near drainageways and short slopes.

***Figure 12.*—Typical landscape of Mystic and Caleb soils. Trees in background are on Lindley soils.**

Included with these soils in mapping are some severely eroded areas, some steep slopes, and a few small areas of Caleb soils.

These soils are used for pasture, woodland, range, and wildlife. Because the hazard of further erosion is very severe, they are not suitable for cultivation. The surface layer is in poor tilth and is low in fertility, and seeded pasture is therefore difficult to establish. The soils receive varying amounts of seepage, but in most places artificial drainage is not practical. Organic-matter content is low. Capability unit VIe–2; woodland suitability group 5c1.

Mystic-Caleb complex, 14 to 18 percent slopes, severely eroded (94E3).—This mapping unit is on the sides of high bench terraces along the larger streams of the county. It is about 60 percent Mystic soil and 40 percent Caleb soil. In many places the Mystic soil is at slightly higher elevations than the Caleb soil and has a more clayey subsoil. These soils are downslope from Pershing and other Mystic soils.

These soils have profiles similar to those described as representative of their respective series, but the surface layer is thinner. Erosion has removed all or most of the original surface layer. In much of the area the present surface layer is less than 3 inches of the original surface and subsurface layer mixed with part of the subsoil through plowing. The surface layer ranges from loam to clay. The surface layer of Mystic soils is commonly clayey in rills or gullies.

Included with these soils in mapping are a few short steep slopes and some areas that are mostly Caleb soils.

Most of the acreage is in permanent pasture, but many pastures are not productive. The surface layer is in poor tilth. It becomes hard and cloddy when dry and tends to seal over during rains, which reduces infiltration and increases runoff. It is also very low in organic-matter content. Good seeded pasture is difficult to establish. Unless these soils are protected by dense vegetation, gullies form readily. Capability unit VIIe–2; woodland suitability group 5c1.

Nodaway Series

The Nodaway series consists of moderately well drained soils that are on both narrow and wide first bottoms near the main channel of streams. These soils formed in stratified silty alluvium. Floods deposit fresh sediments on the surface. Some areas are dissected by meandering old stream channels.

In a representative profile the surface layer is dark grayish-brown silt loam 13 inches thick. The substratum to a depth of 60 inches or more is variable thin strata of very dark gray, grayish-brown, and brown, friable light silty clay loam or silt loam. Thin strata of fine sand are in places.

Nodaway soils are subject to flooding. Available water capacity is high, and permeability is moderate. Natural fertility is medium. The surface layer is neutral and does not need additions of lime. The subsoil is neutral, is medium in available phosphorus and potassium, and is moderately well aerated.

Except for those Nodaway soils that are mapped in a complex with Alluvial land, these soils can be used intensively for row crops and are productive if protected from overflow. Nodaway soils in the Alluvial land complex are frequently flooded, include old stream channels, and in most places support a dense stand of trees.

Representative profile of Nodaway silt loam, 550 feet south and 1,350 feet east of the northwest corner of sec. 7, T. 67 N., R. 17 W.

A—0 to 13 inches, dark grayish-brown (10YR 4/2) silt loam, grayish brown (10YR 5/2) when dry; moderate, fine, granular structure; friable; neutral; gradual, smooth boundary.

C1—13 to 20 inches, stratified very dark gray (10YR 3/1), dark grayish-brown (10YR 4/2), and grayish-brown (10YR 5/2) silt loam, grayish brown (10YR 5/2) when dry; massive with some horizontal cleavage; friable; neutral; gradual, smooth boundary.

C2—20 to 60 inches, stratified dark grayish-brown (10YR 4/2), very dark gray (10YR 3/1), grayish-brown (10YR 5/2), and brown (10YR 4/3) silt loam, grayish brown (10YR 5/2) when dry; massive with some horizontal cleavage; friable, the thin brown layers are sandy loam; neutral.

The A horizon ranges from dark gray (10YR 4/1) to dark grayish brown (10YR 4/2). In some cultivated areas the A horizon is very dark grayish-brown (10YR 3/2) silt loam about 6 inches thick. The profile is silt loam to a depth of 40 to 60 inches. The bulk texture to this depth is less than 15 percent fine or medium sand. Some platy structure and narrow layers, or lenses, of light colored silt or fine sand are in most places due to stratification of the relatively recent deposits of material. If mottles occur, they are at a depth of 10 to 24 inches and are few, fine, and faint. Their occurrence depends on the frequency and duration of flooding. The reaction of the solum ranges from slightly acid to neutral.

Nodaway soils are associated with Colo, Chequest, Landes, and Radford soils. They are not so fine textured as Colo and Chequest soils and are better drained. They have less sand in the solum than Landes soils. They do not have the buried dark-colored silty clay loam horizon at about 24 inches that is typical of Radford soils.

Nodaway silt loam (0 to 2 percent slopes) (220).—This soil is on first bottoms of the smaller streams in the county. Slopes are more undulating than those of some other soils on bottom land. These undulating slopes commonly are remnants of old meandering streams. In places a large permanent stream dissects areas of Nodaway soils or runs parallel to their boundary.

This soil has the profile described as representative of the series. It is friable and shows little development of horizons.

Included with this soil in mapping are a few areas that have a dark buried soil below a depth of 40 inches. Their subsoil is not mottled in most places, but the amount and color of mottles vary with the frequency of flooding. Also included are some slightly lower areas of soils that have a darker colored surface layer.

This soil is well suited to row crops. Most of the acreage is cultivated, but occasional flooding is a hazard. Pasture and forest are flooded more frequently than cultivated fields because they are generally next to the main stream channel. Instead of artificial drainage, protection from overflow is needed. Tilth generally is not a problem. This soil is low to medium in organic-matter content. It warms up quickly and can be worked early in spring. Capability unit I–1; woodland suitability group 5w2.

Nodaway-Alluvial land complex (0 to 2 percent slopes) (315).—This mapping unit is adjacent to meandering stream channels of the major streams in the county. Slopes are more undulating than those of other bottom-land soils. The area is dissected by many old stream channels and bayous, some of which are filled with water at least part of the year.

The Nodaway soil has a profile similar to the one described as representative of the Nodaway series, but it is more stratified. The Alluvial land is dominantly loamy, dark-colored, recently deposited alluvial sediments of meandering stream channels and bayous. Texture ranges from loamy sand to silty clay within short distances. Nodaway soils make up about 65 percent of the complex and Alluvial land the rest.

This mapping unit is subject to frequent flooding. In most places it supports a thick stand of trees. A few areas are cropped, but most of the acreage is used for permanent pasture or forest. Generally it is not practical to use this complex for crops because trees must be cleared, channels straightened or filled, and dikes built or drainage ditches dug. Yields of row crops vary greatly unless overflow is controlled. If trees and shrubs are removed, the carrying capacity of pasture is high. Capability unit Vw–1; woodland suitability group 5w2.

Olmitz Series

The Olmitz series consists of moderately well drained, loamy soils on the foot slopes. These soils formed in loamy material that washed from adjoining slopes. The native vegetation was prairie grasses. In many places these soils are on slightly concave foot slopes between soils on the bottom lands and the steeper till-derived soils on hillsides. They are not, however, in a continuous band. These soils are also on alluvial fans. They are in all parts of the county, and individual areas range from 3 to 20 acres in size. Slopes range from 2 to 5 percent.

In a representative profile the surface layer, about 30 inches thick, is black to very dark gray loam in the upper part and very dark grayish-brown clay loam in the lower part. The subsoil extends to a depth of 5 feet or more. It is very dark grayish-brown, friable clay loam that grades to dark grayish brown with increasing depth.

Olmitz soils receive runoff and some overwash from uplands. Available water capacity is high, and permeability is moderate. Natural fertility is medium to high. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is medium in available phosphorus and potassium, and is moderately well aerated. These soils are subject to erosion.

These soils commonly are in small areas and are managed along with soils on the steeper uplands as pasture. They are suited to intensive row cropping.

Representative profile of Olmitz loam, 2 to 5 percent slopes, on a foot slope where slope is 5 percent; 720 feet east and 90 feet south of the northwest corner of the SE¼ sec. 14, T. 68 N., R. 17 W.

A1—0 to 8 inches, black (10YR 2/1) loam, dark gray (10YR 4/1) when dry; moderate, fine, granular structure; friable; neutral; gradual, smooth boundary.

A12—8 to 16 inches, black (10YR 2/1) loam, dark gray (10YR 4/1) when dry; moderate, fine, granular structure; friable; slightly acid; gradual, smooth boundary.

A13—16 to 22 inches, black (10YR 2/1) to very dark gray (10YR 3/1) heavy loam, dark gray (10YR 4/1) to gray (10YR 5/1) when dry; weak, very fine, subangular blocky structure; friable; medium acid; gradual, smooth boundary.

A3—22 to 30 inches, dark-brown (10YR 3/3) light clay loam; faces of peds are very dark grayish brown (10YR 3/2); weak, very fine, subangular blocky structure; friable; few grainy ped coatings; medium acid; gradual, smooth boundary.

B2—30 to 38 inches, very dark grayish-brown (10YR 3/2) and dark grayish-brown (10YR 4/2) clay loam; weak, fine, subangular blocky structure; friable; few grainy ped coatings in upper part; few, fine, dark-brown (7.5YR 3/2) and yellowish-brown (10YR 5/4) soft oxides; slightly acid; gradual, smooth boundary.

B3—38 to 60 inches, dark grayish-brown (10YR 4/2) to brown (10YR 4/3) clay loam; weak, fine, subangular blocky structure; friable; few fine dark-brown (7.5YR 3/2) and yellowish-brown (10YR 5/6) soft oxides; neutral.

The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in color and from 24 to 36 inches in thickness. The B horizon ranges from very dark grayish brown (10YR 3/2) to dark yellowish brown (10YR 4/4) light to medium clay loam. Mottles, where present, are in the B horizon and are few, fine, faint, and yellowish brown (10YR 5/6), dark yellowish brown (10YR 4/4), or strong brown (7.5YR 5/6). Reaction in the solum ranges from neutral to strongly acid. Glacial till of clay loam texture is below a depth of 40 inches.

Olmitz soils are associated with Colo and Vesser soils. They contain less clay and more sand than Colo and Vesser soils and are better drained. They do not have an A2 horizon that is typical of Vesser soils.

Olmitz loam, 2 to 5 percent slopes (273B).—This soil is generally on foot slopes downslope from Gara and Shelby soils or near the mouth of upland drainageways (fig. 13). Variations in texture occur in places because of the different kinds of sediment deposited rather than from profile development.

Figure 13. **Typical landscape of gently sloping Olmitz soils.**

This soil has the profile described as representative of the series. The surface layer is thick and is black to very dark grayish-brown loam. Its color depends on the amount and source of the recently deposited sediments. It is mostly loam, but ranges to light clay loam in places.

Included with this soil in mapping are a few areas that have recent deposits of loamy sediments. Also included are some small areas that have a sandy surface layer. These are indicated by a sand spot symbol on the soil map.

Many areas of this soil are cultivated along with the soils on adjoining bottom lands. Diversion terraces are needed in places to reduce the hazard of sheet erosion by diverting runoff from higher areas. If it is tilled on the contour, this soil is well suited to intensive row cropping. Tilth generally is good, and crops generally grow well. This soil has a high organic-matter content, but additions of lime are needed. Capability unit IIe–2; woodland suitability group 2o1.

Olmitz-Vesser-Colo complex, 2 to 5 percent slopes (13B).—This mapping unit is along narrow drainageways and near gently sloping to steep soils of the upland that were derived from till. This mapping unit occurs throughout the county.

Olmitz loam, Vesser silt loam, and Colo silty clay loam are the dominant soils. Olmitz soils make up about 40 percent of the area, Vesser soils 30 percent, and Colo soils 30 percent. Along the narrow drainageways, the Colo soils are adjacent to streams, and the Olmitz soils are in fairly uniform bands at the base of upland side slopes. Vesser soils are generally at the upper ends of drainageways in the more gently sloping areas. Included in mapping are small entrenched drainageways that carry water part of the year.

These soils are well suited to pasture if they are protected from gullying. They are well suited to intensive row cropping if gullying is prevented and drainage is provided. These soils are subject to flooding and are moderately well drained to poorly drained. Diversion terraces can be used to control runoff from the uplands, and most areas can be drained by tile. Grassed waterways are needed in gullied areas. Capability unit IIw–1; woodland suitability group 5w3.

Pershing Series

The Pershing series consists of somewhat poorly drained to moderately well drained soils on uplands in the north-central parts of the county. These soils formed in leached loess 48 to 96 inches thick over a buried, very slowly permeable, gray clayey soil. In some places these soils are on benches along major streams and are underlain by stratified alluvium. The native vegetation was a mixture of grass and trees. Slopes range from 2 to 9 percent and are mostly short and convex. These soils are upslope from Armstrong, Clarinda, and Gara soils. The landscape of Pershing soils is similar to that of Grundy and Weller soils. Individual areas range from 3 to 25 acres in size.

In a representative profile the surface layer is very dark gray silt loam about 7 inches thick. The subsurface layer is dark grayish-brown or grayish-brown, friable silty clay loam about 7 inches thick. The subsoil, about 46 inches thick, is mottled grayish-brown, firm silty clay that grades to silty clay loam with increasing depth.

Pershing soils erode readily if cultivated, and they are seepy early in spring. Available water capacity is high, and permeability is slow. Natural fertility is low to medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is medium to low in available phosphorus, is very low in available potassium, and is somewhat poorly aerated.

Row crops are commonly grown on the less sloping soils, but the moderately sloping areas are generally in pasture or meadow. Crop response to management is favorable.

Representative profile of Pershing silt loam, 2 to 5 percent slopes, in a cultivated field on a stable ridgetop where slope is 3 percent; 785 feet south and 100 feet west of the northeast corner of the SE¼NW¼ sec. 35, T. 70 N., R. 17 W.

Ap—0 to 7 inches, very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) when dry; weak, thin, platy to moderate, fine, granular structure; friable; neutral; clear, smooth boundary.

A21—7 to 11 inches, dark grayish-brown (10YR 4/2) light silty clay loam, light brownish gray (10YR 6/2) when dry; weak, thin, platy structure breaking to moderate, medium, granular; friable; few dark reddish-brown (5YR 3/4) oxide stains; few, fine, iron-manganese concretions; medium acid; gradual, smooth boundary.

A22—11 to 14 inches, grayish-brown (10YR 5/2) medium silty clay loam, light gray (10YR 7/2) when dry; common, fine, mottles of brown (10YR 5/3); moderate, medium, granular structure; friable; few, fine, iron-manganese concretions; strongly acid; clear, smooth boundary.

B1—14 to 17 inches, brown (10YR 5/3) light silty clay; faces of peds grayish brown (10YR 5/2); few, fine, faint mottles of yellowish brown (10YR 5/6), light gray (10YR 7/2) when dry; moderate, fine, subangular blocky structure; friable; light-gray (10YR 7/2) when dry, grainy coatings on ped faces; few, fine, iron-manganese concretions; medium acid; abrupt, smooth boundary.

B21t—17 to 24 inches, grayish-brown (10YR 5/2) medium silty clay; common, fine, faint mottles of yellowish brown (10YR 5/6); moderate, fine, subangular blocky structure; firm; few, fine, dark-brown (7.5YR 3/2) oxide stains; few, fine, iron-manganese concretions; thin discontinuous clay films on ped faces; medium acid; gradual, smooth boundary.

B22t—24 to 33 inches, grayish-brown (2.5Y 5/2) light silty clay; few, fine, faint mottles of yellowish brown (10YR 5/4); moderate, fine, subangular blocky structure; firm; few, fine, iron-manganese concretions; thin discontinuous clay films on ped faces; medium acid; gradual, smooth boundary.

B31—33 to 38 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam; few, fine, distinct mottles of strong brown (7.5YR 5/6); weak, fine, subangular blocky structure; few, fine, iron-manganese concretions; slightly acid; gradual, smooth boundary.

B32—38 to 60 inches, grayish-brown (2.5Y 5/2) light silty clay loam; few, fine, distinct mottles of strong brown (7.5YR 5/6); weak, medium, prismatic structure; firm; few, fine, iron-manganese concretions; slightly acid.

The A1 or Ap horizon ranges from 6 to 10 inches in thickness and is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2). The A2 horizon ranges from 3 to 8 inches in thickness and from dark grayish brown (10YR 4/2) to grayish brown (10YR 5/2). The B2t horizon ranges from grayish brown (10YR 5/2) to brown (10YR 4/3) in the upper part to grayish brown (2.5Y 5/2) in the lower part, and from light clay to medium silty clay. The maximum content of clay is 42 to 48 percent and occurs at a depth of about 14 to 20 inches. The gray subsoil colors are relict and related to deoxidized and leached weathering zones. Reaction of the B horizon ranges from medium acid to very strongly acid in the most acid part. The depth to the glacial till of clay texture ranges from 48 to 92 inches.

Pershing soils are associated with Grundy, Lineville, and Weller soils, and they formed in parent material similar to that of Kniffin and Rathbun soils. They have a thinner A1 or Ap horizon than Grundy soils, and they have a grayish colored A2 horizon that Grundy soils do not have. They contain more clay and less sand in the upper part of the B horizon than Lineville soils. They have a thicker A1 or Ap horizon and a less pronounced A2 horizon than Weller soils. They have less clay in the B horizon than Kniffin and Rathbun soils.

Pershing silt loam, 2 to 5 percent slopes (131B).—This soil is on ridgetops and slightly convex side slopes that are adjacent to the valleys of major drainageways in the county. Individual areas range from 5 to 25 acres in size.

This soil has the profile described as representative of the series. Included in mapping are some moderately eroded areas that have a thinner surface layer. In some of the eroded areas, part of the subsurface layer is mixed into the plow layer.

Much of the acreage of this soil is cropped, and the rest is forested or pastured. Runoff is rapid, and erosion is a hazard in cultivated areas that are not tilled on the contour. Row crops are moderately suited to this soil under good management. The surface layer is friable and is medium in organic-matter content. Capability unit IIIe-3; woodland suitability group 4w1.

Pershing silt loam, 5 to 9 percent slopes (131C).—This soil is on ridgetops and short, slightly convex side slopes. Individual areas are as large as 30 acres in size.

This soil has a very dark gray surface layer 6 to 8 inches thick. It has a very thin subsurface layer that is grayish when wet. The mottled subsoil is medium silty clay and commonly is at a depth of 14 to 18 inches.

Much of the acreage is cropped, and the rest is forest or pasture. This soil is moderately suited to row crops if it is terraced and tilled on the contour. Runoff is rapid, and erosion is a hazard in cultivated areas. The organic-matter content is medium. Additions of lime and nitrogen are needed if this soil is used for cultivated crops. Capability unit IIIe-4; woodland suitability group 4w1.

Pershing silt loam, 5 to 9 percent slopes, moderately eroded (131C2).—This soil is on rounded ridgetops and short, convex side slopes. Individual areas are as large as 20 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is very dark grayish-brown to very dark gray silt loam 3 to 6 inches thick. Erosion has removed part of the surface layer, and in most places plowing has mixed the subsurface layer with the surface layer. The mottled subsoil is medium silty clay and is commonly at a depth of 7 to 12 inches. On the rounded shoulders of side slopes the subsoil is exposed in some places. In a few small spots plowing has mixed the subsoil with the surface layer.

This soil is moderately suited to row crops. Runoff is rapid. After rains the surface layer tends to seal and crust. The surface layer, which is low in organic-matter content, erodes where vegetation is sparse. The soil responds well to applications of lime and fertilizer. Capability unit IIIe-4; woodland suitability group 4w1.

Pershing silt loam, benches, 2 to 5 percent slopes (T131B).—This soil is on high benches that extend out into the bottom lands. The strongly sloping soils that derived from till are generally upslope from this soil, and the Caleb and bottom land soils are downslope.

This soil has a profile similar to that described as representative of the series, but the underlying material is more variable. The surface layer is very dark gray silt loam 6 to 10 inches thick, and the silty clay subsoil is somewhat less mottled than Pershing soils on uplands. The underlying material, at a depth of 6 to 10 feet, commonly consists of stratified, dominantly loamy alluvial sediments. Some of the loess parent material may have come from adjacent stream valleys. Included in mapping are a few small moderately eroded spots.

Most of the acreage is cultivated, although erosion is a hazard in cultivated areas. If tilth becomes poor, the soil should be kept in meadow for an additional year. The organic-matter content is medium. Response to lime and fertilizer generally is good. Seepage and variable textures can be expected in deep cuts and fills. Capability unit IIIe-3; woodland suitability group 4w1.

Pershing silt loam, benches, 5 to 9 percent slopes (T131C).—This soil is on high benches along many of the major streams in the county. It is on the side slopes and short ridgetops upslope from the soils on bottom lands. Individual areas are small.

This soil has a profile similar to that described as representative of the series, but the lower part of the subsoil and the underlying material commonly contain less clay. This soil has a very dark grayish-brown to very dark gray surface layer 6 to 8 inches thick. In some places plowing has mixed the subsurface layer with the surface layer. The mottled silty clay subsoil is at a depth of 12 to 14 inches. The underlying material, at a depth of 6 to 10 feet, is stratified loamy to sandy alluvial sediments in places.

This soil is moderately suited to row crops. Runoff is rapid, and erosion is a hazard. The organic-matter content of this soil is low. Crop response to additions of lime or nitrogen and phosphate fertilizers is good. Seepage and variable textures can be expected where deep cuts or fills are made. Capability unit IIIe-4; woodland suitability group 4w1.

Radford Series

The Radford series consists of stratified, moderately well drained to somewhat poorly drained soils. These soils formed in recent alluvial sediments and have a buried dark-colored silty clay loam soil at a depth of about 20 to 36 inches. These soils are on first bottoms adjacent to Zook and Colo soils. Recent vegetation, which consists of trees and prairie grasses, has not influenced soil formation.

In a representative profile the surface layer is very dark grayish-brown silt loam about 12 inches thick.

Stratified very dark grayish-brown, dark grayish-brown, and grayish-brown, friable loam extends to a depth of about 21 inches. Below this is very dark gray and dark-gray, buried, friable to firm silty clay loam. The recently buried soil extends to a depth of 60 inches or more.

Radford soils commonly receive excess runoff from the valley slopes. Available water capacity is high, and permeability is moderate. Natural fertility is medium. The surface layer is neutral and does not need additions of lime. The subsoil is neutral, is medium to low in available potassium, is low in available phosphorus, and is poorly aerated.

Radford soils are well suited to row crops. They are occasionally flooded, but crop damage is generally only slight.

Representative profile of Radford silt loam that has a 1 percent slope; 250 feet north and 205 feet west of the southeast corner of the NW¼NW¼ sec. 5, T. 67 N., R. 16 W.

A1—0 to 12 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; weak, medium, subangular blocky structure; friable; few, hard, manganese-iron concretions; few soft reddish oxides; neutral; abrupt, smooth boundary.

C1—12 to 17 inches, stratified very dark grayish-brown (10YR 3/2) silt loam layers and dark grayish-brown (10YR 4/2) fine sand layers; horizontal cleavage breaking to weak, fine, granular structure; friable; few hard, manganese-iron concretions; neutral; abrupt, smooth boundary.

C2—17 to 21 inches, stratified thin layers of dark grayish-brown (10YR 4/2) and grayish-brown (10YR 5/2) silt loam and very dark gray (10YR 3/1) and very dark grayish-brown (10YR 3/2) silty clay loam; horizontal cleavage breaking to weak, fine, granular structure; friable; few, hard, manganese-iron concretions; neutral; clear, smooth boundary.

IIAb11—21 to 30 inches, very dark gray (10YR 3/1) medium silty clay loam; moderate, medium, subangular blocky structure; friable; neutral; gradual, smooth boundary.

IIAb12—30 to 38 inches, very dark gray (10YR 3/1) and dark-gray (10YR 4/1) light silty clay loam; common, fine, faint mottles of dark brown (10YR 3/3 and 7.5YR 3/2); moderate, medium, subangular blocky structure; friable; few, hard, manganese-iron concretions; neutral; gradual, smooth boundary.

IIBb2—38 to 60 inches, dark-gray (10YR 4/1) medium silty clay loam; common, fine, faint mottles of dark brown (10YR 3/3 and 7.5YR 3/2); moderate, medium, subangular blocky structure; friable to firm; few, hard, manganese-iron concretions; neutral.

Radford soils are highly stratified in the upper 20 to 36 inches. They range from very dark grayish brown (10YR 3/2) to grayish brown (10YR 4/2). The thin strata are sandy loam to silty clay loam, but the texture is dominantly silt loam. Thin, parallel layers of grayish brown (10YR 5/2), dark grayish brown (10YR 4/2), or in places, lighter colors, are in that part of the overburden identified as the C horizon. The buried soil is light to medium silty clay loam and is very dark gray (10YR 3/1) to dark gray (10YR 4/1). Dark brown mottles increase with increasing depth.

Radford soils are associated with Nodaway, Colo, Zook, Landes, and Kennebec soils. They have a dark buried soil at a depth of about 20 to 36 inches that Nodaway soils do not have, and they have a higher sand content in the A horizon. They have a lighter colored A horizon, contain less clay, and are better drained than Colo and Zook soils. They contain less sand in the upper 40 inches of the profile than Landes soils. They are stratified, whereas Kennebec soils are not stratified in the upper part of their profile.

Radford silt loam (0 to 2 percent slopes) (467).—This soil is on bottom lands of the major streams in the county. Excess water from minor side streams and valley slopes have deposited the lighter colored stratified silt loam on top of an older, dark-colored soil. Included in mapping are a few small areas that slope about 3 percent. Drainage is somewhat restricted in places because of the dark silty clay loam buried soil at a depth of 20 to 36 inches.

This soil is well suited to row crops. It is subject to flooding from small streams that flow through the area or from drainage waters from higher adjacent valley slopes. Although this soil receives excess runoff in most years, this does not interfere seriously with cropping. This soil is in good tilth, and it is easy to work. The organic-matter content in the surface layer is low to medium. Capability unit IIw–1; woodland suitability group 5w2.

Rathbun Series

The Rathbun series consists of somewhat poorly drained soils on uplands. These soils formed in leached loess 48 to 80 inches thick over a buried reddish clayey soil. The buried materials are similar to the Keswick soils that formed in Kansan till. These soils are upslope from Keswick, Gara, and Lindley soils. They are in most parts of the county except the northeastern and north-central parts. Slopes range from 2 to 9 percent and are generally short and convex. Individual areas range from 5 to 35 acres in size. The native vegetation was forest.

In a representative profile the surface layer is very dark gray silt loam about 4 inches thick. The subsurface layer is yellowish-brown, friable silt loam 9 inches thick. The subsoil is about 43 inches thick and is mottled, grayish-brown to brown, very firm silty clay that grades to silty clay loam with increasing depth. The substratum is mottled light brownish-gray silty clay loam.

Rathbun soils erode readily where they are cultivated. Available water capacity is high, and permeability is very slow. Natural fertility is low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low in available phosphorus, is very low in available potassium, and is somewhat poorly aerated.

Rathbun soils are used mainly for hay and pasture, but some corn and oats are grown. Some areas are in forest.

Representative profile of Rathbun silt loam, 2 to 5 percent slopes, where slope is 3 percent; 300 feet south and 850 feet west of the northeast corner of the NW¼ sec. 21, T. 67 N., R. 18 W.

A1—0 to 4 inches, very dark gray (10YR 3/1), silt loam dark grayish brown (10YR 4/2) when crushed, light brownish gray (10YR 6/2) when dry; weak, thin, platy structure; friable; strongly acid; abrupt, smooth boundary.

A2—4 to 13 inches, yellowish-brown (10YR 5/4) silt loam, very pale brown (10YR 7/3) when dry; weak to moderate, thin, platy structure; friable; few, fine, dark reddish-brown (5YR 3/2) oxides; strongly acid; clear, smooth boundary.

B1—13 to 17 inches, yellowish-brown (10YR 5/4) light silty clay; faces of peds pale brown (10YR 6/3); continuous light-gray (10YR 7/1) coatings when dry; strong, very fine, subangular and angular blocky structure; firm; strongly acid; abrupt, smooth boundary.

B21t—17 to 23 inches, brown (10YR 4/3) heavy silty clay; faces of peds dark grayish brown (10YR 4/2); few, fine, distinct grayish-brown (2.5Y 5/2) mottles; moderate, fine, subangular blocky structure; very firm; thin continuous clay films; few, very fine, soft, dark-brown (7.5YR 3/2) oxides; strongly acid; gradual, smooth boundary.

B22t—23 to 29 inches, brown (10YR 4/3) medium silty clay; faces of peds dark grayish brown (10YR 4/2); few, fine, distinct grayish-brown (2.5Y 5/2) mottles and few, fine, faint mottles of dark brown (10YR 3/3); weak, coarse, prismatic structure breaking to moderate, medium, subangular blocky; very firm; thin continuous clay films; few, very fine, soft, dark-brown (7.5YR 3/2) oxides; medium acid; gradual, smooth boundary.

B23t—29 to 36 inches, mottled grayish-brown (2.5Y 5/2) and brown (10YR 4/3) medium to light silty clay; few, fine to medium, faint mottles of dark brown and dark yellowish brown (10YR 3/3 and 10YR 3/4); weak, coarse, prismatic structure breaking to weak to moderate, medium, subangular blocky; firm; few discontinuous clay films; few dusky-red (2.5YR 3/2) oxides; very few patches of light-gray (10YR 7/2) grainy ped coatings; medium acid; gradual boundary.

B31t—36 to 43 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam to light silty clay; common, fine, distinct mottles of dark yellowish brown (10YR 4/4) and strong brown (7.5YR 5/6); weak, coarse, prismatic structure breaking to weak, medium, subangular blocky; firm; few, thin, discontinuous clay films and clay fills along root channels; few soft dark reddish-brown (5YR 2/2) oxides; few dusky-red (2.5YR 3/2) oxides; very few light-gray (10YR 7/2) grainy ped coatings; medium acid; gradual boundary.

B32—43 to 56 inches, mottled grayish-brown (2.5Y 5/2), yellowish-brown (10YR 5/4), and strong-brown (7.5YR 5/6) silty clay loam; weak, medium, prismatic structure; firm; thin discontinuous light-gray (10YR 7/1) grainy coatings on prism faces; common dark-brown (7.5YR 3/2) oxide stains; few clay flows along root channels; iron-manganese stains on vertical prism faces and along root channels; neutral; gradual boundary.

C—56 to 65 inches, mottled light brownish-gray (2.5Y 6/2), yellowish-brown (10YR 5/6), and strong-brown (7.5YR 5/6) light silty clay loam; massive with vertical cleavage; discontinuous light-gray (10YR 7/1) grainy coatings on prism faces; many, hard, dark-brown (7.5YR 3/2) concretions; few iron-manganese stains of dark reddish brown (5YR 2/2) on cleavage faces; neutral; gradual boundary.

The A1 horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 2 to 5 inches in thickness. Cultivated or slightly eroded areas generally have a dark grayish-brown (10YR 4/2) Ap horizon. The A2 horizon ranges from grayish brown (10YR 5/2) to yellowish brown (10YR 5/4) in color and from 4 to 12 inches in thickness. The B21t horizon ranges from brown (10YR 4/3) to grayish brown (2.5Y 5/2). The grayish color of the lower part of the B horizon is relict and is related to a deoxidized and leached weathering zone. The clay maximum occurs at a depth of about 15 to 20 inches. The maximum clay content of the B2t horizon ranges from 48 to 58 percent. Reaction ranges from medium acid to very strongly acid in the most acid part of the solum. Depth to glacial till of clay texture ranges from 48 to 80 inches.

Rathbun soils are associated with Kniffin, Keswick, Gara, and Lindley soils and formed in parent material similar to that of Weller soils. They have a thinner dark A horizon and browner colors in the B horizon than Kniffin soils. They are not so red as Keswick soils, and they contain less sand. They did not form in glacial till as did Gara and Lindley soils, and they contain less sand and gravel than those soils. They have a finer textured B horizon than Weller soils.

Rathbun silt loam, 2 to 5 percent slopes (532B).—This soil is on moderately wide ridgetops and slightly convex side slopes. Individual areas are as large as 35 acres in size.

This soil has the profile described as representative of the series. The horizon that has maximum clay content is commonly at a depth of 16 to 20 inches.

Some of the acreage is still wooded, but the trees have been removed in places and the soil is cultivated or pastured. This soil is moderately suited to row crops. Where this soil is cultivated, the thin dark surface layer has been mixed with the subsurface layer. If this soil is cultivated, it erodes readily. The surface layer is friable and floury, and the organic-matter content is low. The soil responds well to applications of manure. It is strongly acid to very strongly acid in the most acid part and it needs liming. Capability unit IIIe–1; woodland suitability group 4w1.

Rathbun silt loam, 2 to 5 percent slopes, moderately eroded (532B2).—This soil is on rounded ridgetops. Individual areas are as large as 30 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner. The surface layer is very dark grayish-brown to grayish-brown silt loam about 2 to 4 inches thick. In most places plowing has mixed the surface layer with the subsurface layer. The maximum clay content is commonly at a depth of 14 to 16 inches. A few small rills are common. Near the edges of some areas erosion has removed most of the surface layer, thus exposing the clayey subsoil.

This soil is moderately suited to row crops. The surface layer is low in organic-matter content and is very erodible. After rains it tends to seal and crust. Capability unit IIIe–1; woodland suitability group 4w1.

Rathbun silt loam, 5 to 9 percent slopes (532C).—This soil is on ridgetops and short, slightly convex side slopes. Individual areas are as large as 20 acres in size. Included in mapping are some moderately eroded areas.

Much of the acreage is cropped, and the rest is pastured. This soil is moderately well suited to row crops. It erodes readily in cultivated areas because runoff is rapid. It is low in organic-matter content. Additions of lime are needed because this soil is strongly acid to very strongly acid in the most acid part. Capability unit IIIe–2; woodland suitability group 4w1.

Rathbun silt loam, 5 to 9 percent slopes, moderately eroded (532C2).—This soil is on rounded ridgetops and short, convex side slopes. Individual areas are as large as 30 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner and is very dark grayish brown to grayish brown. Plowing has mixed the subsurface layer with the surface layer in most places, and in a few small spots the subsoil has been mixed with the surface layer. On the rounded shoulders of side slopes, the subsoil is exposed in places. These severely eroded spots are indicated by a spot symbol for severe erosion on the soil map.

This soil is moderately suited to row crops. Runoff is rapid and further erosion is a hazard in unvegetated areas. After rains the surface of this soil tends to seal and crust. The content of organic matter is low. Crops respond well to applications of lime and fertilizer, but soil loss and the high clay content of the subsoil are limitations to the use of this soil for crops. Capability unit IIIe-2; woodland suitability group 4w1.

Seymour Series

The Seymour series consists of somewhat poorly drained soils on uplands in most parts of the county except the northern part. These soils formed in leached loess 48 to 84 inches thick over a buried, very slowly permeable, gray clayey soil. Slopes range from 2 to 9 percent and are mostly short and convex. Individual areas generally are large. The native vegetation was prairie grasses.

In a representative profile the surface layer is very dark gray silt loam that grades to silty clay loam and is about 12 inches thick. The subsoil is about 48 inches thick. It is mottled, dark grayish-brown, firm silty clay in the upper part that grades to mottled, light brownish-gray firm silty clay loam in the lower part.

Seymour soils are seasonally wet and are subject to erosion where they are cultivated. Available water capacity is high, and permeability is very slow. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low in available phosphorus, is medium in available potassium, and is somewhat poorly aerated.

These soils are used mostly for row crops. Corn, soybeans, small grain, and meadow are the main crops. A few moderately sloping areas are used for pasture. Crop response to improved management is favorable.

Representative profile of Seymour silt loam, 2 to 5 percent slopes, on an east aspect where the slope is 3 percent; 80 feet east and 100 feet north of the southwest corner of the NW¼NW¼ sec. 27, T. 69 N., R. 18 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) when dry; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

A3—8 to 12 inches, very dark gray (10YR 3/1) light silty clay loam; moderate, fine, granular structure; friable; medium acid; clear, smooth boundary.

B1—12 to 15 inches, dark grayish-brown (10YR 4/2) medium silty clay loam; few, fine, faint mottles of yellowish brown (10YR 5/4); weak, fine, subangular blocky structure; friable; common grainy ped coatings; medium acid; clear, smooth boundary.

B21t—15 to 18 inches, dark grayish-brown (10YR 4/2) silty clay; few, fine, faint mottles of yellowish brown (10YR 5/6); moderate, fine, subangular blocky structure; very firm; thin almost continuous clay films; few grainy ped coatings; strongly acid; clear, smooth boundary.

B22t—18 to 24 inches, dark grayish-brown (10YR 4/2) silty clay; few, fine, faint mottles of yellowish brown (10YR 5/4); moderate, fine, subangular blocky structure; very firm; thin continuous clay films; medium acid; gradual, smooth boundary.

B23t—24 to 31 inches, grayish-brown (10YR 5/2) silty clay; few, fine, faint mottles of yellowish brown (10YR 5/4); weak, medium, subangular blocky structure; firm; thin discontinuous clay films; few, soft, manganese-iron concretions; slightly acid; gradual, smooth boundary.

B31—31 to 38 inches, grayish-brown (2.5Y 5/2) heavy silty clay loam; few, fine, faint mottles of strong brown (7.5YR 5/6), dark gray (10YR 4/1), and yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm; common, fine, manganese-iron concretions; neutral; gradual, smooth boundary.

B32—38 to 60 inches, light brownish-gray (10YR 6/2) medium silty clay loam; few, medium, distinct mottles of strong brown (7.5YR 5/6); weak, coarse, angular blocky structure; firm; common, fine, manganese-iron concretions; neutral.

The solum, depending on topographic position, ranges from 4 feet to more than 6 feet in thickness. Depth to glacial till of clay texture ranges from 4 to 7 feet. The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2) in color and from 10 to 15 inches in thickness. The upper part of the B horizon ranges from very dark grayish brown (10YR 3/2) to grayish brown (2.5Y 5/2). The B2t horizon ranges from medium to heavy silty clay. The B3 horizon ranges from silty clay to silty clay loam. Reaction in the upper part of the B horizon is strongly acid to medium acid. Where the C horizon is present, its texture is light to medium silty clay loam, and it ranges from gray to light olive gray in hues of 2.5Y and 5Y.

Seymour soils are associated with Kniffin, Grundy, Clarinda, and Edina soils. They differ from Kniffin soils in that they do not have an A2 horizon and they generally have a thicker dark A horizon. They have a finer textured B2t horizon than Grundy soils. They have gray clay and silty clay textures that do not extend as deep as those in Clarinda soils. They do not have the prominent grayish A2 horizon that is typical of Edina soils.

Seymour silt loam, 2 to 5 percent slopes (312B).—This soil is on short, slightly convex side slopes and ridgetops near broad upland flats. It is generally adjacent to moderately sloping Seymour soils downslope and Edina soils upslope. This soil has the profile described as representative of the series.

Included with this soil in mapping are a few areas of a soil that has a slightly grayish layer below the surface layer. Also included are a few small areas of a moderately eroded soil that has a slightly thinner surface layer.

This Seymour soil is suited to frequent cropping. It is subject to erosion (fig. 14). Tilth is generally good and can be maintained if crop residues are returned to the soil. The soil is seepy along waterways in wet seasons. It is acid unless it has been recently limed. It responds well to applications of lime and fertilizer. Capability unit IIIe-3; woodland suitability group 4w1.

Seymour silt loam, 5 to 9 percent slopes, moderately eroded (312C2).—This soil is on short, slightly convex and irregular side slopes and on short, convex ridgetops. It commonly is adjacent to other Seymour soils.

The surface layer is thinner where small rills occur or on short, strong side slopes adjacent to drainageways. Thickness of the surface layer between rills commonly ranges from 10 to 12 inches. In most places the surface layer is silty clay loam. The subsoil is mottled silty clay.

Included with this soil in mapping are small areas of Clarinda soils and a few areas that contain more

Figure 14.—**Tilling on the contour and keeping crop residue on the surface are effective in reducing soil loss on Seymour soils.**

sand in the upper 18 inches. Also included are areas of Seymour soils that are only slightly eroded.

This soil is moderately suited to row crops if it is terraced and tilled on the contour. Runoff is generally rapid because this soil is sloping and its surface layer is compacted in places. This soil is cloddy when it dries, and tilth needs to be improved. The organic-matter content is medium. This soil is acid unless it has been recently limed. Response to applications of lime and fertilizer is good. Capability unit IIIe-4; woodland suitability group 4w1.

Shelby Series

The Shelby series consists of moderately well drained soils that formed in glacial till on uplands. The native vegetation was prairie grasses and a few trees. Slopes range from 9 to 18 percent. These soils are extensive in all parts of the county.

In a representative profile the surface layer is black to very dark grayish-brown loam about 11 inches thick. The subsoil, about 23 inches thick, is brown to yellowish-brown, firm clay loam that has some mottles in the lower part. The substratum is mottled yellowish-brown, firm clay loam that is neutral or mildly alkaline.

Shelby soils are subject to a severe hazard of erosion if they are cultivated. Available water capacity is high, and permeability is moderately slow. Natural fertility is low to medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available phosphorus, is low to very low in available potassium, and is somewhat poorly aerated.

The severely eroded or moderately steep areas of these soils are used mainly for permanent pasture or meadow. The less sloping areas are occasionally used for row crops. Corn, small grain, and hay are the principal crops.

Representative profile of Shelby loam, 9 to 14 percent slopes, moderately eroded, on an east-facing, convex side slope where slope is 11 percent; 500 feet east and 700 feet north of the southwest corner of sec. 35, T. 69 N., R. 16 W.

A1—0 to 7 inches, black (10YR 2/1) to very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) when dry, very dark gray (10YR 3/1) when kneaded; moderate, fine, granular structure; friable; common roots; neutral; clear, smooth boundary.

A3—7 to 11 inches, very dark grayish-brown (10YR 3/2) loam, very dark gray (10YR 3/1) when kneaded; moderate, fine, granular structure breaking to moderate, very fine, subangular blocky; friable; few, fine, black (10YR 2/1) coatings on peds; neutral; clear, smooth boundary.

B1t—11 to 14 inches, brown (10YR 4/3) clay loam; few, fine, faint mottles of yellowish brown (10YR 5/4), brown (10YR 5/3) when dry; moderate, fine and very fine, subangular blocky structure; friable to firm; neutral; gradual, smooth boundary.

B21t—14 to 21 inches, brown (10YR 5/3) clay loam; moderate, fine, subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual, smooth boundary.

B22t—21 to 28 inches, dark yellowish-brown (10YR 4/4) clay loam; moderate, fine to medium, subangular blocky structure; firm; thin discontinuous clay films; slightly acid; gradual, smooth boundary.

B3t—28 to 34 inches, mottled yellowish-brown (10YR 5/4) and gray (5Y 5/1) heavy clay loam; few, fine, faint mottles of dark yellowish brown (10YR 4/4); weak, medium and coarse, blocky and subangular structure; firm; few clay films on vertical cleavages; neutral; abrupt, smooth boundary.

C1—34 to 39 inches, mottled yellowish-brown (10YR 5/6 and 5/8) and light olive-gray (5Y 6/2) clay loam; massive; few cleavage planes; firm; carbonate concretions; neutral; gradual, smooth boundary.

C2—39 to 60 inches, mottled light olive-gray (5Y 6/2) and yellowish-brown (10YR 5/6) clay loam; few, fine, faint brown (7.5YR 4/4) mottles; massive; few cleavage planes; firm; mildly alkaline.

The A1 horizon ranges from 10 to 18 inches in thickness, where not eroded, and from black (10YR 2/1) to very dark grayish brown (10YR 3/2). The A1 horizon is typically loam, but ranges from loam to light clay loam. The B2t horizon ranges from dark brown (10 YR 4/3) to yellowish brown (10YR 5/6) and from light to medium clay loam. Reaction of the B2t horizon ranges from slightly acid to strongly acid in the most acid part, but is commonly medium acid. Depending on the position of these soils, the C horizon has carbonates commonly at depths of 30 to 48 inches.

Shelby soils are associated with Adair, Clarinda, Lamoni, and Gara soils. They have less clay and a more yellowish-brown B horizon than Adair, Clarinda, and Lamoni soils. They have a brownish B horizon, whereas the B horizon of the Clarinda soils is grayish, and part of the B horizon of the Adair soils is reddish. They overlie glacial till that is not so highly weathered as that of Adair and Clarinda soils. They do not have an A2 horizon and have a thicker dark A1 horizon than Gara soils.

Shelby loam, 9 to 14 percent slopes, moderately eroded (24D2).—This soil is in bands that in many places cover entire side slopes. It is downslope from Adair and Lamoni soils. This soil formed in Kansas till and has moderately rounded slopes, generally in strongly dissected areas. Individual areas are as large as 80 acres in size.

This soil has the profile described as representative of the series. The yellowish-brown subsoil is exposed near drains in side slopes and near areas of Adair soils upslope.

Included with this soil in mapping are small areas of Adair and Lamoni soils. Also included are areas of

Shelby soils that are only slightly eroded and have a thicker surface layer.

This soil is moderately suited to row crops. Runoff is rapid because slopes are strong and permeability in the subsoil is moderately slow. This soil erodes readily in cultivated areas. Although lime occurs at a depth of 36 inches or more, this soil generally is medium acid or slightly acid in the upper part of the subsoil. It is generally low in organic-matter content. Response to applications of nitrogen and phosphate fertilizers is fairly good. Capability unit IIIe–6; woodland suitability group 2o1.

Shelby loam, 14 to 18 percent slopes, moderately eroded (24E2).—This soil is in all parts of the county, but most of it is near the valleys of large streams. It covers entire side slopes between Adair soils upslope and Olmitz, Vesser, and Colo soils downslope. Slopes are slightly irregular and complex in many places.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner. The surface layer is very dark gray to very dark grayish-brown, friable to firm loam 3 to 6 inches thick. In some places at the base of slopes, where local colluvium has accumulated, the surface layer is 6 to 14 inches thick.

Included with this soil in mapping are small areas that slope 18 to 25 percent, and small areas in native grasses that are not eroded. Also included are small areas of Adair soils and clayey Nebraskan gumbotil.

This soil is better suited to pasture than to row crops. Row crops are occasionally grown for a year when pastures are renovated. Runoff is rapid, and the hazard of erosion is severe in cultivated areas. Tilth is generally poor, particularly where the yellowish-brown subsoil is exposed. The organic-matter content is low. Most of this soil is slightly acid, but lime generally is abundant below a depth of 30 inches. Capability unit IVe–1; woodland suitability group 2o1.

Shelby soils, 9 to 14 percent slopes, severely eroded (24D3).—These soils occur in places as a series of severely eroded areas between drainageways on strong side slopes, commonly associated with other phases of Shelby soils. They are also in thin, narrow bands at the shoulder of side slopes immediately downslope from Adair and Clarinda soils. Individual areas range widely in size, but they generally are less than 20 acres.

These soils have a profile similar to that described as representative of the series, but part of the original surface layer has been removed through erosion. The remaining surface layer is very dark grayish-brown or dark-brown to dark yellowish-brown, firm clay loam or loam. It is generally 3 to 8 inches thick, but in some rills and near the shoulder of side slopes much of the subsoil is exposed. Included in mapping are a few gullies.

These soils are better suited to pasture than to row crops. They are strongly sloping and absorb moisture slowly, and are subject to a severe hazard of erosion if cultivated. They puddle easily and seal quickly after rains. These soils are low in organic-matter content. Although lime is abundant at a depth of 36 inches and below, the upper part of the subsoil is medium acid or slightly acid. Although row crops are poorly suited, they will probably continue to be grown in small areas that adjoin better soils. Capability unit IVe–1; woodland suitability group 2o1.

Shelby soils, 14 to 18 percent slopes, severely eroded (24E3).—These soils are on the shoulders of side slopes downslope from Adair and Clarinda soils. They are on irregular sidehills in a series of sharply rounded slopes in places. Slopes generally are moderately long.

These soils have a profile similar to that described as representative of the series, but nearly all the original surface layer has been lost through erosion. There are spots, however, that still have enough of the original surface layer to give plowed fields a spotted light and dark appearance. The present surface layer is firm clay loam or loam that is very dark grayish brown, dark brown, or dark yellowish brown. In some areas gullies are so deep that they cannot be crossed with ordinary farm implements. Included in mapping are small areas of Adair and Clarinda soils.

These soils are not suited to row crops. They should remain in permanent pasture. These soils are generally in poor tilth, and they puddle readily if they are worked when wet. When dry, the surface layer is hard and cracked. Organic-matter content is low. Where renovating pasture is practical, gullies should be filled and a grass-legume mixture should be planted along with a nurse crop. Capability unit VIe–3; woodland suitability group 2o1.

Sogn Series

The Sogn series consists of somewhat excessively drained, strongly sloping to moderately steep, shallow soils on convex lower side slopes along Cooper, Walnut, and Shoal Creeks and along the southwestern side of the Chariton River. They are downslope from Armstrong, Keswick, Rathbun, Kniffin, Gara, or Lindley soils. In Appanoose County, Sogn soils are mapped only as part of the Sogn-Gosport-Clanton complex.

In a representative profile the surface layer is about 13 inches thick. The upper 8 inches is black loam, and the lower 5 inches is very dark brown silty clay loam. Hard limestone bedrock is at a depth of about 13 inches.

These soils are not suitable for row crops because of the shallowness over bedrock and the strongly sloping to moderately steep slopes. They are better suited to permanent pasture than to most other uses. If these soils are allowed to erode, the thin mantle of soil material is soon removed and the limestone bedrock is exposed on the surface. Reaction in the surface layer generally is neutral. Available water capacity is very low, and permeability is moderate above the limestone bedrock. The soils are very low in available phosphorus and medium in available potassium.

Representative profile of Sogn silty clay loam on a north aspect where the slope is 11 percent, in an area of Sogn-Gosport-Clanton complex, 9 to 18 percent slopes, moderately eroded; 840 feet north and 2,340 feet east of the southwest corner of sec. 24, T. 69 N., R. 18 W.

A11—0 to 8 inches black (10YR 2/1) loam; moderate, medium, granular structure; friable; many fine roots; common quartz grains; neutral; gradual, smooth boundary.

A12—8 to 13 inches, very dark brown (10YR 2/2) heavy silty clay loam; faces of peds black (10YR 2/1); moderate, medium, subangular and angular blocky structure; firm; many fine roots; common quartz grains; neutral; abrupt, wavy boundary.

R—13 inches, hard level-bedded limestone.

The A horizon ranges from 4 to 18 inches in thickness and from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is mostly loam, but ranges from silty clay loam to stony silty clay loam or silt loam in places and is less than 35 percent limestone fragments. Reaction ranges from slightly acid to moderately alkaline in the A horizon.

Sogn soils are associated with Clanton and Gosport soils. They differ from other soils in the county in having limestone bedrock within a depth of 18 inches.

Sogn-Gosport-Clanton complex, 9 to 18 percent slopes, moderately eroded (413D2).—This mapping unit is most extensive on convex lower parts of side slopes and escarpments along deeply entrenched drainageways southwest of the Chariton River. Individual areas are small in size. Slopes are less than 14 percent in about 25 percent of the area.

Although the proportions of the soils vary from place to place, this mapping unit generally is about 40 percent Sogn soil, 30 percent Gosport soil, and 30 percent Clanton soil.

Included with these soils in mapping are some severely eroded areas that are indicated by a special symbol on the soil map and a few areas that are not eroded. In places a few small rills or gullies have formed. Also included are some exposed limestone and shale outcrops (fig. 15).

These shallow to deep, stony to clayey, droughty soils are not suitable for cultivation. They are better suited to pasture or wildlife habitat than to most other uses. Available water capacity is very low. Common limestone and shale outcrops, strong slopes, and the severe hazard of further erosion are the chief limitations in management. A permanent cover of grass and protection from overgrazing are needed to control erosion. Good pasture can be maintained on these soils in periods of normal or heavy rainfall. Capability unit VIIe-3; woodland suitability group 5w1.

Tuskeego Series

The Tuskeego series consists of poorly drained soils on slightly concave to level foot slopes and low terraces along the major stream valley in the county. These soils lie between soils on bottom lands and steeper till-derived soils on hillsides. They formed in silty

***Figure 15.*—Limestone outcrops on Sogn-Gosport-Clanton complex, 9 to 18 percent slopes.**

alluvium and wash from adjoining slopes under a mixed vegetation of trees and water-tolerant prairie grasses. Slopes range from 0 to 5 percent. Individual areas range from 5 to 20 acres in size.

In a representative profile the surface layer is very dark gray silt loam about 9 inches thick. The subsurface layer is dark-gray, friable silt loam and silty clay loam about 10 inches thick. The subsoil, about 41 inches thick, is mottled, very dark gray silty clay that grades to grayish-brown silty clay loam with increasing depth.

Tuskeego soils are seasonally wet because of the high water table and excessive runoff from adjacent soils upslope. Available water capacity is high, and permeability is very slow. Natural fertility is low to medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is very low in available potassium and available phosphorus, and is poorly aerated.

Most of the acreage is cropped. Corn, soybeans, and small grains are the main crops. Drainage improvement and protection from excessive runoff on gently sloping areas are needed for good plant growth.

Representative profile of Tuskeego silt loam, 0 to 2 percent slopes, where the slope is 1 percent; 525 feet west of the southeast corner of the NE¼SW¼ sec. 1, T. 68 N., R. 17 W.

Ap—0 to 9 inches, very dark gray (10YR 3/1) to very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry, very dark grayish brown (10YR 3/2) when kneaded; moderate, fine, granular structure; friable; many roots and pores; neutral; abrupt, smooth boundary.

A21—9 to 15 inches, dark-gray (10YR 4/1) to gray (10YR 5/1) silt loam; light gray (10YR 6/1) when dry on lower side of plates and light gray (10YR 7/1) when dry on upper side of plates, dark grayish brown (10YR 4/2) when kneaded; moderate, thin, platy structure; friable; common roots; many fine pores; common soft oxides; nearly continuous grainy ped coatings when dry; medium acid; clear, smooth boundary.

A22—15 to 19 inches, dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) light silty clay loam, gray to light gray (10YR 6/1) and grayish brown (10YR 5/2) when dry; common, fine, faint mottles of brown (10YR 5/3) and yellowish brown (10YR 5/4); moderate, thin, platy structure and moderate, fine, subangular blocky; friable; discontinuous grainy ped coatings when dry; common soft oxides; few pores and roots; medium acid; clear, smooth boundary.

B1g—19 to 24 inches, dark-gray (10YR 4/1) and dark grayish-brown (10YR 4/2) heavy silty clay loam; many, fine, faint mottles of yellowish brown (10YR 5/4); moderate, fine, subangular blocky structure; firm; few grainy ped coatings when dry; few fine pores; many concretions; common soft oxides; medium acid; gradual, smooth boundary.

B21tg—24 to 30 inches, very dark gray (10YR 3/1) and dark grayish-brown (10YR 4/2) medium silty clay; many, fine, prominent mottles of yellowish brown (10YR 5/6 and 5/8); moderate, fine to medium, subangular blocky structure; firm; common fine concretions and soft oxides; thick discontinuous very dark gray (10YR 3/1) clay films; common fine pores; medium acid; gradual, smooth boundary.

B22tg—30 to 35 inches, grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) light silty clay; few, fine, faint mottles of yellowish red (5YR 4/6); moderate, fine to medium, subangular blocky structure; firm; common concretions and soft oxides; few, thin, discontinuous clay films; common fine pores; medium acid; gradual, smooth boundary.

B23tg—35 to 41 inches, grayish-brown (2.5Y 5/2) and strong-brown (7.5YR 5/6) heavy silty clay loam; few, fine, faint mottles of yellowish red (5YR 4/6); moderate, medium, subangular blocky structure; firm; very dark gray (10YR 3/1) clay films on vertical faces; common fine pores; common concretions and soft oxides; slightly acid; gradual, smooth boundary.

B3tg—41 to 60 inches, grayish-brown (2.5Y 5/2) medium silty clay loam; many, fine, prominent, strong-brown (7.5YR 5/6) and few, fine, prominent, reddish-brown (5YR 4/4) mottles; weak, medium, subangular blocky structure; firm; very dark gray (10YR 3/1) clay films on vertical faces; common fine pores; common concretions and soft oxides; neutral.

The A horizon is very dark gray (10YR 3/1) or very dark grayish brown (10YR 3/2) and ranges from 6 to 10 inches in thickness. The A2 horizon ranges from dark gray (10YR 4/1) to light brownish gray (10YR 6/2) in color and from 8 to 12 inches in thickness. The B2t horizon ranges from very dark gray (10YR 3/1) to grayish brown (2.5Y 5/2). The B1 horizon ranges from medium to heavy silty clay loam. Maximum clay content of the B2t horizon typically ranges from 38 to 48 percent. Clay films are evident throughout the B2t horizon. The solum is medium acid to strongly acid in the most acid part. The underlying material is generally below a depth of 60 inches.

Tuskeego soils are associated with Colo, Vesser, Coppock, and Humeston soils. They differ from Colo soils in that they have a dark-gray silty A2 horizon and a finer textured B horizon. They have a B horizon that contains more clay than that of Vesser and Coppock soils. They have thinner A1 and A2 horizons and a lighter colored B2t horizon than Humeston soils.

Tuskeego silt loam, 0 to 2 percent slopes (453A).—This nearly level to slightly depressional soil is on low terraces that are generally downslope from Caleb and Mystic soils.

This soil has the profile described as representative of the series. Included in mapping are a few areas that have a thinner dark-colored surface layer.

This soil is moderately suited to row crops. Water often ponds for short periods after rains, and the soil is generally wet. Tile drainage generally is effective, but it needs close spacing. Surface drains are needed on some areas to remove excess surface water. Even in areas that are artificially drained, this soil is difficult to work and puddles easily. It dries slowly in spring or after rains, and cultivation is commonly delayed. Good management is required to maintain good soil tilth and productivity. Organic-matter content is low. Capability unit IIIw-1; woodland suitability group 5w3.

Tuskeego silt loam, 2 to 5 percent slopes (453B).—This soil is on foot slopes, generally downslope from Caleb soils, and it fans out to the soils on bottom lands. Most areas of the soil slope 4 percent or less.

This soil has a profile similar to that described as representative of the series, but in a few places the very dark gray surface layer is slightly thinner. Beneath the surface layer is a light grayish brown, leached subsurface layer over a thick silty clay loam subsoil.

This soil is often farmed along with soils on first bottoms. It generally is wet, because it receives excessive runoff from adjacent soils upslope and considerable seepage from the water-bearing layers of soils upslope. Interceptor tile drainage in some places can reduce this seepage. Diversion terraces generally are built on upslope soils to divert runoff. Tile drains require close spacing because the subsoil is clayey. Tilth becomes poor in places after frequent row cropping. Erosion is not a serious hazard. Organic-matter content is low. Capability unit IIIw–1; woodland suitability group 5w3.

Vesser Series

The Vesser series consists of somewhat poorly drained to poorly drained soils on bottom lands and foot slopes. These soils formed in alluvium under a native vegetation of prairie grasses.

In a representative profile the surface layer is very dark gray silt loam about 12 inches thick. The subsurface layer is 20 inches thick. It is gray to dark-gray, friable silt loam in the upper part and gray, slightly firm silty clay loam in the lower part. The subsoil to a depth of 60 inches or more is dark-gray, firm silty clay loam.

Vesser soils are subject to flooding and have a seasonally high water table. Available water capacity is high, and permeability is moderate. Natural fertility is medium. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is low to very low in available phosphorus and potassium, and is poorly aerated.

Areas that are drained and protected from flooding are among the most productive in the county. Most of the acreage is used for corn, soybeans, and meadow.

Representative profile of Vesser silt loam, 0 to 2 percent slopes, where the slope is 1 percent, in a cultivated field; 1,100 feet south and 100 feet east of the northwest corner of sec. 28, T. 69 N., R. 17 W.

Ap—0 to 8 inches, very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) when dry; moderate, fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—8 to 12 inches, very dark gray (10YR 3/1) silt loam; grayish brown (10YR 5/2) when dry; moderate, fine, granular structure; friable; medium acid; gradual, smooth boundary.

A21—12 to 18 inches, gray and dark-gray (10YR 5/1 and 4/1) silt loam, light gray (10YR 6/1 and 7/1) when dry; weak, medium, platy structure; friable; porous; few fine soft oxides; medium acid; gradual, smooth boundary.

A22—18 to 24 inches, gray (10YR 6/1 and 5/1) silt loam, light gray (10YR 7/1) when dry; weak, medium, platy structure; friable; porous; common, fine, dark, soft oxides; strongly acid; gradual, smooth boundary.

A23—24 to 32 inches, gray (10YR 5/1) light silty clay loam, light gray (10YR 7/1) when dry; weak, medium, prismatic structure breaking to weak, fine, subangular blocky; slightly firm; common very dark gray (10YR 3/1) fills in root channels and worm holes; common soft oxides; porous; strongly acid; clear, smooth boundary.

B1tg—32 to 42 inches, dark-gray (10YR 4/1) medium silty clay loam, light gray (10YR 6/1 and 7/1) when dry; weak, medium, prismatic structure breaking to weak, fine, subangular blocky; firm; common black (10YR 2/1) clay fills in root channels; common soft oxides; porous; strongly acid; gradual, smooth boundary.

B2tg—42 to 60 inches, black and dark-gray (10YR 2/1 and 4/1) medium silty clay loam; weak, medium, prismatic structure breaking to moderate, fine, subangular blocky; firm; thin discontinuous clay films; few soft oxides; porous; medium acid.

The A1 or Ap horizon ranges from 10 to 18 inches in thickness and from very dark gray (10YR 3/1) to black (10YR 2/1). The A2 horizon ranges from 16 to 22 inches in thickness and from gray (10YR 6/1) to grayish brown (10YR 5/2). The B1tg horizon ranges from dark gray (10YR 4/1) to grayish brown (10YR 5/2) and from light to medium silty clay loam. Layers of underlying material that are higher in clay content occur in places at a depth of 60 inches or more.

Vesser soils are associated with Amana, Olmitz, Humeston, Coppock, and Tuskeego soils. They differ from Amana and Olmitz soils in having a grayish A2 horizon. They have a B2t horizon that contains less clay than that of the Humeston soils. They have a darker, thicker A1 horizon and a grayer A2 horizon than Coppock and Tuskeego soils.

Vesser silt loam, 0 to 2 percent slopes (51A).—This soil is along streams and is subject to occasional flooding. Individual areas generally range from 10 to 30 acres in size.

This soil has the profile described as representative of the series. Included in mapping are small areas of a soil that has a thinner gray subsurface layer and contain more clay in the subsoil.

This soil, although flooded occasionally, is used mostly for cultivated crops. Areas that are flooded most frequently and those that are inaccessible are in pasture or trees. Where this soil is artificially drained and protected from flooding, it is well suited to row crops. The content of organic matter is medium, and tilth is generally good. This soil has poor natural drainage, and cultivation is often delayed unless the soil is artificially drained. Tile lines work well in draining this soil, because permeability is moderate in the subsoil. Crop response to applications of lime and fertilizer is favorable. Capability unit IIw–1; woodland suitability group 5w3.

Vesser silt loam, 2 to 5 percent slopes (51B).—This soil is on high second bottoms and on plane to slightly concave gentle foot slopes. It is downslope from the Caleb, Shelby, and Gara soils. This soil formed in alluvium and local sediments that washed from adjacent soils on uplands. Most areas of this soil slope 3 percent or less. Included in mapping on the lower parts of foot slopes are overwashed areas that have a thicker surface layer of recent loamy sediments.

This soil is well suited to row crops if it is adequately drained. Erosion is not a serious hazard. This soil is often wet because it receives excessive runoff and some seepage from adjacent uplands. The seepage can be reduced by tile drainage. In many places diversion terraces are built on soils on adjacent uplands to divert runoff from higher lying areas. The content of organic matter is medium, and tilth is generally good. Capability unit IIw–1; woodland suitability group 5w3.

Wabash Series

The Wabash series consists of very poorly drained soils in slack-water areas on level to slightly depressed flood plains. These soils formed in silty alluvium on bottom lands. In many places they are away from the stream channel and adjacent to foot slopes. They are likely to be the first flooded as they are generally slightly lower than surrounding soils on the bottom lands. These soils are of minor extent in the county.

In a representative profile the surface layer is black or very dark gray silty clay about 24 inches thick. The subsoil to a depth of about 60 inches is black to very dark gray, very firm silty clay.

Wabash soils are subject to flooding, and the water table is seasonally at or near the surface. Adequate drainage is difficult to provide. Available water capacity is high, and permeability is very slow. The shrink-swell potential is high. Natural fertility is medium. The surface layer is neutral and generally does not need lime. The subsoil is neutral, is high in available phosphorus, is very low in available potassium, and is poorly aerated.

The choice of crops grown on these soils is somewhat limited. Alfalfa is subject to winterkill. Surface ponding is common. Areas that are not drained are used for pasture.

Representative profile of a level Wabash silty clay, 526 feet east and 120 feet south of the northwest corner of sec. 2, T. 68 N., R. 17 W.

Ap—0 to 4 inches, very dark gray (10YR 3/1) silty clay, gray (10YR 5/1) when dry; weak, fine, granular structure; friable; neutral; clear smooth boundary.

A12—4 to 10 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) when dry; weak, fine, subangular blocky structure; firm; few concretions and soft oxides; neutral; clear, smooth boundary.

A13—10 to 17 inches, black (10YR 2/1) heavy silty clay, dark gray (10YR 4/1) when dry; weak to moderate, fine, subangular blocky structure; firm; few concretions and soft oxides; neutral; gradual, smooth boundary.

A14—17 to 24 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) when dry; few, fine, distinct mottles of dark reddish brown (5YR 3/3); moderate, fine, subangular blocky structure; firm; few concretions and soft oxides; neutral; gradual, smooth boundary.

B1g—24 to 31 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay; common, fine, distinct mottles of dark reddish brown (5YR 3/3), very dark gray (10YR 3/1) to dark gray (10YR 4/1) when dry; moderate, fine to medium, subangular blocky structure; very firm; common concretions and soft oxides; neutral; gradual, smooth boundary.

B2g—31 to 38 inches, black (10YR 2/1) to very dark gray (10YR 3/1) silty clay; few, fine, distinct mottles of dark reddish brown (5YR 3/3); moderate, medium, angular and subangular blocky structure; very firm; few concretions and soft oxides; neutral; gradual, smooth boundary.

B31g—38 to 45 inches, mixed black (10YR 2/1) and very dark gray (10YR 3/1) silty clay; few, medium, distinct mottles of dark reddish brown (5YR 3/4); moderate, medium, angular and subangular blocky structure; firm; few fine concretions; common soft oxides; neutral; gradual, smooth boundary.

B32g—45 to 60 inches, very dark gray (10YR 3/1) light silty clay; many, medium, distinct mottles of dark reddish brown (5YR 3/4) and yellowish red (5YR 4/6); weak, medium, angular and subangular blocky structure to massive; firm; many concretions and soft oxides; neutral.

The A horizon is light or medium silty clay and is black (10YR 2/1 to N 2/0) or very dark gray (10YR 3/1 to N 3/0). It ranges from 12 to 24 inches in thickness. Colors that have values of 3 or less extend to a depth of 40 inches in many places. The B horizon ranges in all parts from black (10YR 2/1) to very dark gray (10YR 3/1) and from heavy silty clay to clay. Reaction in the B horizon ranges from slightly acid to neutral. This soil formed in fine-textured alluvium that is more than 3½ feet thick. The content of sand is very low.

Wabash soils are associated with Zook, Colo, Vesser, Humeston, and Carlow soils. They have a more clayey B horizon than Zook and Colo soils. They do not have an A2 horizon as is typical of Vesser and Hueston soils. They are similar to Carlow soils, but they have a less mottled, darker, and less acid B horizon.

Wabash silty clay (0 to 2 percent slopes) (172).—Most areas of this soil are on nearly level bottom lands adjoining foot slopes. Some areas are in old bayous that have received deposits from streams but that are now a considerable distance from the stream channel. This soil formed in low areas where floodwater commonly stands long enough to allow the clay in it to settle. Individual areas range from 5 to 50 acres in size.

This very poorly drained soil is silty clay throughout the profile. When it is dry, this soil is extremely hard and has many cracks that extend from the surface into the subsoil. The soil then absorbs rainfall at a moderate rate for a short time until it is saturated and the cracks seal. After the cracks seal the surface layer is slowly permeable and the subsoil is very slowly permeable. Included in mapping are small areas that have an overwash of less clayey soil material and that are indicated by a spot symbol on the soil map.

If this soil is drained and properly managed, it is moderately suited to frequent row cropping. Because it ponds after heavy rains, excess water usually delays field operations in spring and fall and seedbeds are difficult to prepare. In periods of above-average rainfall, crops are occasionally lost. Flooding from streams is only occasional. Tile drains do not function well in this soil, but surface drains can be used to prevent ponding after rains. Areas that are not drained are used for pasture. The soil is high in organic-matter content. Tilth is improved by plowing in the fall and growing soybeans instead of corn. Capability unit IIIw-2; woodland suitability group 5w3.

Weller Series

The Weller series consists of moderately well drained to somewhat poorly drained soils on uplands. These soils are in the north-central and northeastern parts of the county and on benches along most of the major streams. They formed in leached loess 48 to 96 inches thick over a buried, reddish, clayey soil. These buried materials are similar to Keswick soils that formed in Kansan till. The soils on benches are underlain by stratified alluvium. The native vegetation was forest. Slopes range from 2 to 14 percent and are generally short and convex. These soils are upslope from Keswick and Lindley soils and are on landscape positions similar to those of Pershing, Grundy, and Lineville soils. Individual areas range from 5 to 30 acres in size.

In a representative profile the surface layer is very dark grayish-brown silt loam about 5 inches thick. The subsurface layer is grayish-brown, friable silt loam about 11 inches thick. The subsoil, about 24 inches thick, is mottled grayish-brown to brown, firm silty clay that grades to silty clay loam with increasing depth. The underlying material is mottled grayish-brown silty clay loam.

Weller soils erode readily if they are cultivated. Available water capacity is high, and permeability is slow. Natural fertility is low. The surface layer is acid unless it has been limed within the past few years. The subsoil is acid, is medium in available phosphorus, is very low in available potassium, and is moderately well aerated.

Some of the acreage is wooded, but where it has been cleared, row crops are occasionally grown on less sloping areas. Strongly sloping or eroded areas are better suited to pasture or meadow than to most other uses.

Representative profile of Weller silt loam, 2 to 5 percent slopes, on a stable ridgetop where the slope is 3 percent; 375 feet east and 300 feet north of the southwest corner of the SE¼NW¼ sec. 10, T. 70 N., R. 16 W.

A1—0 to 5 inches, very dark grayish-brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2 when dry; moderate, thin, platy structure; friable; strongly acid; abrupt, smooth boundary.

A21—5 to 11 inches, dark grayish-brown to grayish-brown (10YR 4/2 to 5/2) silt loam, light gray (10YR 7/2) when dry; weak, thin, platy structure; friable; few, very fine, iron-manganese concretions; very strongly acid; gradual, smooth boundary.

A22—11 to 16 inches, grayish-brown (10YR 5/2) silt loam, light gray (10YR 7/2) when dry; weak, medium, granular structure; friable; few, thin, light-gray (10YR 7/2) grainy coatings on peds; few, very fine, iron-manganese concretions; very strongly acid; clear boundary.

AB—16 to 19 inches, brown (10YR 5/3) light silty clay loam; few, fine, faint mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; friable to firm; few, thin, light-gray (10YR 7/2) grainy coatings on peds; very strongly acid; clear, smooth boundary.

B21t—19 to 25 inches, mixed grayish-brown and brown (10YR 5/2 and 5/3) medium silty clay; common, fine, faint mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; thin continuous clay films; few, very fine, iron-manganese concretions; strongly acid; gradual, smooth boundary.

B22t—25 to 32 inches, mixed grayish-brown (10YR 5/2) and brown (10YR 5/3) medium silty clay; few, fine, distinct mottles of yellowish brown (10YR 5/6); moderate, medium, subangular blocky structure; firm; thin discontinuous clay films; few, very fine, iron-manganese concretions; strongly acid; gradual, smooth boundary.

B3t—32 to 40 inches, grayish-brown (10YR 5/2) heavy silty clay loam; few, fine, distinct mottles of yellowish brown (10YR 5/6); weak, medium, subangular blocky structure; firm; few, thin, discontinuous clay films; few, very fine, iron-manganese concretions; strongly acid; gradual boundary.

C—40 to 60 inches, grayish-brown (10YR 5/2) silty clay loam; common, fine, faint mottles of brown (10YR 5/3) and few, fine, distinct mottles of yellowish brown (10YR 5/6); massive; firm; few black (10YR 2/1) fills in root channels; few, very fine, iron-manganese concretions; neutral.

The A1 horizon ranges from 2 to 5 inches in thickness and from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). The A2 horizon ranges from 5 to 12 inches in thickness and is dark grayish brown (10YR 4/2) or grayish brown (10YR 5/2). The B2t horizon ranges from grayish brown (10YR 5/2) to yellowish brown (10YR 5/4) and from light to medium silty clay. The range of clay maximum is 42 to 48 percent. The grayish B horizon colors are relict and related to a deoxidized and leached weathering zone. Reaction in the B horizon ranges from very strongly acid to medium acid. The depth to glacial till of clay texture ranges from 48 to 96 inches.

Weller soils are associated with Kniffin, Pershing, Rathbun, and Weswick soils. They have a thinner A1 horizon and a more distinct A2 horizon than Kniffin and Pershing soils. They have less clay in the B horizon than Rathbun soils. They have less reddish colors and a lower sand content in the B horizon than Keswick soils.

Weller silt loam, 2 to 5 percent slopes (132B).—This soil is on moderately wide ridgetops and slightly convex side slopes. Individual areas range from 5 to 30 acres in size.

This soil has the profile described as representative of the series. If it is cultivated, the thin surface layer becomes mixed with the lighter colored subsurface layer. Included in mapping are small areas of Beckwith and Rathbun soils.

Much of the acreage is still wooded, but the trees have been removed in places and the soil is cultivated or pastured. Under cultivation this soil erodes readily. The surface layer tends to seal during rains and become hard and crusty upon drying. The organic-matter content is low. This soil is moderately suited to row crops. Response to additions of lime and fertilizer is favorable. Capability unit IIIe-1; woodland suitability group 4w1.

Weller silt loam, 2 to 5 percent slopes, moderately eroded (132B2).—This soil is on gently sloping, rounded ridgetops. Individual areas are as large as 30 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is very dark grayish-brown to grayish-brown silt loam about 3 inches thick. The subsoil is silty clay about 16 to 20 inches thick. In most places plowing has mixed the thin surface layer with the subsurface layer.

This soil is moderately suited to row crops. Organic-matter content is low. Runoff is rapid, and the hazard of further erosion is severe. The surface layer tends to seal during rains and becomes hard and crusty upon drying. This soil is better suited to hay and pasture than to most other uses. Capability unit IIIe-1; woodland suitability group 4w1.

Weller silt loam, 5 to 9 percent slopes, moderately eroded (132C2).—This soil is on rounded ridgetops and on short, convex side slopes along the major stream valleys. This soil is upslope from Keswick and Ashgrove soils. Individual areas are as large as 35 acres in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is only about 3 inches thick. Depth to the silty clay subsoil is typically 10 to 14 inches. On the rounded shoulders of side slopes, the subsoil is exposed in places. In a few small spots plowing has mixed the subsoil with the surface layer.

Included with this soil in mapping are small areas of Lindley soils and areas of Weller soils that are only slightly eroded. Also included are small severely eroded areas of Weller soils that are indicated by severely eroded spot symbols on the soil map.

This soil is moderately suited to row crops. Runoff is rapid, and after rains the surface layer tends to seal and crust. What remains of the surface layer is low in organic-matter content and is subject to a severe hazard of further erosion if the soil is barren of vegetation. The soil is better suited to hay or pasture than to most other uses. Capability unit IIIe–2; woodland suitability group 4w1.

Weller silt loam, 9 to 14 percent slopes, moderately eroded (132D2).—This soil is at the crest of narrow ridges and is on strongly sloping side slopes. It is upslope from the foot slope soils. Individual areas are small in size.

This soil has a profile similar to that described as representative of the series, but the depth of the silty clay subsoil is only about 6 to 10 inches. Plowing mixes the subsurface layer with the surface layer, and in places exposes the clayey subsoil on rounded crests.

Included with this soil in mapping are small areas of Kniffin, Pershing, and Rathbun soils. Also included are a few small areas on high benches and in these places the loess parent material may have come from adjacent stream valleys.

Much of the acreage of this soil is pastured, but some is cultivated. Because of strong slopes and excessive runoff, the hazard of further erosion is severe unless a plant cover is maintained. This soil is low in organic-matter content. This soil is better suited to pasture or hay than to most other uses. Response to additions of lime and fertilizer is favorable. Capability unit IVe–2; woodland suitability group 4w1.

Weller silt loam, benches, 2 to 5 percent slopes (T132B).—This soil is on the loess-covered benches that extend out into the bottom lands. The moderately to strongly sloping, till-derived soils are generally upslope from this soil and the bottom land soils are downslope.

This soil has a profile similar to that described as representative of the series, but the underlying material below a depth of 6 to 10 feet generally is alluvial sediments of variable textures. The maximum clay content is commonly at a depth of 18 to 22 inches. Where this soil has been cultivated, the surface layer has been mixed with the subsurface layer in places. The underlying substratum has high seepage potential and low stability where deep cuts are made. Included in mapping are small areas of eroded Weller soils.

Much of the acreage is used for crops, but in some places it is still wooded. This soil erodes readily if it is cultivated. It is low in organic-matter content. Runoff is rapid. Content of moisture is favorable, and this soil is friable and easily worked. Capability unit IIIe–1; woodland suitability group 4w1.

Weller silt loam, benches, 5 to 9 percent slopes, moderately eroded (T132C2).—This soil is on benches along many of the major stream valleys and on side slopes and short ridges upslope from the bottom land soils. Individual areas are small in size.

This soil has a profile similar to that described as representative of the series, but the surface layer is thinner, and the underlying material below a depth of 6 to 10 feet is more variable in texture. The underlying material has high seepage potential and low stability where deep cuts are made. The surface layer is 3 to 6 inches thick over a grayish-brown subsurface layer about 3 inches thick. The subsoil is silty clay 14 to 20 inches thick. The horizon of maximum clay content is commonly at a depth of 16 to 18 inches. Plowing exposes the subsoil in places at the edge of slope shoulders and at the head of waterways. Included in mapping are small, noneroded areas and a few severely eroded spots that are indicated by a severely eroded spot symbol on the soil map.

Much of the acreage is used for crops, but it is better suited to hay or pasture. This soil is subject to a severe hazard of further erosion. The surface layer is low in organic-matter content, and tilth is generally poor. Using the soil as meadow generally improves soil tilth. After rains the surface tends to crust. The soil responds well to applications of lime and fertilizer or manure. Capability unit IIIe–2; woodland suitability group 4w1.

Wiota Series

The Wiota series consists of moderately well drained soils along the major stream valleys. These soils formed in silty alluvium on second bottoms or low stream benches under a native vegetation of prairie grasses. They are on lower stream benches than Pershing and Weller soils on benches. They are generally surrounded by soils of first bottom lands. Slopes are 1 to 3 percent. Individual areas range from 5 to 15 acres in size.

In a representative profile the surface layer is very dark brown and very dark grayish-brown silt loam about 14 inches thick. The subsoil to a depth of 60 inches or more is brown silty clay loam that grades to grayish brown with increasing depth.

Wiota soils are not subject to flooding (fig. 16). Available water capacity is high, and permeability is moderate. Natural fertility is medium. The subsoil is acid, is very low in available phosphorus, is low to medium in available potassium, and is moderately well aerated. The surface layer is neutral and generally does not need additions of lime.

Wiota soils are among the most productive soils in the county. Most of the acreage is used for corn and soybeans.

Representative profile of Wiota silt loam, 1 to 3 percent slopes, in a cultivated field on a second bottom of the Chariton River; 50 feet south and 190 feet west of the northeast corner of the SE¼SW¼ sec. 35, T. 69 N., R. 17 W.

Ap—0 to 8 inches, very dark brown (10YR 2/2) heavy silt loam, dark grayish brown (10YR 4/2) when dry; cloddy, breaking to weak, fine, granular structure; friable; neutral; gradual, smooth boundary.

A3—8 to 14 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) when dry; faces of peds very dark brown (10YR 2/2); moderate, medium, granular structure; friable; medium acid; gradual, smooth boundary.

B1—14 to 19 inches, dark-brown (10YR 3/3) light silty clay loam; faces of peds very dark grayish brown (10YR 3/2); moderate, fine, subangular blocky structure; friable; very few, thin, patchy clay films; strongly acid; gradual, smooth boundary.

B21t—19 to 27 inches, brown (10YR 4/3) medium silty clay loam; weak, fine, prismatic structure breaking to moderate, fine, subangular blocky; friable; few, thin, discontinuous clay films; few, dark, soft oxides; strongly acid; gradual, smooth boundary.

B22t—27 to 34 inches, brown (10YR 4/3) medium silty clay

***Figure 16.*—Chequest soils in foreground are subject to flooding. Farm buildings are on Wiota soils.**

loam; faces of peds grayish brown (10YR 5/2) and brown (10YR 5/3); common, fine, distinct mottles of yellowish brown (10YR 5/6) and few, fine, faint mottles of grayish brown (10YR 5/2) on ped interiors; weak, fine, prismatic structure breaking to moderate, medium, subangular blocky; friable; few, thin, discontinuous clay films; few soft oxides; strongly acid; gradual, smooth boundary.

B31—34 to 46 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) medium silty clay loam; faces of peds grayish brown (2.5Y 5/2); weak, medium, prismatic structure breaking to weak, moderate, subangular blocky; firm; few discontinuous clay films; common soft oxides; common discontinuous light-gray (10YR 7/1) grainy ped coatings; strongly acid; gradual, smooth boundary.

B32—46 to 60 inches, mottled grayish-brown (2.5Y 5/2) and yellowish-brown (10YR 5/6) medium clay loam; faces of peds grayish brown (2.5Y 5/2); weak, medium, prismatic structure breaking to weak, moderate, subangular blocky; firm; few discontinuous clay films; common soft oxides; common discontinuous light-gray (10YR 7/1) grainy ped coatings; strongly acid; gradual, smooth boundary.

The A horizon ranges from 13 to 20 inches in thickness and from very dark brown (10YR 2/2) to very dark gray (10YR 3/1). It is generally silt loam, but ranges from loam to light silty clay loam. The B2t horizon ranges from brown (10YR 4/3) to grayish brown (10YR 5/2) and from light to medium silty clay loam or clay loam. A few mottles commonly are in the lower part of the B horizon. Reaction of the B2t horizon ranges from slightly acid to strongly acid. The C horizon ranges widely in texture and color, depending upon the amount of stratification.

Wiota soils are associated with Colo, Kennebec, Olmitz, and Vesser soils. They have less clay and more sand in the solum than Colo soils. They have more clay in the B horizon than Kennebec soils. They have a greater B horizon and contain less sand than Olmitz soils. They do not have the thick A2 horizon layer that is typical of Vesser soils.

Wiota silt loam, 1 to 3 percent slopes (7A).—This soil is on second bottoms in major stream valleys. Slopes are dominantly less than 2 percent. In most places this soil is in small, elevated areas within first bottoms.

In most places this soil contains more medium sand in the subsoil than is typical of the series. In a few places coarse sand or gravel are at a depth of 40 inches or more.

Many areas are cultivated along with the soils on adjoining bottom lands. This soil is well suited to row crops. It contains few waterways, but surface drainage is adequate in most places. Tilth is not a problem. This soil warms up quickly and can be worked earlier in the spring than soils that have a more developed profile. Organic-matter content is high. Corn frequently responds very well to applications of fertilizer. Capability unit IIe–2; woodland suitability group 5w2.

Zook Series

The Zook series consists of poorly drained soils on bottom lands on flood plains in slack-water areas away from the stream channel. These soils formed in fine-textured alluvium.

In a representative profile the upper 17 inches of the surface layer is black silty clay loam. Below this is about 6 inches of black silty clay. The subsoil extends to a depth of 60 inches or more. It is black to very dark gray, firm silty clay that grades to firm silty clay loam in the lower part. Mottling begins at a depth of about 37 inches. Mottles are generally brownish colored.

Zook soils are subject to flooding, and the water table is seasonally at or near the surface. Available water capacity is high, and permeability is slow. Natural fertility is medium. The surface layer is neutral and generally does not need additions of lime. The subsoil is acid, is medium in available phosphorus, is high in available potassium, and is poorly aerated.

If artificially drained, these soils are fairly well suited to row crops. Undrained areas are commonly used for permanent pasture. These soils are often ponded for several days after rains.

Representative profile of Zook silty clay loam, 0 to 2 percent slopes; 80 feet west and 970 feet south of the northeast corner of sec. 2, T. 68 N., R. 17 W.

Ap—0 to 6 inches, black (10YR 2/1) to very dark gray (10YR 3/1) light silty clay loam, dark gray (10YR 4/1) when dry, dark gray (10YR 3/1) when kneaded; moderately fine, granular structure; friable; neutral; abrupt, smooth boundary.

A12—6 to 11 inches, black (10YR 2/1) medium silty clay loam, dark gray (10YR 4/1) when dry; few, fine, faint, dark grayish-brown (10YR 4/2) mottles; moderate, medium, angular and subangular blocky structure; firm; compacted in upper part of horizon (plowpan); neutral; clear, smooth boundary.

A13—11 to 17 inches, black (10YR 2/1) heavy silty clay loam, dark gray (10YR 4/1) when dry; moderate, very fine, subangular blocky structure; firm; few fine concretions and soft oxides; neutral; clear, smooth boundary.

A3—17 to 23 inches, black (10YR 2/1) light silty clay, dark gray (10YR 4/1) to gray (10YR 5/1) when dry; moderate, very fine, subangular and fine, angular blocky structure; firm; few fine concretions and soft oxides; few grainy ped coatings when dry; neutral; gradual, smooth boundary.

B1—23 to 29 inches, black (10YR 2/1) medium silty clay, dark gray (10YR 4/1) when dry; common, fine, distinct mottles of yellowish brown (10YR 5/8); moderate, medium, prismatic structure breaking to fine, angular blocky; firm; few fine concretions and soft oxides; few grainy ped coatings when dry; medium acid; gradual, smooth boundary.

B2—29 to 37 inches, black (10YR 2/1) medium silty clay; weak, medium, prismatic structure breaking to medium subangular blocky; firm; few concretions and soft oxides; medium acid; gradual, smooth boundary.

B31—37 to 44 inches, black (10YR 2/1) to very dark gray 10YR 3/1) light silty clay; few, fine, faint mottles of dark brown to brown (10YR 4/3); weak, medium, prismatic structure breaking to subangular blocky; firm; few concretions and soft oxides; slightly acid; gradual, smooth boundary.

B32—44 to 60 inches, black (10YR 2/1) and very dark gray (10YR 3/1) heavy silty clay loam; few, fine, faint mottles of dark brown to brown (10YR 4/3); weak, medium, prismatic structure; firm; few concretions and soft oxides; slightly acid.

The A horizon ranges from black (10YR 2/1 to N 2/0) to very dark gray (10YR 3/1) and from 32 to 42 percent in content of clay. It is silty clay loam to a depth of 12 to 24 inches. The B horizon is black (10YR 2/1) to very dark gray (10YR 3/1). Colors that have a value of 3 or less extend to a depth of 36 inches or more. The B horizon ranges from heavy silty clay loam to light or medium silty clay and from 36 to 46 percent in content of clay.

Zook soils are associated with Colo, Chequest, Wabash, Humeston, and Vesser soils. They differ from Colo and Chequest soils in having a finer textured B horizon, but they are not so fine textured in the B horizon as Wabash soils. They differ from Humeston and Vesser soils in not having a grayish-colored A2 horizon.

Zook silty clay loam, 0 to 2 percent slopes (54A).—This soil is on first bottoms in the wider stream valleys. It parallels river channels in many places, and it is generally away from the channel and adjacent to uplands or valley foot slopes. Individual areas are 30 acres or less in size.

This soil has the profile described as representative of the series. Included in mapping are a few low depressional areas of Wabash soils and small spots that have an overwash of loamy materials, indicated by a special spot symbol on the soil map.

Poor drainage and occasional flooding are the main limitations to use and management of this soil. It is generally farmed along with soils that are better suited to cultivated crops. If this soil is cultivated, it needs to be drained by open ditches. It puddles if it is worked when wet. Fields that are artificially drained are well suited to row crops. Undrained areas are better suited to pasture. Harvest is sometimes delayed because of surface wetness. The slowly permeable subsoil makes proper spacing of tile drains essential. Crop response to applications of fertilizer is good. Capability unit IIw–1; woodland suitability group 5w3.

Zook silty clay loam, 2 to 5 percent slopes (54B).—This soil is on flat to slightly concave alluvial or colluvial foot slopes downslope from Gara and Lindley soils. In places it is downslope from the Sogn-Gosport-Clanton soil complex and fans out to the soils on bottom lands. It is in small areas near streams and rivers. Slopes are chiefly 3 percent or less.

This soil has a profile similar to that described as representative of the series, but in places it contains a higher amount of fine sand. The alluvial material in which this soil formed was recently deposited erosional sediments from adjacent side slopes of uplands. The surface layer is mostly silty clay loam, but ranges to gritty clay loam or to clay loam in places. Thickness of the surface layer ranges from 16 to 24 inches.

This soil is well suited to frequent row cropping where it is protected from runoff and is drained. Areas are small and are managed along with adjacent soils. Erosion is not a serious hazard. This soil generally is wet because it receives excessive runoff and seepage from adjacent uplands. Diversion terraces are built on many of the adjacent higher slopes to divert runoff from uplands. Capability unit IIw–1; woodland suitability group 5w3.

Use and Management of the Soils

The soils of Appanoose County are used chiefly for crops and pasture. This section tells how the soils can be used for these purposes. The system of capability classification used by the Soil Conservation Service is explained, the groups of soils are described, and the use and management of the soils are suggested. Predicted yields of the principal crops grown in the county are shown in table 3.

This part of the survey also contains information on woodland, wildlife, and recreation. It reports data from engineering tests and interpretations of soil properties that affect highway construction and other engineering structures.

Management of Crops and Pasture

About 137,000 acres, or about 41 percent, of Appanoose County is used for crops. About 148,000 acres, or about 44 percent, is used for pasture. Much of the approximately 40,000 wooded acres is also used for pasture and is included in the pasture acreage. Also included in the pasture acreage is about 44,000 acres of cropland used for pasture.

Corn, soybeans, legumes, and legume-grass hay are the main crops. Smaller acreages are in oats, wheat, and sorghum. Alfalfa is the principal hay crop along with timothy, red clover, and grass mixtures of brome, bluegrass, and birdsfoot trefoil. Birdsfoot trefoil is used mostly as a pasture forage legume, but is gaining recognition as a hay and seed crop.

Most pastures in the county are permanent bluegrass. Some have been renovated, and such plants as birdsfoot trefoil have been introduced. Such grass-legume mixtures as alfalfa-bromegrass are also pastured. Many of these pastures are of low quality, but under improved management that includes applications of fertilizer and lime, the quantity and quality of forage can be greatly improved. Several acres of Lindley and Gara soils have been cleared of trees and seeded to permanent improved pasture.

Such conservation measures as minimum tillage, maximum use of crop residue, terraces, tillage on the contour, and grassed waterways are used to reduce soil erosion on Seymour, Grundy, Pershing, and Shelby soils that are subject to sheet erosion. Diversion terraces are used in places upslope from Olmitz soils to reduce runoff from the higher lying soils on these alluvial foot slopes. Gully control structures, farm ponds, and grassed waterways are used to control gullying in watercourses. The farm ponds also furnish water for livestock and recreation.

In a few places levees are used to protect bottom lands from flooding, but this is not a common practice. The Rathbun Reservoir will reduce flooding on the Chequest, Zook, and Wabash soils on bottom land of the Chariton River.

Drain tiles are used to reduce wetness in the Colo, Zook, and Chequest soils. Interceptor tiles are used to reduce wetness in the Lamoni and Clarinda soils. In places, surface drains are used to remove excess water from such soils as Wabash and Carlow, because tile drains do not work well in these soils that have a high clay content.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, for forest trees, or for engineering.

In the capability system, all kinds of soil are grouped at three levels—the capability class, subclass, and unit. These are described in the following paragraphs.

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, 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, require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants, 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 largely to pasture or range, woodland, or wildlife.

Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife, or water supply, or to esthetic purposes. (None in Appanoose County.)

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 too cold or too dry.

In Class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in Class V are subject to little or no erosion, although they have other limitations that restrict their use largely to pasture, range, woodland, wildlife, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe–2 or IIIw–1. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass, or kind of limitation, as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In the following pages the capability units in Appanoose County are described and the use and management of the soils are suggested. The mention of the soil series represented in each capability unit does not mean that all the soils in the series are in the unit. To determine the soils in a capability unit, refer to the "Guide to Mapping Units" at the back of this survey.

CAPABILITY UNIT I–1

This unit consists of nearly level, moderately well drained to somewhat poorly drained soils on bottom land. These soils are in the Amana, Kennebec, and Nodaway series. They have a silt loam surface layer and subsoil or underlying material. Most of the rain that falls in normal amounts is readily absorbed, and permeability is moderate. Available water capacity is high.

These soils are easy to work and easy to keep in good tilth. Because they warm up quickly in spring, they can be worked somewhat sooner than the associated soils on bottom land. Internal drainage is only slightly restricted, and the soils are seldom wet. Erosion is no problem.

These soils are well suited to cultivated crops. Row crops can be grown year after year, but protection from flooding is needed in some years. Much of the acreage is cultivated, but some areas are used for pasture and woodland. Corn and soybeans are the major crops, but oats and hay are also grown. The pasture or woodland is generally along the main channel of streams and is flooded more often than cultivated fields. In some places, old bayous can be drained through open ditches and stream channels straightened to reduce the hazard of flooding.

Crops respond well to fertilizer. Corn that does not follow a legume needs nitrogen and, in smaller amounts, phosphorus and potassium. A legume seeding responds well to phosphorus. Lime is needed in some places.

CAPABILITY UNIT IIe–1

The one soil in this unit, Grundy silty clay loam, 2 to 5 percent slopes, is gently sloping and somewhat poorly drained. It has a silty clay loam surface layer and a silty clay subsoil. Much of the rainfall is absorbed and held available for plants. Permeability of the subsoil is slow. Available water capacity is high.

The soil in this unit is well suited to cultivated crops, but the slope makes it subject to sheet erosion. Generally wetness is no problem. Soil tilth is good. The content of organic matter is high.

Much of the acreage is cultivated. Corn and soybeans are the main crops, but oats, hay, and pasture also grow well. If the soil is protected by terraces and tilled on the contour, it can be used for row crops year after year. Eliminating weeds and insects and maintaining tilth are likely to be difficult.

This soil responds very well to fertilizer. Corn that does not follow a legume generally needs nitrogen. Small grain and legumes respond very well to applications of phosphorus and potassium. In most places the soil requires additions of lime.

CAPABILITY UNIT IIe–2

This unit consists of gently sloping, well-drained to somewhat poorly drained soils on colluvial foot slopes, alluvial fans, and smaller higher areas within the flood plains. These soils are in the Cantril, Olmitz, and Wiota series. Wiota soils generally are on higher areas within the flood plain, but are not subject to flooding. They have a loam or silt loam surface layer and a loam to silty clay loam subsoil. Permeability is moderate in Olmitz and Wiota soils and moderate to moderately slow in Cantril soils.

These soils warm up early in spring and dry out quickly after rains. They normally are in very good tilth. Erosion is a slight hazard. These soils receive some deposition from steeper soils upslope. These deposits are less fertile and are lower in organic-matter content than the original surface layer. Wetness is not a limitation in most places, but some small areas of Cantril soils need tile. Available water capacity is high or moderate. The organic-matter content is low to high.

These soils are well suited to row crops and other crops commonly grown in the county. Corn is the main row crop, but soybeans, small grain, and hay or pasture are also grown (fig. 17). Areas of these soils generally are small. Where it is more practical, these soils are farmed along with the steeper adjacent soils upslope and are used for hay or pasture. Other areas of soils are row cropped intensively along with more poorly drained alluvial soils downslope. Diversion terraces are used to intercept runoff from the steeper soils upslope and to reduce deposition. Tilling on the contour

***Figure 17.*—Gently sloping Olmitz soil on colluvial foot slopes in background is used for pasture and corn.**

reduces runoff and erosion. If these practices are used, row crops can safely be grown often. An occasional meadow crop or a green-manure crop can be grown if soil tilth becomes poor or if weeds or insects become a problem. Generally, tilth is easily maintained by returning crop residues to the soil surface.

The soils in this unit respond very well to fertilizer. Small grain and legumes respond well to applications of phosphorus and potassium. In most places these soils, especially Cantril soils, need additions of lime.

CAPABILITY UNIT IIw-1

This unit consists of nearly level and gently sloping, moderately well drained to poorly drained soils on first bottoms along drainageways and on low foot slopes. These soils are in the Amana, Olmitz, Chequest, Colo, Coppock, Landes, Radford, Vesser, and Zook series. These soils have a fine sandy loam, loam, silt loam, or silty clay loam surface layer. The subsoil ranges from fine sandy loam to silty clay and is moderately permeable to slowly permeable. Only the Landes soils have a fine sandy loam surface layer and upper part of the subsoil. Olmitz soils are mapped with Vesser and Colo soils.

These soils are excessively wet because they are flooded, the water table is high, or both. The movement of water and air in them is slightly restricted. The Chequest, Colo, and Zook soils dry out somewhat slowly in spring and cannot be worked as soon after rains as many soils. Tilth is generally good if wetness is controlled, but the soils puddle if they are worked when wet. Available water capacity is high in all of these soils, except Landes soils, in which it is moderate.

Erosion is a hazard only where an active gully or a stream channel forms. Before draining into a major stream or river channel, water from runoff collects on these soils and drains across them. The soils of this unit are flooded occasionally and are damaged by sediments and excess water.

These soils are well suited to cultivated crops, but some require artificial drainage. Much of the acreage can be drained by tile drains or by surface ditches and farmed intensively. Most areas of these soils are large enough to be managed separately, but the Olmitz, Vesser, and Colo soils in small drainageways are often farmed along with adjacent soils on uplands.

Corn and soybeans are suited to these soils and are the main crops. Also suited are small grain, hay, and pasture. These soils are easier to manage if drainage is improved, but they are farmed in many places without drainage or protection from overflow. If tilth is poor, oats can be seeded with a green-manure crop.

All crop residue should be returned to the soil to maintain the content of organic matter and to improve tilth. To divert runoff from some areas of these soils, diversion terraces are built at the base of upland slopes.

Where rowcropping is intensive, these soils need additions of fertilizer and lime for continued good crop growth. Unless corn follows a legume in the rotation, additions of nitrogen generally are needed. Small grain and legumes respond well to applications of phosphorus and potassium.

CAPABILITY UNIT IIw-2

The one soil in this unit, Haig silty clay loam, is a nearly level soil on uplands. It formed in loess. It is poorly drained and has a fine-textured, mottled subsoil that is very slowly permeable. The surface layer is silty clay loam. Surface runoff is slow. The water table is generally high in spring and in autumn, but is somewhat lower during July or August.

Tilth is generally good, but the surface layer puddles easily if worked when wet. Available water capacity is high. This soil warms slowly in spring and dries slowly after rains.

This soil is intensively row cropped, and if drained, is well suited to row crops. It is also suited to oats, hay, and pasture (fig. 18). Corn and soybeans are the main row crops.

Shallow surface ditches are needed. In individual areas, slow runoff and restricted drainage can delay planting and cause crops to mature late. Crops in undrained areas generally are not lost, but they do not grow well. In years of high rainfall, early maturing crops should be planted. If tilth is poor, oats can be seeded with a green-manure crop. All crop residue should be returned to the soil to maintain the content of organic matter.

Applications of fertilizer are needed for continued good growth of crops. Crops respond well in drained areas. Unless corn follows a legume in the rotation, additions of nitrogen are needed. Additions of lime are required.

CAPABILITY UNIT IIIe-1

This unit consists of gently sloping soils that formed in loess on uplands. These moderately well drained to somewhat poorly drained soils are in the Rathbun and Weller series. They have a silt loam surface layer and a very slowly permeable or slowly permeable silty clay subsoil. Available water capacity is high.

These soils can be worked only within a narrow range of moisture content. The surface layer tends to crust after rains. Tilth is generally only fair. The

Figure 18.—**Meadow on Haig silt loam, artificially drained.**

organic-matter content is low. Erosion on these soils is a hazard.

These soils are moderately suited to cultivated crops if erosion is controlled. Corn and soybeans are the main row crops, but grain, sorghum, and hay are also suited (fig. 19). Some areas are in permanent pasture or native trees. Row crops planted on the contour help to reduce soil loss. Oats and meadow are often included in a cropping rotation to help reduce erosion. Terraces and contour tillage are used to reduce runoff onto adjacent soils. Contour tillage on some of the benches is more practical than terracing because of the irregular soil pattern. All crop residue should be returned to the soil to maintain the content of organic matter, improve tilth, and reduce erosion.

Applications of fertilizer are needed for continued good crop growth. Mixtures of legumes and grasses respond well to phosphorus and nitrogen fertilizer. These soils need additions of lime.

CAPABILITY UNIT IIIe-2

This unit consists of moderately sloping soils that formed in loess on uplands. These moderately well drained to somewhat poorly drained soils are in the Rathbun and Weller series. They have a silt loam surface layer and a very slowly permeable or slowly permeable silty clay subsoil. They absorb water slowly. Available water capacity is high.

Runoff on these soils is rapid. The hazard of erosion is severe. The surface layer tends to crust after rains. The organic-matter content is low. These soils can be worked only within a narrow range of moisture content if a good seedbed is to be established.

If erosion is controlled, these soils are moderately suited to cultivated crops. Corn, oats, and hay or pasture are the main crops. Some areas remain in native vegetation of trees or have been cleared and are used as permanent pasture. Contour tillage, terraces, and use of oats or meadow in a rotation are effective in reducing soil erosion. Terrace channels that expose the fine-textured subsoil may require special treatment with fertilizer to restore productivity. Moderately eroded areas require intensive management if an adequate plant cover is to be maintained. Returning all crop residue to the soil helps to reduce soil loss and maintain soil tilth.

Crops and pasture grown on these soils respond to applications of fertilizer. Unless corn follows a legume in the rotation, additions of nitrogen are generally needed. Legumes respond very well to applications of phosphorus and potassium. Additions of lime are needed for maximum crop growth.

CAPABILITY UNIT IIIe-3

This unit consists of gently sloping soils that formed in loess on uplands. These soils are moderately well drained to somewhat poorly drained. They are in the Kniffin, Lineville, Pershing, and Seymour series. The silt loam surface layer is underlain by a silty clay or clay subsoil. These soils absorb rainfall slowly. Per-

Figure 19.—Cleared areas of Weller soils are suited to meadow or permanent pasture.

meability is very slow in Kniffin and Seymour soils, slow in Pershing soils, and moderately slow in Lineville soils. Available water capacity is high. These soils are somewhat poorly aerated.

The hazard of erosion is severe. Some areas of Pershing soils are moderately eroded. Natural fertility is low to medium. Tilth is generally good, but it can be destroyed if the soils are worked when wet.

Erosion is a limitation to use, but if erosion is controlled these soils are moderately suited to cultivated crops. Corn and soybeans are the main crops, but oats, hay, or pasture are also well suited (fig. 20). Use of terraces, tillage on the contour, and a rotation that includes oats or meadow are effective in keeping soil loss to a minimum. If row crops are grown year after year, it is difficult to control weeds and insects and to maintain tilth and fertility. Minimum tillage and use of crop residues are effective in reducing soil loss and maintaining soil tilth.

Crops on these soils respond very well to fertilizer. Unless corn follows a legume in the rotation, additions of nitrogen are generally needed. Small grain and legumes respond very well to applications of phosphorus and potassium. Additions of lime are needed for maximum crop growth.

CAPABILITY UNIT IIIe-4

This unit consists of moderately sloping, moderately well drained to somewhat poorly drained soils that formed in loess on uplands. These soils are in the Kniffin, Pershing, Lineville, and Seymour series. They have a silt loam surface layer. The subsoil is clayey, and permeability is moderately slow to very slow. The soils in this unit absorb rainfall slowly. Available water capacity is high. These soils are somewhat poorly aerated.

The hazard of erosion is severe. Some areas of Pershing, Lineville, and Seymour soils are moderately eroded. The content of organic matter is medium to low. Tilth is generally good. If these soils are worked when wet, they puddle easily and are cloddy and hard when they dry.

These soils are moderately suited to cultivated crops. Much of the acreage of these soils is in cultivated crops. Corn, soybeans, and hay are the main crops, but oats or pasture are also well suited. If row crops are planted, contour tillage and terracing are needed. Where subsoil material is exposed in the terrace channels, additions of topsoil and manure are needed. Leaving crop residue on the surface helps to control erosion by improving the rate of water intake and by reducing runoff. Grassed waterways are needed to prevent the formation of gullies in areas where water accumulated.

Crops grown on these soils, particularly row crops that are planted frequently, respond well to applications of fertilizer. Unless corn follows a legume in the

Figure 20.—**Improved permanent pasture on Pershing soil.**

rotation, additions of nitrogen are needed. Oats and meadows respond well to a phosphorus fertilizer. These soils need lime, particularly for legume crops.

CAPABILITY UNIT IIIe-5

This unit consists of somewhat poorly drained to moderately well drained, moderately sloping soils that formed in till and old alluvium. These soils are in the Adair, Armstrong, Keswick, and Mystic series. They have a loam, clay loam, or silt loam surface layer, except for some small areas of severely eroded Armstrong and Mystic soils that have a loam to clay surface layer. The subsoil is clayey, and permeability is mainly slow. Mystic soils are very slowly permeable. Available water capacity is high. Aeration is seasonally poor. Narrow seepage bands occur where these soils border upslope soils that formed in loess.

These soils are subject to sheet erosion and gully erosion because they have moderate slopes and take in water slowly. They are seasonally wet because of seepage from more permeable soils upslope. Runoff is fairly rapid, and erosion is difficult to control. Organic-matter content is low to medium. Tilth is generally satisfactory, but the soils puddle if they are worked when wet, and they are cloddy and hard when they dry.

These soils are moderately suited to cultivated crops, but they are better suited to semipermanent pasture or hay. Corn, soybeans, oats, hay, and pasture plants are suited. Permanent pasture or scattered stands of trees are on some areas of the uneroded soils. In some areas these soils are not cultivated, because they are surrounded by other soils that are suited only to pasture or trees.

If these soils are used for row crops, contour tillage or terracing is needed to prevent excessive loss of soil and water. Where subsoil material is exposed in the terrace channels, additions of topsoil and manure are needed. Interceptor tile drains are needed in many places to control seepage and should be placed upslope from and parallel to the seep line.

These soils require fertilizer for good crop growth. Oats respond well to applications of nitrogen and phosphorus. Additions of lime and phosphorus are needed for good stands of meadow. Unless corn follows a legume in the rotation, additions of nitrogen and phosphorus are needed.

CAPABILITY UNIT IIIe-6

This unit consists of moderately well drained, strongly sloping soils that formed in till. These soils are in the Shelby series. They have a loam surface layer and a clay loam subsoil. Permeability is moderately slow. Moisture and air generally move easily in these soils, and wetness is not a hazard. Available water capacity is high.

Erosion is a serious hazard, and in some areas the rate of water intake has been reduced somewhat because of the crusting of the eroded surface. These soils are easy to work, and they warm up quickly in spring. They can be worked fairly soon after rains. Because slopes are strong, some of the water that falls on the surface is not absorbed. Organic-matter content is generally low.

These soils are moderately suited to cultivated crops. Corn and soybeans are the main row crops, but oats, hay, and pasture are also suited. If row crops are planted, tillage on the contour and terraces are needed to control erosion. Some areas of these soils are not used for cultivated crops because they are surrounded by areas of other soils that are suited only to pasture. Forage crops grow well on these soils. Individual areas are generally large enough to be managed separately. If the soils are not terraced, they can be seeded to hay or pasture. Before a depleted pasture or hay meadow is reseeded, the soils generally are plowed on the contour and planted to a row crop.

Fertilizer is needed for good crop growth. All corn needs a phosphorus fertilizer, and corn that does not follow a legume in the rotation generally needs additions of nitrogen. Oats need some nitrogen and large amounts of phosphorus in places. Legumes need additions of phosphorus and lime. These soils need lime in varied amounts.

CAPABILITY UNIT IIIw-1

This unit consists of nearly level to gently sloping, poorly drained soils on bottom lands and low foot slopes. These soils are in the Humeston and Tuskeego series. They have a silt loam surface layer that is underlain by a bleached layer. The subsoil is mottled silty clay that is slowly permeable to very slowly permeable. Available water capacity is high.

The water table is high at times, but is somewhat lower in summer. The movement of air and water in these soils is restricted. Root development of some plants is limited because of the fine-textured subsoil and the perched high water table. These soils are generally in good tilth unless they are worked when wet. The surface layer puddles readily if worked when wet. Organic-matter content is low to medium.

These soils are only moderately suited to cultivated crops. Soybeans, corn, small grain, hay, and pasture are grown. Soybeans are generally grown more frequently than corn. Wetness is the main limitation to use. The water table is close to the surface at times because internal drainage is very low. Undrained soils are better suited to permanent vegetation than to row crops. Row crops can be grown if these soils are drained. Some of the acreage is not drained and is in permanent vegetation. Tile drainage does not work well in these soils, but shallow ditches can be used on the bottom lands. Diversion terraces upslope from the soils on foot slopes help to divert water and reduce wetness.

Additional plant nutrients are needed if these soils are used for row crops. Crop response to fertilizer is generally moderate. Unless corn follows a legume in the rotation, additions of nitrogen are needed. Both corn and legumes need a phosphorus fertilizer and need some potassium in places. These soils need additions of lime, particularly for legume crops.

CAPABILITY UNIT IIIw-2

This unit consists of poorly drained and very poorly drained soils on the bottom land. These soils are in the

Carlow and Wabash series. In most places they have a silty clay surface layer and subsoil. They absorb rainfall very slowly and have a high available water capacity. They are poorly aerated or very poorly aerated. They warm up slowly in spring and cannot be worked as soon after normal rains as surrounding soils. The water table is high at times. Runoff is very slow and often ponds. Carlow soils are more acid than Wabash soils.

These soils are difficult to work, and they puddle easily even if drained. The surface layer becomes cloddy and hard when it dries, and deep cracks form in midsummer. Not all of the moisture held in the soil is available for plant use because the content of clay is high. The soils are fertile and acid. They contain large amounts of organic matter.

If drained, these soils are moderately suited to cultivated crops. Undrained areas are suited to pasture (fig. 21). Excess water is a severe limitation. Floodwater from adjacent streams and runoff from uplands are generally more frequent on these soils than on most other soils on the bottom land. The growth of roots is restricted by wetness and poor aeration.

Most areas of these soils are large and can be farmed separately. Some drained fields are used for corn or soybeans, and others for small grain or meadow. Soybeans are generally better suited than corn. Row crops can be grown frequently. Growth of crops depends on artificial drainage. Properly graded shallow ditches remove excess water. Tile drainage does not work in these fine-textured soils. Protection from runoff and flooding is difficult. The soils are usually plowed in fall so that workability is improved by freezing and thawing. Planting is often delayed, however, even when the soils are plowed in fall.

If planted to row crops frequently, these soils require additions of nitrogen and phosphorus and generally require additions of lime and potassium.

CAPABILITY UNIT IIIw-3

This unit consists of poorly drained, very slowly permeable, nearly level soils that formed in loess on uplands. These soils are in the Appanoose, Beckwith, Belinda, and Edina series. They have a silt loam surface layer that is underlain by a bleached layer. The subsoil is clayey, and these soils do not absorb moisture readily. They are poorly drained because runoff is slow and the water table is seasonally high. Available water capacity is high.

These soils are generally in good tilth, but they puddle if worked when wet and are cloddy and hard when they dry. They are slow to warm in spring, and they dry out slowly after rains. These soils are medium to low in content of organic matter. Erosion is not a

Figure 21.—**Pasture and meadow on Carlow soil.**

hazard. In years of heavy rainfall, slow runoff and restricted drainage delay planting in places and cause crops to mature late.

These soils are moderately suited to cultivated crops if the surface is drained. Corn and soybeans are the main row crops, but oats, hay, and pasture are also suited (fig. 22). Although most of the acreage is in cultivated crops, many cultivated fields do not have surface drains. Crops do not grow well in these areas, but generally they are not lost. Tile drainage is not suited to these soils because of the high clay content of the subsoil. Shallow ditches are needed to improve surface drainage. If tilth becomes poor, the rotation should provide oats seeded with a green-manure crop. Returning all crop residue to the soil helps to maintain organic-matter content. Crop growth is generally moderate to high if drainage is improved, but on Beckwith soils it is moderate to low unless large amounts of fertilizer and lime are applied.

If row crops are planted frequently, applications of fertilizer are needed to maintain crop growth. Unless corn follows a legume in the rotation, additions of nitrogen are needed. Corn, small grain, and legumes respond well to additions of phosphorus and potassium. These soils, particularly Belinda and Beckwith soils, need lime.

CAPABILITY UNIT IVe–1

This unit consists of moderately well drained soils that are strongly sloping to moderately steep. These soils are in the Gara and Shelby series. They have a surface layer that is loam in most places. The subsoil is clay loam and is moderately slow in permeability. The movement of air and water within these soils is fairly good, and wetness is generally not a limitation. Available water capacity is high.

Erosion is a serious hazard because runoff is rapid and the soils are highly erodible. The uneroded soils are generally in good tilth, but the eroded soils are in poor tilth in places. Some of the Shelby soils are severely eroded. These soils are low in organic-matter content.

These soils are moderately suited to cultivated crops, but in most places they should be used for hay or pasture. They can be planted to corn for 1 year when pasture is renovated. Most of the moderately eroded to severely eroded areas have been farmed, but now many of these areas are used only for pasture. Alfalfa mixed with bromegrass is suitable for semipermanent hay or posture. Suitable for permanent pasture are birdsfoot trefoil and orchardgrass or bluegrass. These plants live longer and are productive longer than alfalfa. Corn, soybeans, and oats are also grown on these

***Figure 22.*—Hay and pasture on nearly level Appanoose soil and gently sloping Kniffin soil.**

soils, but they do not grow well. If good stands of alfalfa or alfalfa mixed with bromegrass are established, the fields should not be plowed until stands become poor. If the strongly sloping soils are terraced and tilled on the contour, a rotation of corn, oats, and meadow is suitable. The moderately steep soils generally are not terraced.

Applications of manure and fertilizer are needed in fields used for row crops. Mixtures of legumes and grasses respond well to phosphorus fertilizer and to lime. Crop growth can be increased by topdressing with phosphorus. Pastures that are mainly in grass respond well to additions of nitrogen and phosphorus.

CAPABILITY UNIT IVe–2

This unit consists of poorly drained to moderately well drained, moderately sloping to strongly sloping soils. These are the Adair, Armstrong, Ashgrove, Caleb, Clarinda, Gara, Keswick, Lamoni, Mystic, Shelby, and Weller soils. The surface layer is loam, clay loam, silt loam, or silty clay loam. Except in the Caleb, Gara, and Shelby soils in complexes with other soils, the subsoil is high in content of clay. Caleb, Gara, and Shelby soils have a clay loam subsoil. Permeability is moderately rapid to slow in Caleb soils and is moderately slow to very slow in the rest of the soils. Available water capacity is moderate to high.

These soils are wet and seepy in spring. Aeration is poor. Cultivated areas are very susceptible to erosion because the intake of water is somewhat slow and runoff is rapid. Much of the water that falls on the surface of these soils is not absorbed. Small rills are common in the moderately eroded areas. Organic-matter content is low.

These soils are suited to hay or pasture. They are moderately suited to row crops. They should be tilled on the contour because they are moderately sloping to strongly sloping and are susceptible to severe sheet erosion. Narrow bands and other small areas of these soils are within large fields that are used for cultivated crops. These small areas should be left in permanent vegetation until the cultivated crop is harvested, at which time they can be seeded to pasture along with the rest of the field. Erosion needs to be controlled in these small areas because seeding and establishing a stand are difficult if the subsoil is exposed. Terraces are not generally used on these soils, because the fine-textured subsoil is exposed in the terrace channels. If terracing is used, however, manure or topsoil should be spread in the terrace channels.

Alfalfa mixed with orchardgrass grows fairly well on these soils. Birdsfoot trefoil mixed with orchardgrass or bluegrass can be seeded for pasture that is to be grazed for a long time. Birdsfoot trefoil and orchardgrass or bluegrass live longer and are more productive than alfalfa. Corn, soybeans, and small grain are also grown on these soils, but growth generally is poor.

Fertilizer and lime generally are needed for all crops. Additions of lime and phosphorus are needed for legume seedings.

CAPABILITY UNIT IVw–1

This unit consists of moderately sloping soils that have a clayey subsoil and are poorly drained and seepy. These soils are in the Clarinda series. They have a silty clay loam surface layer. The clay subsoil is firm to very firm when moist and plastic when wet. Water is absorbed and moves through the soils very slowly. Aeration is poor. Available water capacity is high.

Wetness often delays cultivation in spring. Parts of these soils are extremely wet in places until midsummer because of a narrow, wet, seepy band at the upper border in places. These soils are cold and are slow to warm in spring. Tilth generally is fair or good, but it is easily destroyed by working the soils when they are wet. Deep cracks are visible in many places when these soils dry out in summer. Organic-matter content generally is medium to low. These soils are occasionally plowed in fall so that fieldwork can be started earlier in spring. Freezing and thawing seem to improve the structure of the surface soil and make the soils easier to work.

These soils are only moderately suited to cultivated crops. Wetness is the main limitation, but the soils are also susceptible to erosion because they are saturated quickly when it rains and because runoff is rapid. The very slowly permeable subsoil inhibits use of tile drains in these areas, but interceptor tile can be placed upslope in adjacent soils. Some areas that are too small to be farmed separately are in permanent pasture, but many areas are farmed along with Grundy and Seymour soils.

If these soils are used for row crops, terracing can be used to help control erosion. The subsoil is clay, however, and terracing is not a good practice unless the exposed subsoil is dressed with topsoil or large amounts of manure. Even if eroded areas are fertilized, crops generally do not grow well. If terraces are built, a rotation of corn, oats, and meadow, each grown for 1 year, is suitable. A suitable practice is planting a crop of corn before reseeding areas that are generally used only for hay or pasture.

Row crops and small grain may need additions of nitrogen, phosphorus, and potassium. Most areas need large applications of lime.

CAPABILITY UNIT Vw–1

This unit of Nodaway–Alluvial land complex consists of nearly level loamy soils of the Nodaway series and the mixed sandy to clayey soils of Alluvial land. These soils are severely dissected by old stream channels and bayous. They are frequently flooded. Alluvial land is sandy and droughty in some places and is clayey and poorly drained in others.

The soils in this unit are mostly timbered or are under a cover of scattered trees and grass. They are best suited to trees, although open areas can be used for pasture. Alluvial land is less suited to pasture than Nodaway soils because the vegetation is mainly sedges, marshgrass, and shrubs. Some areas of Nodaway soils that can be used for crops, generally require land leveling and protection from flooding. In years of below-average flooding, some small areas are used for crops. Without major reclamation, the soils of this unit are better suited to pasture, trees, or wildlife habitat than to most other uses.

CAPABILITY UNIT VIe–1

This unit consists of moderately well drained, moderately steep soils of the Gara and Lindley series. The surface layer is loam. The subsoil is clay loam and absorbs water moderately slowly. Available water capacity is high.

These soils are extremely erodible. Runoff is rapid because slopes are moderately steep. These soils contain only medium to small amounts of plant nutrients. They are acid.

These soils are not suited to cultivated crops but are moderately well suited to pasture. Areas are generally fairly large and can be used separately. Most areas are in pasture or timber. The timber generally is of poor quality and of little value. Much timbered land is grazed, but where the pasture is unimproved, its carrying capacity is moderate to low. These soils can be used for permanent pasture or tree plantings (fig. 23).

Most of the permanent pasture is in bluegrass and in native grasses of low quality, but forage can be increased by seeding a mixture of alfalfa and orchardgrass or birdsfoot trefoil and grasses. Reseeding pastures to more productive legumes and grasses generally requires some tillage that weakens or destroys existing plants. Oats are generally grown as a cover crop when pastures are renovated. In addition to reseeding, pasture is improved by adding fertilizer. Pasture that does not contain legumes responds to nitrogen. All pasture plants respond to phosphorous fertilizer. Pastures of alfalfa, birdsfoot trefoil, or other legumes need additions of phosphorus and lime. Controlling grazing and undesirable vegetation also improves pasture.

Areas now in trees should be protected from grazing, and other areas can be planted to suitable trees. Specialists at the local office of the Soil Conservation Service or the forester assigned to the county by the State Conservation Commission are available to help plan tree planting and other woodland management.

CAPABILITY UNIT VIe–2

This unit consists of somewhat poorly drained to moderately well drained soils that are moderately steep. These soils are in the Armstrong, Mystic, Gara, and Caleb series. The Gara and Caleb soils are mapped only with Armstrong and Mystic soils. All of these soils have a loam to silt loam surface layer. The Mystic, Armstrong, and Gara soils have a clay or clay loam subsoil that absorbs water slowly or moderately slowly. Permeability in Caleb soils is moderate. Available water capacity in all of the soils is medium to high.

Runoff is rapid because slopes are moderately steep. These soils are subject to erosion, and gullies form easily unless the soils are protected. All of these soils

***Figure 23.*—Recently cleared area of Lindley soil. Permanent pasture can be established by seeding a mixture of birdsfoot trefoil and grasses.**

contain only medium to small amounts of plant nutrients and are acid. Root development is restricted in Armstrong and Mystic soils by clayey impermeable subsoils. Armstrong and Mystic soils are seasonally wet because of seepage from more permeable soils upslope.

These soils are not suited to row crops. They are moderately well suited to pasture anl are well suited to wildlife habitat. The hazard of erosion is the most serious limitation to use. In some small areas wetness and seepage from more permeable, adjacent soils upslope limit the choice of plants and management. Most of the permanent pasture is bluegrass and native grasses of low quality. Forage can be increased by seeding a mixture of alfalfa and orchardgrass or birdsfoot trefoil and grasses. Areas now in trees should be protected from grazing. Mowing weeds, controlling grazing, and seeding to more productive grasses and legumes increase the carrying capacity of pastures. Interceptor tile placed in adjacent soils upslope reduces wetness of some areas and assists in establishing deep-rooted legumes.

Plant response to applications of fertilizer and lime is good. Pastures of alfalfa, birdsfoot trefoil, or other legumes need additions of phosphorus and lime.

CAPABILITY UNIT VIe–3

This unit consists of severely eroded soils that are moderately sloping to moderately steep. These soils are in the Adair, Armstrong, Caleb, Clarinda, Gara, Keswick, Lamoni, Mystic, and Shelby series. They have a loam to silty clay surface layer. Permeability is moderately rapid to slow in the Caleb soil and moderately slow to very slow in the rest. Runoff is rapid, and gullies are common.

These soils are in poor tilth and are difficult to work and manage. The surface tends to seal during rains, and runoff increases. The soils are hard and cloddy when dry. They are low to very low in organic-matter content and are slightly acid. In spring the Clarinda soil is seepy in many places, particularly where it borders upslope soils that formed in loess.

These soils are not suited to cultivated crops. Erosion is a serious hazard, and wetness is a limitation in many places. Terraces can be built to control erosion, but good seedbeds are difficult to prepare and crops do not grow well. The soils are better suited to hay or pasture than to grain. Alfalfa is not well suited to the fine-textured soils of this unit, but it grows fairly well on Shelby soils. A suitable pasture mixture is birdsfoot trefoil and orchardgrass or bluegrass.

The soils in this unit are best suited to permanent pasture. Small areas within large fields of more fertile soils should be either seeded and left idle or used for pasture if the cultivated crops are grazed. Seeding often fails because the soils are in poor tilth. Gullies should be filled before seeding and lime and fertilizers applied. Heavy applications of manure improve tilth and help in preventing further erosion. Control of grazing is needed until seedings are well established.

CAPABILITY UNIT VIe–4

This unit consists mainly of clayey, strongly sloping to moderately steep soils that formed in shale on uplands. These soils are in the Gosport-Clanton complex. They have a silt loam to silty clay loam surface layer. They have a firm silty clay or clay subsoil. The soils are moderately well drained or somewhat poorly drained. Permeability is very slow. Available water capacity is high.

Runoff is rapid after the surface layer is saturated. The root zone is unfavorable because of the shale soil structure. The organic-matter content and fertility are low.

These soils are not suited to crops, and have some limited use as pasture. They are moderately well suited to trees. Erosion, gullying, very low fertility, and poor response to treatment are the chief limitations. Most areas are in permanent pasture or timbered pasture. Some areas are cropped along with more suitable moderately and strongly sloping soils. Controlling grazing, seeding more productive pasture plants where practical, and mowing weeds increase the productivity of existing pastures. Many areas in timbered pasture would be more productive of wood crops if they were managed as woodland and livestock were fenced out.

CAPABILITY UNIT VIIe–1

This unit consists of moderately steep and steep soils of the Gara and Lindley series. Slope and moderate erosion are very severe limitations. The available water capacity is high, but water runs off rapidly and only a small amount enters the soil. Aeration is somewhat restricted. Fertility is very low or low.

These soils are not suited to cultivated crops, and they are poorly suited to pasture (fig. 24). They can be used as woodland and as wildlife habitat. Forage crops are difficult to establish, and controlled grazing is needed to insure a permanent plant cover. Some areas can be planted to trees, but many are too steep to renovate. Areas now in trees should be protected from grazing. Large applications of fertilizer generally are not practical, but lime commonly is needed if legumes are grown. These soils provide suitable sites for ponds that supply water for livestock.

CAPABILITY UNIT VIIe–2

This unit consists of moderately steep to steep severely eroded soils of the Armstrong, Caleb, Gara, Lindley, and Mystic series. The hazard of erosion is very severe. Available water capacity is medium to high, but much of the rain runs off the steep slopes. Organic-matter content is low to very low.

These soils are not suited to cultivated crops. Although some areas are of limited use for pasture, grazing needs to be carefully controlled to insure a permanent plant cover. Most areas are too steep to be renovated with regular farm machinery, and waterways and gullies are common. Diversions constructed around the top of the drainage system help to prevent some severely eroded areas and gullies from becoming larger and more active. Areas now in trees should be protected from grazing, and other areas can be planted to suitable trees. These soils provide habitat for wildlife.

CAPABILITY UNIT VIIe–3

This unit consists of strongly sloping to steep, shal-

Figure 24.—**Lindley loam, 18 to 24 percent slopes, seeded to permanent vegetation and used as pasture.**

low to deep soils that formed in shale and limestone on uplands. These soils are in the Gosport, Clanton, and Sogn series. The Gosport and Clanton soils formed in shale, and Sogn soils are shallow over hard limestone. The available water capacity is very low to high, and runoff is rapid.

These soils are suited to pasture, trees, or wildlife habitat. The severe hazard of erosion, low fertility, poor response to treatment, and droughtiness are limitations to use and management. Most areas are in pasture, timbered pasture, or trees and many are inaccessible to farm machinery. Control of grazing, renovation, and seeding of more productive plants, where practical, increase the carrying capacity of pasture. Tree growth is slow. Selective cutting and other woodland management practices improve the stand of desirable trees. Many areas in timbered pasture would be more productive of wood crops if livestock were fenced out and they were managed as woodland.

CAPABILITY UNIT VIIw–1

Only the land type, Marsh, is in this unit. It consists of very wet areas or of areas that are under water for most of the year. Most areas are scattered along the Chariton River bottom.

Marsh has no value in farming. The areas generally are low lying and lack suitable outlets for drainage. Some of them could be reclaimed for pasture or cultivated crops if the water level could be controlled.

Marsh is better suited to wildlife habitat than to most other uses. Willows, cattails, and other plants that tolerate wetness grow well in the marshy areas. Waterfowl, muskrat, and upland game find cover, food, and nesting places in and around these areas.

Yield Predictions

In table 3 the average acre yields of the principal crops are predicted for soils of the county under a high level of management. Under this level of management, seedbed preparation, planting, and tillage practices provide for adequate stands of adapted varieties; erosion is controlled; the organic-matter content and soil tilth are maintained; the level of fertility for each crop is maintained (as indicated by soil tests and field trials); the water level in wet soils is controlled; excellent weed and pest control are provided; and operations are timely.

Many available sources of yield information were used to make these estimates, including data from the Federal census, the Iowa farm census, from experimental farms and cooperative experiments with farmers, and from on-farm experience of soil scientists, extension workers, and others.

The yield predictions in table 3 are approximate values only and are intended to serve as guides. Many users will consider the comparative yields between soils to be of more value than actual yields. These relationships are likely to remain constant over a period of years. On the other hand, actual yields have been increasing in recent years. If they continue to increase as expected, predicted yields in this table will soon be too low.

TABLE 3.—*Predicted average yields per acre of principal crops under high level of management*

[Absence of a figure indicates that the crop is not suited to the soil or is not generally grown on it]

Mapping unit	Corn	Soybeans	Oats	Alfalfa-brome pasture	Alfalfa-brome pasture
	Bushels	*Bushels*	*Bushels*	*Tons*	*AUD* [1]
Adair clay loam, 5 to 9 percent slopes	73	28	40	3.1	155
Adair clay loam, 5 to 9 percent slopes, moderately eroded	65	25	36	2.7	135
Adair clay loam, 9 to 14 percent slopes, moderately eroded	54	20	30	2.3	115
Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded	64	25	35	2.6	130
Adair-Shelby complex, 9 to 14 percent slopes, severely eroded	---		--	1.8	90
Amana silt loam	110	42	60	4.6	230
Appanoose silt loam	76	29	42	3.3	165
Armstrong loam, 5 to 9 percent slopes, moderately eroded	59	22	37	2.5	125
Armstrong loam, 9 to 14 percent slopes, moderately eroded	50	19	28	2.0	100
Armstrong soils, 5 to 9 percent slopes, severely eroded	---	--	--	1.8	90
Armstrong soils, 9 to 14 percent slopes, severely eroded	--	--	-	1.4	70
Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded	58	22	32	2.4	120
Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded	---	--	--	1.2	60
Armstrong-Gara complex, 9 to 14 percent slopes, severely eroded	---	--	-	1.7	85
Armstrong-Gara complex, 14 to 18 percent slopes, severely eroded	---	--		1.0	50
Ashgrove silt loam, 5 to 9 percent slopes, moderately eroded	49	18	27	2.0	100
Ashgrove silt loam, 9 to 14 percent slopes, moderately eroded	40	15	22	1.6	80
Beckwith silt loam	76	29	42	3.7	185
Belinda silt loam	86	33	47	3.9	195
Belinda silt loam, benches	86	33	47	3.9	195
Cantril loam, 2 to 5 percent slopes	94	36	52	4.0	200
Carlow silty clay	67	25	37	2.7	135
Chequest silty clay loam	98	37	54	3.9	195
Clarinda silty clay loam, 5 to 9 percent slopes	63	24	34	2.6	130
Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	55	21	30	2.2	110
Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	46	17	25	1.8	90
Clarinda soils, 5 to 9 percent slopes, severely eroded	--	--	--	1.5	75
Colo silt loam, overwash	106	42	80	4.2	210
Colo silty clay loam, 0 to 2 percent slopes	104	40	78	4.2	210
Colo silty clay loam, 2 to 5 percent slopes	102	39	76	4.0	200
Coppock silt loam	89	34	49	3.7	185
Edina silt loam	86	33	47	3.6	180
Gara loam, 9 to 14 percent slopes, moderately eroded	75	28	41	3.1	155
Gara loam, 14 to 18 percent slopes	---		--	2.5	125
Gara loam, 14 to 18 percent slopes, moderately eroded	---	--	--	2.2	110
Gara loam, 18 to 24 percent slopes, moderately eroded	---	--	--	1.5	75
Gara soils, 9 to 14 percent slopes, severely eroded	---	--	--	2.2	110
Gara soils, 14 to 18 percent slopes, severely eroded	---	--	--	1.5	75
Grundy silty clay loam, 2 to 5 percent slopes	107	41	59	4.5	190
Haig silty clay loam	105	40	58	4.2	210
Humeston silt loam, 0 to 2 percent slopes	88	33	48	3.7	185
Humeston silt loam, 2 to 5 percent slopes	86	32	47	3.6	180
Kennebec-Amana silt loams	115	43	63	4.8	240
Keswick loam, 5 to 9 percent slopes	61	23	33	2.6	130
Keswick loam, 5 to 9 percent slopes, moderately eroded	53	20	29	2.2	110
Keswick loam, 9 to 14 percent slopes	52	20	29	2.2	110
Keswick loam, 9 to 14 percent slopes, moderately eroded	44	17	24	1.8	90
Keswick soils, 9 to 14 percent slopes, severely eroded				1.2	60
Kniffin silt loam, 2 to 5 percent slopes	82	31	45	3.5	175
Kniffin silt loam, 5 to 9 percent slopes	77	29	42	3.3	165
Kniffin silt loam, 5 to 9 percent slopes, moderately eroded	72	27	39	3.0	150
Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	61	23	33	2.6	130
Lamoni soils, 9 to 14 percent slopes, severely eroded	-	--	-	1.5	75
Landes fine sandy loam, heavy subsoil variant	85	32	46	3.6	180
Lindley loam, 14 to 18 percent slopes, moderately eroded	--		--	1.5	75
Lindley loam, 18 to 24 percent slopes	---	--	--	1.2	60
Lindley loam, 18 to 24 percent slopes, moderately eroded	---	--	-	1.0	50

TABLE 3.—*Appanoose County, Iowa* (continued)

Mapping unit	Corn	Soybeans	Oats	Alfalfa-brome pasture	Alfalfa-brome pasture
	Bushels	*Bushels*	*Bushels*	*Tons*	*AUD*[1]
Lineville silt loam, 2 to 5 percent slopes	77	29	42	3.2	160
Lineville silt loam, 5 to 9 percent slopes	70	27	38	2.9	145
Lineville silt loam, 5 to 9 percent slopes, moderately eroded	65	24	34	2.7	135
Lineville silt loam, dark variant, 5 to 9 percent slopes	76	29	70	3.2	160
Lineville silt loam, dark variant, 5 to 9 percent slopes, moderately eroded	71	27	67	3.0	150
Mystic silt loam, 5 to 9 percent slopes, moderately eroded	60	23	33	2.5	125
Mystic silt loam, 9 to 14 percent slopes, moderately eroded	51	19	28	2.0	100
Mystic soils, 5 to 9 percent slopes, severely eroded	44	16	24	1.8	90
Mystic soils, 9 to 14 percent slopes, severely eroded	---	---	20	1.5	75
Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded	60	23	46	2.5	125
Mystic-Caleb complex, 9 to 14 percent slopes, severely eroded	---	---	---	1.5	75
Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded	---	---		1.0	50
Nodaway silt loam	110	42	61	4.6	230
Nodaway-Alluvial land complex	---	---	---	3.0	150
Olmitz loam, 2 to 5 percent slopes	100	38	55	4.2	210
Olmitz-Vesser-Colo complex, 2 to 5 percent slopes	90	34	50	3.8	190
Pershing silt loam, 2 to 5 percent slopes	101	38	56	4.2	210
Pershing silt loam, 5 to 9 percent slopes	96	36	53	4.0	200
Pershing silt loam, 5 to 9 percent slopes, moderately eroded	91	35	50	3.8	190
Pershing silt loam, benches, 2 to 5 percent slopes	101	38	56	4.2	210
Pershing silt loam, benches, 5 to 9 percent slopes	96	36	53	4.0	200
Radford silt loam	106	40	58	4.5	225
Rathbun silt loam, 2 to 5 percent slopes	76	29	42	3.2	160
Rathbun silt loam, 2 to 5 percent slopes, moderately eroded	71	27	39	3.0	150
Rathbun silt loam, 5 to 9 percent slopes	70	26	38	2.9	145
Rathbun silt loam, 5 to 9 percent slopes, moderately eroded	65	25	36	2.8	140
Seymour silt loam, 2 to 5 percent slopes	88	33	48	3.7	185
Seymour silt loam, 5 to 9 percent slopes, moderately eroded	83	32	45	3.5	175
Shelby loam, 9 to 14 percent slopes, moderately eroded	81	31	44	3.4	170
Shelby loam, 14 to 18 percent slopes, moderately eroded	66	25	36	2.7	135
Shelby soils, 9 to 14 percent slopes, severely eroded	70		38	3.0	150
Tuskeego silt loam, 0 to 2 percent slopes	82	31	45	3.3	165
Tuskeego silt loam, 2 to 5 percent slopes	80	30	44	3.2	160
Vesser silt loam, 0 to 2 percent slopes	95	36	52	4.0	200
Vesser silt loam, 2 to 5 percent slopes	93	35	51	3.9	195
Wabash silty clay	68	26	37	1.8	90
Weller silt loam, 2 to 5 percent slopes	95	36	52	4.0	200
Weller silt loam, 2 to 5 percent slopes, moderately eroded	90	34	49	3.8	190
Weller silt loam, 5 to 9 percent slopes, moderately eroded	85	32	46	3.2	160
Weller silt loam, 9 to 14 percent slopes, moderately eroded	76	29	42	2.8	140
Weller silt loam, benches, 2 to 5 percent slopes	95	36	52	3.8	175
Weller silt loam, benches, 5 to 9 percent slopes, moderately eroded	85	32	46	3.2	160
Wiota silt loam, 1 to 3 percent slopes	108	41	59	4.5	225
Zook silty clay loam, 0 to 2 percent slopes	96	36	54	3.8	190
Zook silty clay loam, 2 to 5 percent slopes	94	36	52	3.8	190

[1] An animal-unit-day is the number of days that 1 acre will provide grazing for one animal, or 1,000 pounds of live weight, without damage to the pasture.

Woodland[3]

Most of Appanoose County was in prairie grasses when it was settled. Trees grew mainly in narrow belts on bottom lands, along streams in the uplands, and in some upland areas in the eastern part of the county. The trees in the uplands were mostly hardwoods and included white oak, red oak, black oak, elm, shagbark hickory, and green ash. The trees on the bottom lands were mostly soft maple, walnut, green ash, and cottonwood.

Most of the original timber has been cut over or cleared so that the soils could be used for crops and pasture. Some trees remain, however, in scattered tracts, mainly on steep soils in small areas bordering stream valleys. Most of the existing trees in the uplands grow on the Armstrong, Keswick, Lindley, Gara, Rathbun, Pershing, Caleb, or Kniffin soils (fig. 25). Wooded areas on the bottom lands are on the Olmitz-Vesser-Colo complex and on the Kennebec, Amana, Coppock, Chequest, Nodaway, and Vesser soils.

A large acreage of woodland is pastured. In most areas, grazing and poor logging practices have hindered restocking of trees, and stands produce less than half of their potential capacity. Grazing and poor logging practices also seriously threaten the remaining stands of timber.

Local logging practices have caused gradual deterioration in the quality of trees. The early settlers used

[3] SYLVAN T. RUNKEL, woodland conservationist, Soil Conservation Service, helped prepare this section.

Figure 25.—**Woodland on Lindley loam enhances the potential of farm pond for wildlife and recreation.**

the trees for fuel, posts, and poles, and for building houses and barns and repairing implements. They harvested the best trees and left the less desirable ones. Gradually, the less desirable trees became dominant in the woodland. Because most woodland is used as pasture and is seriously overgrazed, improving it for timber production is difficult.

Native trees still growing in woodland yield a fair quantity of wood products under good management. Good basic management consists of protecting woodland from grazing and fire, gradually improving the composition of the woodland, and regulating the cut or harvest to balance tree growth. The first step in good management is selecting suitable crop trees and allowing them to grow. The next step is removing inferior trees so that they do not compete with the crop trees. Maturing crop trees are harvested selectively, and other crop trees are designated for the next crop or cutting cycle.

Some woodland is of such poor quality that the best procedure is to convert it from hardwood trees to relatively valuable conifer trees. Before such conversion, competition from inferior trees and shrubs needs to be eliminated by mowing or by spraying them with a brush-killing chemical.

Soils vary in their suitability for trees. Generally the deep, well drained or moderately well drained soils that are moderately fertile to highly fertile are well suited to trees. The subsoil should have moderate permeability to moderately slow permeability.

Permeability of the subsoil has much to do with development of tree roots. In most places tree roots growing in a slowly permeable to very slowly permeable, plastic subsoil are poorly developed. If roots are underdeveloped because of poor aeration and poor drainage, trees do not develop normally above the ground. In this county some of the soils that have a slowly permeable to very slowly permeable subsoil are Adair, Armstrong, Mystic, Edina, Clarinda, Rathbun, Keswick, Seymour, and Pershing soils.

Native hardwoods grow better on soils that have not been cultivated than on formerly cultivated soils. They generally are not suited to soils that are moderately or severely eroded. Pines are better suited to these eroded soils than hardwoods.

Landowners can get help from the Soil Conservation

District in judging the best use of their land. Help in managing woodland is available from district farm foresters of the State Conservation Commission.

Woodland suitability groups

The soils of Appanoose County have been placed in woodland groups according to their suitability for planting trees. Each group is made up of soils that have about the same characteristics and are subject to similar limitations or hazards. All of the soils in a group support similar kinds of trees, have about the same potential productivity, and require similar kinds of management.

Site index ratings are given for most of the woodland groups. The site index is the average height of the dominant and codominant trees in a stand at 50 years of age. It indicates potential soil productivity. Board foot production is estimated for stands that are fully stocked and well managed.

Each woodland group is also rated for hazards that need to be considered in management.

Erosion hazard refers to the expected erosion that is a result of the cutting and removal of trees. It is *slight* if potential erosion is unimportant; *moderate* if some practices, such as those for diverting water, are needed to prevent accelerated erosion; and *severe* if intensive treatment is needed to control soil losses. Where erosion is severe, special care must be taken in locating and constructing roads and skid trails, in diverting water during and after logging, and in some places, in seeding grasses.

Seedling mortality refers to the expected loss of planted seedlings that is a result of unfavorable soil characteristics, not a result of plant competition. Mortality is *slight* if no more than 25 percent of the seedlings die, *moderate* if 25 to 50 percent of the seedlings die, and *severe* if more than 50 percent of the seedlings die.

Plant competition refers to the rate unwanted brush, grass, vines, or other undesirable plants interfere with the establishment of planted or naturally occurring tree seedlings. Competition is *slight* if it does not prevent adequate natural regeneration and early growth, or interfere with the normal development of planted seedlings. It is *moderate* if invading plants delay but do not prevent the establishment of seedlings. Competition is *severe* if unwanted plants prevent the growth of the seedlings.

Woodland suitability groups are identified by a three-part symbol. The symbols are a guide to kind of woodland group and its limitations for trees. They provide a uniform system of labeling that expresses some of the important soil-woodland interpretations.

The first numeral denotes the woodland productivity class. It is based on the average site index of an indicator tree species, or forest type, for each soil. Class 1, potentially the highest in productivity, is followed consecutively by classes 2, 3, 4, and subsequent classes to include the entire site-index range of each forest type.

The lowercase letter denotes the subclass. It is used for grouping soils within a woodland suitability class by selected soil properties that are moderate to severe hazards or limitations.

Subclass *w* denotes excessive wetness. Soils are excessively wet, either seasonally or year long, and are significantly limited for woodland use or management. These soils have restricted drainage, a high water table, or a flood hazard that adversely affects either stand development or management.

Subclass *t* denotes toxic substances. Soils have, within the root zone, excessive alkalinity, acidity, sodium salts, or other toxic substances that limit or impede development of desirable tree species.

Subclass *c* denotes clayey soils. Soils are restricted or limited for woodland use or management by the kind or amount of clay in the upper part of the profile.

Subclass *s* denotes sandy soils. Dry sandy soils have only a thin textural B horizon or none and are moderately to severely restricted or limited for woodland use or management. These soils have low available water capacity and normally are low in available plant nutrients. The use of equipment is limited.

Subclass *r* denotes steep soils. Soils are restricted or limited for woodland use or management by steep slopes.

Subclass *o* denotes slight or no limitations. Soils have no significant restrictions or limitations for woodland use or management.

The last numeral in the symbol denotes the woodland group.

The woodland suitability groups recognized in Appanoose County are described in the paragraphs that follow. For most of the groups, site index ratings are given for suitable trees. The kinds of trees that grow well on each group of soils are given. The elm is one of the most numerous and most common species of hardwood trees in the county. It is not listed as a recommended species because of the Dutch elm disease, which is rapidly killing existing stands. Many thousands of elms still remain, but dead and dying trees present a management problem because they need to be removed. The mention of soil series in the description of a group does not mean that all the soils in the series are in the group. To determine the soils in a woodland suitability group, refer to the "Guide to Mapping Units" at the back of this survey.

WOODLAND SUITABILITY GROUP 2o1

This group consists of medium-textured and moderately fine textured, deep, moderately well drained soils of the Gara, Lindley, Olmitz, and Shelby series. Slopes range from 2 to 18 percent. Permeability is moderate and moderately slow, and available water capacity is high. Olmitz soils are on gently sloping foot slopes downslope from strongly sloping Shelby and Gara soils. Runoff is medium on the Gara soils but is slower on the Olmitz soils.

The suitability of these soils for producing wood crops is good to very good. Trees to be favored in existing stands are red oak, white oak, green ash, black walnut, basswood, hackberry, and hard maple. The site index for upland hardwoods ranges from 56 to 75. Soils on which timber now grows produce from 150 to 250 board feet per acre per year.

Erosion generally is a moderate hazard on Gara, Lindley, and Shelby soils, but there is little or no hazard of erosion on Olmitz soils, except in a few places where runoff concentrates and cuts small rills or gullies. Included in this group are small severely eroded areas of Gara, Lindley, and Shelby soils on which the hazard of further erosion is severe. Seedling mortality is generally slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is slight to moderate. The hazard of damage from pests and disease is generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, and Douglas-fir, and the *hardwoods* black walnut, green ash, and hackberry. Trees most suitable for windbreaks are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, and Douglas–fir, and the *hardwoods* Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited to farmstead windbreaks, and the hardwoods to field windbreaks. Suitable for wildlife plantings are honeysuckle, viburnums, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 3r1

This group consists of medium-textured, deep, moderately well drained soils on uplands. Slopes range from 18 to 40 percent, and the aspect is dominantly north and northeast. Permeability is moderately slow, and available water capacity is high. Runoff is rapid. These are soils of the Gara and Lindley series.

The suitability of these soils for producing wood crops is good (fig. 26). Many areas have existing stands of trees, but the trees generally are of low quality. Trees to be favored in existing stands are red oak, white oak, green ash, black walnut, basswood, hackberry, and hard maple. The site index for upland hardwoods ranges from 56 to 65. Soils on which timber now grows produce from 150 to 200 board feet per acre per year. On southwest-facing slopes, production is reduced about 50 board feet per acre per year.

Erosion is a moderate to severe hazard. Seedling mortality is generally slight and depends on damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is moderate. The hazard of damage from pests and disease is generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, European larch, and Douglas-fir, and the *hardwoods* black walnut, green ash, and hackberry. Trees most suitable for

Figure 26.—**Woodland on Lindley loam. Trees are planted parallel to terrace at top of slope.**

windbreaks are the *conifers* eastern white pine, red pine, Scotch pine, eastern redcedar, Norway spruce, and Douglas-fir, and the *hardwoods* Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited to farmstead windbreaks, and the hardwoods to field windbreaks. Suitable for wildlife plantings are honeysuckle, viburnums, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 4w1

This group consists of medium-textured to moderately fine textured, deep, moderately well drained to somewhat poorly drained soils on uplands. Slopes range from 2 to 9 percent. Permeability is slow and very slow, and available water capacity is high. Runoff is moderate. These are soils of the Grundy, Kniffin, Pershing, Rathbun, Seymour, and Weller series.

The suitability of these soils for producing wood crops is fair. Trees are growing on the Pershing, Kniffin, Rathbun, and Weller soils, but they are of low quality in many places. Trees to be favored in existing stands are green ash, hackberry, red oak, and white oak. The site index for upland hardwoods ranges from 46 to 55. Soils on which timber now grows produce from 100 to 500 board feet per acre per year.

Erosion is a slight to moderate hazard. Seedling mortality is generally slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is moderate. The hazard of damage from pests and disease is generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce, and the *hardwoods* cottonwood, soft maple, green ash, and hackberry. Trees most suitable for windbreaks are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce, and the *hardwoods* cottonwood, Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited to farmstead windbreaks and the hardwoods to field windbreaks. Suitable for wildlife plantings are honeysuckle, viburnums, ninebark, lilac, and dogwood.

WOODLAND SUITABILITY GROUP 5w1

The group consists of medium-textured to fine-textured, shallow or deep, moderately well drained to poorly drained soils on uplands. These are soils of the Ashgrove, Clanton, Clarinda, Gosport, Lamoni, and Sogn series. Slopes range from 5 to 24 percent. Ashgrove, Clarinda, and Lamoni soils do not occupy entire side slopes, but commonly are in bands almost on a contour around the hillsides. Permeability is moderate in Sogn soil and very slow in the rest. Runoff is medium. Available water capacity is very low in Sogn soil and is high in the rest. These soils are often seepy and wet. Woodland on these soils is valuable for other such uses as camping sites, picnic areas, wildlife habitat, watershed protection, and beautification.

The suitability of these soils for commercial wood crops is fair to poor. Trees grow on the Ashgrove soils, but they are of low quality in most places. Trees generally do not grow on Clarinda and Lamoni soils that formed under native grasses. The site index for upland hardwoods is less than 45. Soils on which upland hardwoods now grow produce less than 100 board feet per acre per year.

Erosion is a severe hazard on severely eroded Clarinda and Lamoni soils and is a moderate hazard on the rest. Seedling mortality is slight and depends on damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is slight. The hazard of damage from pests and disease is generally slight.

Trees most suitable for planting on these soils are the *conifers* redcedar and Scotch pine, and the *hardwoods* green ash, hackberry, and cottonwood. The conifers listed are especially well suited to farmstead windbreaks, and the hardwoods to field windbreaks. Suitable for wildlife plantings are dogwood, buttonbush, and pussy willow.

WOODLAND SUITABILITY GROUP 5c1

This group consists of medium-textured, deep, moderately well drained and somewhat poorly drained soils. Slopes range from 5 to 18 percent. Permeability is moderately slow to very slow. Available water capacity is high. Runoff is moderate to rapid. These are soils of the Adair, Armstrong, Gara, Keswick, Lineville, Mystic, and Shelby series. The Gara and Shelby soils are mapped only in a complex with Armstrong and Adair soils.

The suitability of these soils for producing wood crops is fair to poor. Woodland on these areas is valuable for other such uses as camping sites, picnic areas, wildlife habitat, watershed protection, and beautification. Some areas have existing stands of trees, but the trees are generally of low quality. Trees to be favored in existing stands are green ash, hackberry, red oak, and white oak. The site index for hardwood trees is less than 45. Soils on which hardwoods now grow produce less than 100 board feet per acre per year.

Erosion is a moderate to severe hazard. Seedling mortality is slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is slight. The hazard of damage from pests and disease is generally slight.

Trees most suitable for planting on these soils are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce and the *hardwoods* green ash and hackberry. Trees most suitable for windbreaks are the *conifers* eastern white pine, Scotch pine, eastern redcedar, and Norway spruce and the *hardwoods* Norway poplar, Siouxland poplar, Robusta poplar, green ash, and hackberry. The conifers listed are especially well suited to farmstead windbreaks, and the hardwoods to field windbreaks. Suitable for wildlife plantings are dogwood, buttonbush, and pussy willow.

WOODLAND SUITABILITY GROUP 5w2

This group consists of deep, moderately well drained and somewhat poorly drained, dominantly medium-textured soils on bottom lands, benches, and foot slopes. These soils are nearly level or gently sloping.

Permeability is moderate to moderately slow, and available water capacity is moderate or high. These soils, except for Wiota soils, are periodically flooded. These are soils of the Amana, Cantril, Kennebec, Landes, Nodaway, Radford, and Wiota series.

The suitability of these soils for producing bottom-land hardwoods is good; from 300 to 700 board feet is produced per acre per year.

Erosion is not a hazard. Seedling mortality is slight and depends on the damage caused by insects and rodents. Plant competition from grasses, weeds, or undesirable species is moderate.

Trees most suitable for planting on these soils are the bottom-land *hardwoods* cottonwood, soft maple, and green ash. These soils are not well suited to upland hardwoods or conifers. Trees most suitable for windbreaks are cottonwoods, soft maple, and green ash. Windbreak site quality is high for cottonwood and soft maple. Suitable for wildlife plantings are dogwood, buttonbush, and pussy willow.

WOODLAND SUITABILITY GROUP 5w3

This group consists of poorly drained to very poorly drained soils on uplands and bottom lands. The soils on uplands are of the Appanoose, Beckwith, Belinda, Edina, and Haig series, and those on bottom lands are of the Carlow, Chequest, Colo, Coppock, Humeston, Olmitz, Tuskeego, Vesser, Wabash, and Zook series. These soils have a medium-textured to fine-textured surface layer and subsoil. Permeability is moderate to very slow. The water table is seasonally at or near the surface. The soils on bottom lands are flooded periodically.

The suitability of these soils for producing wood crops on uplands is fair. The soils on bottom lands produce 200 to 500 board feet of hardwood per acre per year.

Trees most suitable for planting on these soils are soft maple, cottonwood, sycamore, willow, green ash, and hackberry. Conifers are not well suited. Trees most suitable for windbreaks are cottonwood, soft maple, and green ash. Cottonwood and soft maple grow well in windbreaks. Suitable for wildlife plantings are dogwood, buttonbush, and pussy willow.

Recreation

The landscape of the county provides scenery and many potential sites for recreation. The nearly level to sloping, intensively farmed land is in close proximity to rolling terrain of which a high percentage is wooded.

The combination of soils, topography, and vegetation in the county favors the development of facilities for recreation. Soils in associations 3 and 6 provide the best opportunities for recreation because they have many potential sites for ponds (fig. 27).

Several recreational facilities have already been developed in the county. Sharon Bluff State Park, located about 3 miles southeast of Centerville, provides picnic tables and fireplaces.

The construction of multipurpose watershed structures has increased the potential for recreation and wildlife habitat.

Extensive recreational facilities are planned near the shoreline of the recently built Rathbun Reservoir. Picnic areas, playgrounds, camping grounds, paths and trails, and golf courses are planned for the areas surrounding this 11,000 acre lake. Fishing, water skiing, and boating will also be available.

The opportunity for almost any type of outdoor recreation can be increased by good planning, development, and management of soils. The presence of wildlife contributes to the use of soil for additional kinds of recreation and makes such use more enjoyable. The soil properties that affect farm uses are the same ones that affect use of soils for recreation.

Knowledge of the characteristics and qualities of the different kinds of soil and their behavior permits soil interpretations to be made for recreational purposes.

Table 4 was prepared mainly for farmers and other landowners, city and county planners, and developers. It lists features that adversely affect use of soils in the county for cottages and utility buildings, intensive campsites, picnic areas, intensive play areas, trails and paths, and golf fairways.

The features listed are for soils in place. Soils are rated on the basis of three classes of soil limitations: *slight*—relatively free of limitations or limitations are easily overcome; *moderate*—limitations need to be recognized but can be overcome with good management and careful design; and *severe*—limitations are severe enough to make use questionable.

The interpretations in table 4 do not eliminate the need for sampling and testing the soil at a proposed site. The interpretations should be used as a basis for planning more detailed field investigations, so that the conditions of the soil in place can be determined before a proposed site is put to any nonfarm use.

Wildlife

Appanoose County supports many kinds of wildlife that contribute to the economy of the county and that have recreational value. The kinds and numbers of wildlife that can be maintained in the county are largely determined by the kinds and amounts of vegetation the soils can produce and by the way the vegetation is distributed. Wildlife is also influenced by topography. Topography affects wildlife through its influence on land use. Moderately steep and steep irregular areas may be unsuitable for crops, but the undisturbed vegetation on such soils as Lindley soils is valuable to wildlife. If suitable vegetation is lacking on the sloping prairie soils, such as Shelby soils, it generally can be developed to improve conditions for desirable kinds of wildlife.

The soils of Appanoose County produce suitable habitats for a number of wildlife species. The nearly level and gently sloping Edina and Seymour soils, for example, generally are cropped intensively and provide only limited shelter and nesting areas for wildlife, but they provide corn and small grain for feed. Much of the wildlife is on the sloping to steep Gara, Lindley, Shelby, and Armstrong soils in the uplands. These soils are along streams throughout the county that contribute to a good distribution of wildlife.

Figure 27.—Top: **Farm pond in Shelby soils near homestead. Multiflora rose fences in background and wooded areas along natural drains improve the potential for recreation and wildlife.**
Bottom: **Multiple purpose structure in the Moulton Watershed provides recreation, improves wildlife potential, and reduces flooding on bottom land.**

TABLE 4.—*Degree and kind of limitations*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series

Soil series and map symbols	Cottages and utility buildings	Intensive campsites
*Adair: 192C, 192C2, 192D2, 93D2, 93D3 For Shelby part of 93D2 and 93D3, refer to Shelby series.	Moderate: slope more than 5 percent.	Moderate: slope more than 5 percent; slow permeability.
Amana: 422	Severe: subject to flooding; seasonal high water table.	Severe: subject to flooding
Appanoose: 261	Severe: poorly drained	Severe: poorly drained
*Armstrong: 792C2, 792C3, 792D2, 792D3, 993D2, 993D3, 993E2, 993E3. For Gara part of 993D2, 993D3, 993E2, and 993E3, refer to Gara series.	Moderate if slope is less than 14 percent, severe if more than 14 percent: high shrink-swell potential; somewhat poorly drained.	Moderate if slope is less than 14 percent, severe if more than 14 percent: wet for short periods.
Ashgrove: 795C2, 795D2	Severe: poorly drained	Severe: poorly drained; very slow permeability.
Beckwith: 260	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; subject to ponding.
Belinda: 130, T130	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; subject to ponding.
Caleb Mapped only with Mystic soils.	Moderate if slope is less than 14 percent, severe if more than 14 percent.	Moderate if slope is less than 14 percent, severe if more than 14 percent.
Cantril: 56B	Severe: subject to flooding	Severe: subject to flooding
Carlow: 534	Severe: very poorly drained; subject to flooding.	Severe: very poorly drained; subject to flooding; fine textured.
Chequest: 587	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Clanton Mapped only with Gosport soils.	Severe: somewhat poorly drained; high shrink-swell potential.	Severe: very slow permeability; slope more than 9 percent.
Clarinda: 222C, 222C2, 222C3, 222D2	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; very slow permeability.
Colo: 133A, 133B, 133+	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding; moderately slow permeability.
Coppock: 520	Severe: subject to flooding	Severe: somewhat poorly drained and poorly drained; subject to flooding.
Edina: 211	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; subject to ponding of surface water.
Gara: 179D2, 179D3, 179E, 179E2, 179E3, 179F2	Moderate if slope is less than 14 percent, severe if more than 14 percent.	Moderate if slope is less than 14 percent, severe if more than 14 percent.
*Gosport: 313D2, 313E2, 313F2 For Clanton part of 313D2, 313E2, and 313F2, refer to Clanton series.	Severe: somewhat poorly drained; unstable slopes; high shrink-swell potential.	Severe: very slow permeability; rapid runoff.

for recreational facilities

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the that appear in the first column of this table]

Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Moderate: slope more than 5 percent.	Severe: slope more than 5 percent.	Moderate: surface sticky and slippery when wet.	Moderate: vegetation difficult to establish.
Moderate: subject to flooding.	Severe: subject to flooding during periods of use.	Moderate: subject to flooding; muddy and slippery when wet.	Moderate: subject to flooding.
Severe: poorly drained	Severe: poorly drained	Severe: poorly drained	Severe: poorly drained.
Moderate if slope is less than 14 percent, severe if more than 14 percent; slippery when wet.	Severe: slope more than 5 percent; seepy wet spots.	Moderate: surface sticky and slippery when wet.	Moderate: vegetation difficult to establish; remains wet for short periods.
Severe: poorly drained	Severe: poorly drained; slope more than 5 percent.	Severe: poorly drained	Severe: poorly drained; texture.
Severe: poorly drained	Severe: poorly drained; remains wet for long periods.	Severe: poorly drained; remains wet for long periods.	Severe: poorly drained; remains wet for long periods.
Severe: poorly drained; poor trafficability.	Severe: poorly drained; subject to ponding.	Severe: poorly drained	Severe: poorly drained; subject to ponding.
Moderate if slope is less than 14 percent, severe if more than 14 percent.	Severe: slope is more than 5 percent.	Slight if slope is less than 14 percent, moderate if more than 14 percent.	Moderate: very low fertility.
Moderate: subject to flooding.	Moderate: subject to flooding.	Slight: somewhat poorly drained.	Moderate: subject to flooding.
Severe: very poorly drained; subject to flooding; fine textured.	Severe: very poorly drained; subject to flooding; fine textured.	Severe: very poorly drained; subject to flooding; fine textured.	Severe: very poorly drained; subject to flooding; fine textured.
Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Moderate if slope is less than 14 percent, severe if more than 14 percent: slippery when wet.	Severe: very slow permeability; slope is more than 5 percent; fine-textured subsoil.	Moderate: somewhat poorly drained; fine-textured subsoil.	Severe: stays soft and wet for extended periods; low productivity.
Sever: poorly drained	Severe: poorly drained; slope more than 5 percent.	Severe: poorly drained; fine-textured subsoil.	Severe: poorly drained; fine-textured subsoil.
Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Moderate: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.
Moderate: somewhat poorly drained and poorly drained.	Severe: somewhat poorly drained and poorly drained.	Moderate: somewhat poorly drained and poorly drained.	Moderate: somewhat poorly drained and poorly drained.
Severe: poorly drained; subject to ponding of surface water.	Severe: poorly drained; subject to ponding of surface water.	Severe: poorly drained; subject to ponding of surface water.	Severe: poorly drained; subject to ponding of surface water.
Moderate if slope is less than 14 percent, severe if more than 14 percent.	Severe: slope more than 5 percent.	Slight if slope is less than 14 percent, severe if more than 14 percent.	Slight if slope is less than 14 percent, severe if more than 14 percent.
Moderate if slope is less than 14 percent, severe if more than 14 percent.	Severe: very slow permeability; slope more than 5 percent.	Moderate: somewhat poorly drained; fine-textured subsoil.	Severe: very slow permeability; very low fertility; stays wet for extended periods.

TABLE 4.—*Degree and kind of limitations*

Soil series and map symbols	Cottages and utility buildings	Intensive campsites
Grundy: 364B	Moderate: somewhat poorly drained; high shrink-swell potential.	Severe: slow permeability; somewhat poorly drained.
Haig: 362	Severe: poorly drained; high shrink-swell potential.	Severe: poorly drained; remains wet for extended periods.
Humeston: 269A, 269B	Severe: poorly drained to very poorly drained; subject to flooding.	Severe: poorly drained to very poorly drained; subject to flooding; very slow permeability.
*Kennebec: 406 For Amana part refer to Amana series.	Severe: subject to flooding	Severe: subject to flooding
Keswick: 425C, 425C2, 425D, 425D2, 425D3	Moderate: slope is more than 5 percent; high shrink-swell potential.	Moderate: slope is more than 5 percent; slow permeability.
Kniffin: 531B, 531C, 531C2	Moderate: somewhat poorly drained; high shrink-swell potential.	Moderate: very slow permeability; somewhat poorly drained.
Lamoni: 822D2, 822D3	Severe: somewhat poorly drained; high shrink-swell potential.	Severe: very slow permeability; seasonally seepy and wet.
Landes variant: 208	Severe: subject to flooding	Severe: subject to flooding
Lindley: 65E2, 65E3, 65F, 65F2, 65F3, 65G2	Severe: slope is more than 14 percent.	Severe: slope is more than 14 percent.
Lineville and Lineville variant: 452B, 452C, 452C2, 752C, 752C2.	Moderate: moderately well drained and somewhat poorly drained; seasonal perched water table.	Moderate: moderately well drained and somewhat poorly drained.
Marsh: Properties too variable to be rated.		
*Mystic: 592C2, 592C3, 592D2, 592D3, 94D2, 94D3, 94E2, 94E3. For Caleb part of 94D2, 94D3, 94E2, and 94E3, refer to Caleb series.	Moderate: somewhat poorly drained.	Moderate if slope is less than 14 percent, severe if more than 14 percent.
Nodaway: 220, 315	Severe: subject to flooding; low bearing capacity.	Severe: subject to flooding
*Olmitz: 273B, 13B For Colo and Vesser part of 13B, refer to Colo and Vesser series.	Slight	Slight
Pershing: 131B, 131C, 131C2, T131B, T131C	Moderate: somewhat poorly drained; high shrink-swell potential.	Moderate: slow permeability; somewhat poorly drained.
Radford: 467	Severe: subject to flooding	Severe: subject to flooding
Rathbun: 532B, 532B2, 532C, 532C2	Moderate: somewhat poorly drained.	Moderate: very slow permeability.
Seymour: 312B, 312C2	Severe: somewhat poorly drained; high shrink-swell potential.	Severe: very slow permeability

for recreational facilities—Continued

Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained; moderately fine textured surface layer.	Moderate: somewhat poorly drained; remains wet for short periods.	Moderate: somewhat poorly drained; moderately fine textured surface layer.
Severe: poorly drained	Severe: poorly drained; ponding of surface water.	Severe: poorly drained; moderately fine textured surface layer.	Severe: poorly drained; ponding of surface water.
Severe: poorly drained to very poorly drained; subject to flooding.	Severe: poorly drained to very poorly drained; subject to flooding.	Severe: poorly drained to very poorly drained; subject to flooding.	Severe: poorly drained to very poorly drained; subject to flooding.
Moderate: subject to flooding.	Moderate: subject to flooding.	Moderate: subject to flooding	Moderate: subject to flooding.
Moderate: slope is more than 5 percent; moderately fine textured and medium textured surface layer.	Severe: slope is more than 5 percent.	Moderate: moderately fine textured and medium textured surface layer.	Moderate: low fertility; moderately fine textured and medium textured surface layer.
Moderate: somewhat poorly drained.	Moderate: very slow permeability; somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Severe: somewhat poorly drained; seasonally seepy and wet.	Severe: very slow permeability; seasonally seepy and wet.	Severe: somewhat poorly drained; seasonally seepy and wet.	Moderate if slope is less than 9 percent, severe if more than 9 percent; seasonally wet and seepy.
Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding	Moderate: subject to flooding.
Severe: slope is more than 14 percent.	Severe: slope is more than 14 percent.	Moderate if slope is less than 24 percent, severe if more than 24 percent.	Severe: slope is more than 14 percent.
Moderate: moderately well drained and somewhat poorly drained.	Moderate: moderately well drained and somewhat poorly drained; seasonal perched water table.	Moderate: moderately well drained and somewhat poorly drained.	Moderate: moderately well drained and somewhat poorly drained.
Moderate if slope is less than 14 percent, severe if more than 14 percent.	Severe: slope is more than 5 percent; somewhat poorly drained.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained; low fertility.
Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding; good trafficability.	Moderate: subject to flooding.
Slight	Moderate: slope is more than 2 percent.	Slight	Slight.
Moderate: somewhat poorly drained.	Moderate if slope is less than 5 percent, severe if more than 5 percent.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.
Moderate: subject to flooding.	Severe: subject to flooding.	Moderate: subject to flooding	Moderate: subject to flooding; good trafficability.
Moderate: somewhat poorly drained.	Moderate if slope is less than 5 percent; severe if more than 5 percent; very slow permeability.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained; low fertility.
Moderate: somewhat poorly drained.	Severe: very slow permeability.	Moderate: somewhat poorly drained.	Moderate: somewhat poorly drained.

TABLE 4.—*Degree and kind of limitations*

Soil series and map symbols	Cottages and utility buildings	Intensive campsites
Shelby: 24D2, 24D3, 24E2, 24E3	Moderate if slope is less than 18 percent, severe if more than 18 percent.	Moderate if slope is less than 14 percent, severe if more than 18 percent.
*Sogn: 413D2 For Gosport and Clanton parts, see Gosport and Clanton soils.	Severe: shallow over limestone	Severe: shallow over limestone
Tuskeego: 453A, 453B	Severe: poorly drained	Severe: poorly drained; very slow permeability.
Vesser: 51A, 51B	Severe: somewhat poorly drained to poorly drained; subject to flooding.	Severe: subject to flooding; somewhat poorly drained to poorly drained.
Wabash: 172	Severe: very poorly drained; subject to flooding.	Severe: very poorly drained; subject to flooding.
Weller: 132B, 132B2, 132C2, 132D2, T132B, T132C2	Slight if slope is less than 5 percent, moderate if more than 5 percent.	Moderate: slow permeability
Wiota: 7A	Slight	Slight: moderately well drained
Zook: 54A, 54B	Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.

Fox, squirrel, woodchuck, and cottontail rabbit are generally abundant in the uplands. White-tailed deer frequent soil association 7 and the adjacent wooded soils. Muskrat, mink, and some beaver frequent the Chariton River and creeks throughout the county. They probably are most numerous in soil association 7, but they occur along the waterways in other soil associations. Skunk, opossum, and raccoon are common in the uplands.

Quail are plentiful throughout the county. Pheasants, which were introduced to the county some years ago, are becoming more numerous in the western part of the county in soil associations 1 and 2. If habitat is adequate and reproduction is normal, most kinds of game can be hunted each year without depleting their numbers.

Some marsh areas along the Chariton River provide good habitat for such waterfowl as duck and geese. Clayey bottom land of the Wabash and Carlow soils provides sites for dikes and impoundments to improve habitat for waterfowl (fig. 28). These areas are suitable for building hunting blinds and also provide food and cover for wildlife.

Fish, mainly channel catfish, bullheads, and carp, are fairly plentiful in major streams. Many privately owned artificial ponds that range from one-half acre to 15 acres in size are well distributed throughout the county. Some are well managed and provide excellent fishing for bass, bluegill, and catfish. Internal drainage, available water capacity, texture of subsoil, and permeability are important factors in selecting sites for stocked farm ponds and in developing and maintaining habitat for waterfowl.

Several watershed structures provide excellent fishing and enhance the total wildlife habitat. The Rathbun Reservoir, an 11,000-acre permanent pool, is one of the largest bodies of water in Iowa. This body of water has high potential for fishing and for habitat for various kinds of waterfowl. Many of the soils in soil associations 1, 3, and 6 next to the Rathbun Reservoir are suitable for food plantings for waterfowl.

The wildlife resources of the county are mainly important for the opportunities they provide for recreation. Songbirds and hawks, owls, snakes, and other predators are also important in that they control rodents and undesirable insects.

Although many areas in the county are suitable for wildlife habitat, many more could be improved or developed. Generally some soils on each farm support good wildlife habitat if properly used. Small, irregular areas of limited value for other uses can be developed for wildlife habitat. Suitable for this purpose are many areas of moderately steep or steep Adair, Armstrong, Gara (fig. 29), and Lindley soils and the Armstrong-Gara complexes. Brushy or wooded areas can be fenced so that food and cover are not destroyed. The borders of fields can also be planted to grasses and legumes. Those areas should be left unclipped, especially during the nesting season for upland birds.

Engineering Properties of Soils

Engineers have studied soil characteristics that affect construction and have devised systems of soil classification based on these characteristics. Most of these studies have been at the site of construction, *for recreational facilities*—Continued

Picnic areas	Intensive play areas	Trails and paths	Golf fairways
Moderate if slope is less than 14 percent, severe if more than 18 percent.	Severe: slope more than 5 percent.	Slight if slope is less than 14 percent, moderate if more than 14 percent.	Slight if slope is less than 14 percent, moderate if more than 14 percent.
Severe: shallow over limestone.	Severe: shallow over limestone; slope more than 9 percent.	Moderate: shallow over limestone; many rock outcrops.	Severe: shallow over limestone; many rock outcrops.
Severe: poorly drained	Severe: poorly drained; very slow permeability.	Severe: poorly drained	Severe: poorly drained.
Moderate: somewhat poorly drained to poorly drained.	Severe: somewhat poorly drained to poorly drained; subject to flooding.	Moderate: somewhat poorly drained to poorly drained.	Moderate: somewhat poorly drained to poorly drained.
Severe: very poorly drained; subject to flooding.	Severe: very poorly drained; subject to flooding; fine-textured surface layer.	Severe: very poorly drained; subject to flooding.	Severe: very poorly drained; poor trafficability when wet.
Slight if slope is less than 9 percent, moderate if more than 9 percent.	Moderate: slow permeability.	Slight	Moderate: low fertility; slow permeability.
Slight	Slight: moderately well drained.	Slight	Slight: moderately well drained.
Severe: poorly drained; subject to flooding.	Severe: poorly drained; subject to flooding.	Severe: poorly drained	Severe: poorly drained; subject to flooding.

because general information about the engineering properties of the soils of an area has not been readily available.

This soil survey contains information that engineers can use to—

1. Make studies of soil and land use that will aid in selecting and developing sites for industries, business, residences, and recreational areas.
2. Assist in planning and designing drainage and irrigation structures and in planning dams and other structures for controlling water and conserving soil.
3. Make reconnaissance surveys of soil and ground conditions that aid in selecting locations for highways and airports and in planning more detailed soil surveys for the intended locations.
4. Locate probable sources of sand and gravel.
5. Correlate pavement performance with soil properties and thus develop information that will be useful in designing and maintaining pavements.
6. Determine the suitability of soils for cross-country movement of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and from aerial photographs.

With the use of the soil map for identification, the interpretations made in this soil survey can be useful to the planning engineer. It should be emphasized, however, that these interpretations are not a substitute for the sampling and testing needed at a site chosen for a specific engineering work where heavy loads are involved or at a site where the excavations are to be deeper than the depth here reported. Also, engineers should not apply specific values to estimates of bearing capacity given in this survey. Nevertheless, by using this survey, an engineer can select and concentrate on those soil units most important for the proposed kind of construction, and in this way reduce the number of soil samples taken for laboratory testing and complete an adequate investigation at minimum cost.

Some of the terms used in this survey have special meanings in soil science that may be unfamiliar to the engineer, for example, soil, clay, silt, and sand. These and other special terms are defined in the Glossary at the back of this survey.

Engineering classification systems

Most highway engineers classify soil materials in accordance with the systems approved by the American Association of State Highway [and Transportation] Officials (AASHTO) (*1*). In this system soil materials are classified in seven principal groups. The groups range from A–1, consisting of gravelly soils having high bearing capacity, to A–7, which is made up of clayey soils having low strength when wet.

Some engineers prefer to use the Unified soil classification system (*2*). In this system, soil materials are identified as coarse grained (8 classes), fine grained (6 classes), or highly organic. An approximate classification can be made in the field.

Estimated classifications of the soils in Appanoose

Figure 28.—**Series of dikes on Carlow soils provides excellent habitat for waterfowl.**

County under both systems are given in the tables in this section.

Soil engineering data and interpretations

Information and interpretations of most significance to engineers are given in tables 5, 6, and 7. In table 5 are estimates of soil properties significant to engineering. The data in table 5 are based on information in other parts of the survey and on experience with similar soils in other counties. Table 6 gives engineering interpretations of the soils in this county. Table 7 presents laboratory test data for samples taken from five soil profiles in Appanoose County. Additional information can be obtained from other parts of the survey, especially from the sections "General Soil Map," "Descriptions of the Soils," and "Formation and Classification of the Soils." Following are explanations of some of the columns in tables 5 and 6.

The percentage passing sieves shown in table 5 is the normal range of soil particles passing the respective screen sizes.

Permeability refers to the rate of movement of water through an undisturbed soil. It depends largely on soil texture and structure. The estimates do not take into account lateral seepage or such transient soil features as plowpans and crusts.

Available moisture capacity is the capacity of the soil to hold water available for use by most plants. It is commonly defined as the difference between the amount of water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The ratings are of particular value in engineering design for irrigation.

Reaction given in table 5 was determined in the field. It is the estimated range in pH value for each major horizon. The pH value indicates the acidity or alkalinity of the soil. A pH of 7, for example, indicates a neutral soil, a lower value indicates acidity, and a higher value indicates alkalinity.

Shrink-swell potential is the ability of soil material to change volume when subjected to changes in moisture. Those soil materials rated high are normally undesirable from the engineering standpoint, since the increase in volume when the dry soil is moistened generally is accompanied by a loss in bearing capacity. In general, soils classed as CH and A–7 have a high

Figure 29.—Gara soils provide good potential sites for wildlife.

shrink-swell potential. Clean sands and gravels (single-grained structure) and soils containing a small amount of nonplastic to slightly plastic fines have a low shrink-swell potential.

In table 6 are estimates of suitability of the soils in the county as a source of topsoil. Most of the soils are poor or fair as topsoil, but the Nodaway and Kennebec soils are excellent, and the Olmitz soils are good.

Table 6 does not give estimates of the soils as a source of sand and gravel because most of the soils are not suitable sources. The Caleb soils, however, are a fair source of sand and a fair to poor source of gravel. They have pockets of well-graded sand and gravel in the substratum. The Landes heavy subsoil variant is a limited source of poorly graded sand. The Mystic soils are a fair to poor source of sand and a poor source of gravel. They have pockets and strata of well-graded sand in the subsoil in places.

Most of the soils in the county make very poor or poor road fill because the volume change is high and the soils are plastic, low in bearing capacity, and difficult to compact. The Caleb, Gara, Lindley, and Shelby soils, however, make good road fill.

Soil features that affect the selection of highway location are topography, seepage, susceptibility to flooding and frost action, and availability of borrow material.

Soil features that affect foundations for low buildings are compressibility, wetness, susceptibility to frost action, susceptibility to flooding, bearing capacity, and a seasonal high water table.

Among the soil features that affect reservoir areas are permeability, compactibility, shrink-swell potential, and imperviousness. Embankments are affected by stability, shrink-swell potential, and imperviousness of the soil material.

Most of the soils in the county have severe or very severe limitations to use as septic tank disposal fields because they are very slowly permeable, have a seasonal high water table, and are susceptible to flooding.

Farm drainage is affected by permeability, availability of outlets, and seepage.

High available water capacity affects use of soils for irrigation. Also important are the rate of water intake and susceptibility to erosion.

Terraces and diversions can be constructed in many places, but they are hard to maintain on the coarser textured material. Terrace ridges and channels are

TABLE 5.—*Estimates of soil*

[An asterisk in the first column indicates at at least one mapping unit in this series is made up of two or more kinds of soil. The instructions for referring to other series that appear in the first column of

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification
				Unified
	Feet	*Inches*		
*Adair: 192C, 192C2, 192D2, 93D2, 93D3	2–5	0–13	Clay loam	CL
For Shelby part of 93D2 and 93D3, refer to Shelby series.		13–30	Clay loam or clay	CL or CH
		30–64	Clay loam	CL
Amana: 422	3–5	0–60	Silt loam	ML or CL
Appanoose: 261	1–3	0–15	Silt loam	ML or CL
		15–33	Silty clay	CH
		33–60	Silty clay loam	MH, CH, or CL
*Armstrong: 792C2, 792C3, 792D2, 792D3, 993D2, 993D3, 993E2, 993E3.	2–5	0–11	Loam	CL or CL–ML
For Gara part of 993D2, 993D3, 993E2, and 993E3, refer to the Gara series.		11–18	Clay loam	CL
		18–31	Clay	CH or CL
		31–51	Clay loam	CL
Ashgrove: 795C2, 795D2	1–3	0–4	Silt loam	ML or CL
		4–8	Silty clay loam	ML or CH
		8–65	Silty clay or clay	CH
Beckwith: 260	1–3	0–15	Silt loam	ML or CL–ML
		15–39	Silty clay	CH
		39–60	Silty clay loam	CH
Belinda: 130, T130	1–3	0–17	Silt loam	ML
		17–42	Silty clay	CH
		42–62	Silty clay loam	CH
Caleb	1–10	0–14	Loam and silt loam	ML or CL
Mapped only with Mystic soils.		14–29	Sandy clay loam and clay loam.	SC or CL
		29–40	Loam	ML or CL
		40–52	Fine sandy loam	SM or CL
Cantril: 56B	3–5	0–41	Loam	CL
		41–55	Sandy loam	SC or CL–ML
Carlow: 534	1–3	0–55	Silty clay	CH
Chequest: 587	1–4	0–12	Silty clay loam	CH or CL–ML
		12–53	Silty clay loam	CH or CL–ML
Clanton:	>5	0–13	Silty clay loam	CL or CH
Mapped only with Gosport soils.		13–60	Clay	CH
Clarinda: 222C, 222C2, 222C3, 222D2	1–3	0–10	Silty clay loam	CL or CH
		10–60	Silty clay and clay	CH
Colo: 133A, 133B, 133+	1–3	0–24	Silty clay loam	OH or CH or CL
		24–60	Silty clay loam	CH or CL
Coppock: 520	1–3	0–8	Silt loam	CL–ML
		8–25	Silt loam	CL or CL–ML
		25–37	Silty clay loam	CL or CH
		37–60	Silty clay loam	CL or CH
Edina: 211	1–3	0–10	Silt loam	ML or CL
		10–19	Silt loam	ML or CL
		19–46	Silty clay	CH
		46–64	Silty clay loam	CH
Gara: 179D2, 179D3, 179E, 179E2, 179E3, 179F2	>10	0–14	Loam	CL
		14–42	Clay loam	CL
		42–60	Clay loam	CL
*Gosport: 313D2, 313E2, 313F2	>5	0–7	Silt loam	CL
For Clanton part of 313D2, 313E2, and 313F2, refer to Clanton series.		7–18	Clay	MH
		18–60	Clay	MH

properties significant in engineering

soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the this table. The symbol < means less than, the symbol > means more than.]

Classification—Continued	Percentage passing sieve—			Permeability	Available water capacity	Reaction	Shrink-swell potential
AASHTO	No. 4	No. 10	No. 200				
				Inches per hour	*Inches per inch of soil*	*pH*	
A-6(8-12)	95-100	80-95	60-80	0.63-2.0	0.17	5.6-6.8	Moderate.
A-7-6(15-20)	95-100	80-95	55-80	0.06-0.2	.15	5.6-6.5	High.
A-6(8-12)	95-100	80-95	55-80	0.2-0.63	.15	6.1-7.3	Moderate.
A-6(8) to A-7-6(12)	------	100	95-100	0.63-2.0	.19	5.1-6.8	Moderate.
A-6(8) to A-7-6(14)	------	90-100	95-100	0.63-2.0	.18	4.5-6.5	Moderate.
A-7-6(20)	------	90-100	95-100	<0.063	.16	4.5-6.5	High.
A-7-6(16-20)	------	90-100	95-100	0.2-0.63	.17	5.1-6.5	Moderate to high.
A-4(6) to A-6(10)	95-100	85-100	60-80	0.63-2.0	.17	5.1-6.5	Moderate.
A-6(8-12)	95-100	85-100	60-80	0.20-0.63	.16	5.1-6.0	Moderate.
A-7-6(15-20)	95-100	85-100	55-80	0.06-0.20	.15	4.5-5.5	High.
A-6(8-12)	95-100	85-100	55-80	0.20-0.63	.16	4.5-6.0	Moderate.
A-6(8) to A-7-6(14)	100	95-100	85-100	0.63-2.0	.18	4.5-5.5	Moderate.
A-7-6(16-20)	100	95-100	85-100	0.20-0.63	.16	4.5-5.5	High to moderate.
A-7-6(20)	100	95-100	85-100	<0.063	.15	4.5-6.8	Very high.
A-6(8-10)	------	95-100	95-100	0.63-2.0	.18	4.5-5.5	Moderate.
A-7-6(20)	------	100	95-100	<0.063	.15	4.5-6.0	High.
A-7-6(16-20)	------	100	95-100	0.2-0.63	.17	4.5-6.5	Moderate to high.
A-6(8-10)	------	100	95-100	0.63-2.0	.18	5.1-6.5	Moderate.
A-7-6(20)	------	100	95-100	<0.063	.15	5.1-6.0	High.
A-7-6(16-20)	------	100	95-100	0.2-0.63	.17	6.1-6.8	Moderate to high.
A-6(6-10)	90-100	80-100	60-80	0.63-2.0	.17	4.5-5.5	Moderate.
A-4(4) to A-6(10)	85-100	90-100	45-75	0.63-2.0	.15	4.5-5.5	Moderate.
A-4(3) to A-6-8	85-90	80-90	50-65	0.63-2.0	.15	4.5-6.0	Moderate.
A-4	85-100	80-100	40-55	2.00-6.3	.10	4.5-6.0	Low.
A-6(6-10)	100	85-100	60-80	0.63-2.0	.17	5.1-6.8	Moderate.
A-4(1-4)	85-100	70-95	36-60	2.00-6.3	.06	5.6-6.8	Low.
A-7-6(20)	------	100	95-100	<0.063	.15	4.5-6.0	High.
A-7-6(8-14)	------	100	90-100	0.2-0.63	.18	5.1-6.5	High.
A-7-6(12-20)	------	100	90-100	0.2-0.63	.16	5.1-6.0	High.
A-7-6(12-20)	------	100	90-100	0.2-0.63	.16	5.1-6.8	Moderate.
A-7-6(20)	------	100	90-100	<0.063	.15	5.1-7.3	High.
A-6(6-10) to A-7-6(14)	100	95-100	85-100	0.2-0.63	.18	5.6-6.8	High to moderate.
A-7-6(20)	100	95-100	85-100	<0.063	.15	5.6-6.5	Very high.
A-7-6(14-19)	------	100	85-100	0.2-0.63	.21	5.6-6.8	High.
A-7-6(14-19)	------	100	85-100	0.2-0.63	.19	5.6-6.5	High.
A-6(8-12)	------	100	95-100	0.63-2.0	.20	6.1-6.8	Moderate.
A-6(10-16)	------	100	95-100	0.63-2.0	.18	5.6-6.8	Low to moderate.
A-6(10-16)	------	100	95-100	0.63-2.0	.19	5.1-6.0	Moderate to high.
A-7-6(12-18)	------	100	95-100	0.63-2.0	.18	5.1-6.0	High.
A-6(8-10)	------	100	95-100	0.63-2.0	.20	6.1-6.8	Moderate.
A-6(8-10)	------	100	95-100	0.63-2.0	.18	5.6-6.0	Moderate.
A-7-6(20)	------	100	95-100	<0.063	.15	5.6-6.5	Very high.
A-7-6(16-20)	------	100	95-100	0.063-0.2	.17	5.6-6.8	High.
A-4(3) to A-6(8)	85-95	80-90	55-65	0.63-2.0	.18	5.1-6.8	Moderate.
A-6(9) to A-7-6(14)	85-95	80-90	50-65	0.2-0.63	.17	5.1-6.5	Moderate.
A-6(10) to A-7-6(14)	85-95	80-90	50-65	0.2-0.63	.16	6.6-7.8	Moderate.
A-6(8-10)	------	100	95-100	0.63-2.0	.20	5.6-6.5	Moderate.
A-7-5(16-20)	------	100	95-100	<0.063	.15	4.5-5.5	High.
A-7-5(16-20)	------	100	95-100	<0.063	.15	6.1-7.3	High.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification
				Unified
	Feet	*Inches*		
Grundy: 364B	2–5	0–22	Silty clay loam	CL or ML
		22–41	Silty clay	CH
		41–60	Silty clay loam	CL or CH
Haig: 362	1–3	0–13	Silty clay loam	CL or ML
		13–35	Silty clay	CH
		35–60	Silty clay loam	CL or CH
Humeston: 269A, 269B	1–3	0–17	Silt loam	CL–ML
		17–27	Silty clay loam	CL or CH
		27–44	Silty clay	CH
		44–60	Silty clay loam	CL or CH
*Kennebec: 406 For Amana part refer to Amana series.	2–5	0–21	Silt loam	CL or OL
		21–33	Silt loam	CL
		33–60	Silt loam	CL
Keswick: 425C, 425C2, 425D, 425D2, 425D3	2–5	0–10	Loam	CL
		10–14	Clay loam	CL
		14–20	Clay	CH
		20–52	Clay loam	CL
Kniffin: 531B, 531C, 531C2	1–3	0–9	Silt loam	ML or CL
		9–13	Silty clay loam	CL
		13–23	Silty clay	CH
		23–60	Silty clay loam	CL
Lamoni: 822D2, 822D3	1–10	0–5	Silty clay loam	CL
		5–14	Clay loam	CL
		14–36	Clay	CH
		36–56	Clay loam	CL or CH
Landes variant: 208	3–5	0–26	Fine sandy loam	SM
		26–40	Silt loam	ML or CL
		40–60	Silty clay loam	CL or CH
Lindley: 65E2, 65E3, 65F, 65F2, 65F3, 65G2	>10	0–8	Loam	CL
		8–34	Clay loam	CL
		34–60	Clay loam	CL
Lineville: 452B, 452C, 452C2	1–3	0–7	Silt loam	CL or ML
		7–19	Silty clay loam	CL or CH
		19–39	Clay loam	CL
		39–60	Clay	MH
Lineville variant: 752C, 752C2	1–3	0–7	Silt loam	CL or ML
		7–17	Silty clay loam	CL or CH
		17–56	Silty clay loam or clay loam	CL or CH
		56–65	Silty clay	CH
*Mystic: 592C2, 592C3, 592D2, 592D3, 94D2, 94D3, 94E2, 94E3. For Caleb part of 94D2, 94D3, 94E2, and 94E3, refer to Caleb series.	2–5	0–10	Silt loam	CL
		10–13	Silty clay loam	CL or CH
		13–26	Clay	CH
		26–65	Clay loam	CL or CH
*Nodaway: 220, 315 No estimates for Alluvial land part of 315.	3–6	0–20	Silt loam	ML or CL
		20–60	Silt loam	ML or CL
*Olmitz: 273B, 13B For Colo and Vesser part of 13B, refer to Colo and Vesser series.	>5	0–22	Loam	OL or CL
		22–60	Clay loam	CL
Pershing: 131B, 131C, 131C2, T131B, T131C	2–5	0–7	Silt loam	ML or CL
		7–14	Silty clay loam	CL or CH
		14–33	Silty clay	CH
		33–60	Silty clay loam	CL or CH

significant in engineering—Continued

Classification—Continued	Percentage passing sieve—			Perme-ability	Available water capacity	Reaction	Shrink-swell potential
AASHTO	No. 4	No. 10	No. 200				
				Inches per hour	*Inches per inch of soil*	*pH*	
A-7-6(10-12)	------	100	95-100	0.63-2.0	0.20	5.6-6.8	Moderate to high.
A-7-6(16-20)	------	100	95-100	0.06-0.2	.16	5.6-6.5	High.
A-7-6(13-16)	------	100	95-100	0.2-0.63	.17	6.1-6.5	High.
A-7-6(10-12)	------	100	95-100	0.63-2.0	.20	6.1-7.0	Moderate to high.
A-7-6(20)	------	100	95-100	<0.063	.15	5.6-6.8	High.
A-7-6(13-16)	------	100	95-100	0.2-0.63	.17	6.1-6.8	High.
A-6(8-10)	------	100	95-100	0.63-2.0	.18	5.6-7.0	Moderate.
A-7-6(10-12)	------	100	95-100	0.2-0.63	.17	5.1-6.0	Moderate.
A-7-6(16-20)	------	100	95-100	<0.063	.15	5.1-6.5	High.
A-7-6(14-19)	------	100	95-100	0.06-0.2	.16	5.6-6.8	High.
A-6(8-12)	100	95-100	80-100	0.63-2.0	.22	6.1-6.5	Moderate.
A-6(8-12)	100	95-100	80-100	0.63-2.0	.19	5.5-6.5	Moderate.
A-6(8-10)	95-100	90-100	75-100	0.63-2.0	.18	5.1-6.0	Moderate.
A-6(8-12)	95-100	80-90	60-80	0.63-2.0	.18	4.5-6.0	Moderate.
A-6(8) to A-7-6(12)	95-100	80-90	60-80	0.63-2.0	.16	4.5-6.0	Moderate.
A-7-6(16-20)	95-100	85-100	55-80	0.06-0.2	.15	4.5-5.5	High.
A-6(8-12)	95-100	80-90	55-70	0.2-0.63	.16	4.5-6.0	Moderate to high.
A-4(8) to A-6(10)	------	100	95-100	0.63-2.0	.18	5.1-6.5	Moderate.
A-6(10) to A-7-6(14)	------	100	95-100	0.2-0.63	.17	5.1-6.0	Moderate to high.
A-7-6(20)	------	100	95-100	<0.063	.15	4.5-6.0	High.
A-6-10 to A-7-6(14)	------	100	95-100	0.06-0.20	.17	5.6-6.8	Moderate to high.
A-6(10) to A-7-6(12)	95-100	95-100	70-95	0.2-0.63	.19	5.1-6.8	Moderate to high.
A-6(10) to A-7-6(15)	95-100	95-100	80-95	0.2-0.63	.17	5.1-6.8	Moderate to high.
A-7-6(16-20)	95-100	95-100	85-100	<0.063	.15	5.6-6.5	High.
A-6(10) to A-7-6(15)	85-100						
A-4(1-4)	95-100	85-100	36-50	0.63-2.0	.12	6.1-6.8	Low.
A-6(8-10)	------	95-100	90-100	0.63-2.0	.18	5.6-6.5	Moderate.
A-7-6(14-19)	------	100	95-100	0.2-0.63	.16	5.6-6.5	Moderate to high.
A-4(3) to A-6(8)	85-95	80-90	55-65	0.63-2.0	.17	4.5-6.8	Moderate.
A-6(9) to A-7-6(14)	85-95	80-90	50-65	0.2-0.63	.16	4.5-6.0	Moderate.
A-6(6-10)	85-95	80-90	50-65	0.2-0.63	.16	6.1-7.3	Moderate.
A-4(6) to A-6(10)	------	100	95-100	0.63-2.0	.18	5.1-6.8	Moderate.
A-7-6(10-14)	------	100	95-100	0.2-0.63	.18	5.1-6.5	Moderate.
A-6(10-12)	95-100	80-90	55-70	0.2-0.63	.17	5.1-6.0	Moderate.
A-7-6(16-20)		95-100	85-100	<0.063	.15	5.6-6.8	High.
A-4(6) to A-6(10)	------	100	95-100	0.63-2.0	.18	5.1-6.8	Moderate.
A-7-6(10-14)	------	100	95-100	0.2-0.63	.18	5.1-6.5	Moderate to high.
A-7-6(10-14)	95-100	80-90	55-70	0.2-0.63	.17	5.1-6.8	Moderate to high.
A-7-6(20)	100	95-100	85-100	<0.063	.15	5.6-6.9	High.
A-6(8-12)	95-100	90-100	90-95	0.63-2.0	.17	5.1-6.5	Moderate.
A-7-6(11-15)	95-100	90-100	85-95	0.2-0.63	.16	5.6-6.0	Moderate.
A-7-6(16-20)	------	100	75-95	0.06-0.2	.15	4.5-6.0	High.
A-6(8-12) to A-7-6(11-15)	90-100	80-100	55-75	0.2-0.63	.16	5.6-6.5	Moderate to high.
A-4(8) to A-6(10)	100	95-100	90-100	0.63-2.0	.18	6.1-7.3	Moderate.
A-6(8-10)	100	95-100	90-100	0.63-2.0	.19	6.1-7.3	Moderate.
A-6(6-10)	------	90-100	60-80	0.63-2.0	.19	5.1-6.8	Moderate.
A-6(8) or A-7-6(12)		90-100	60-80	0.63-2.0	.18	6.1-7.3	Moderate.
A-4(18) to A-6(10)	------	100	95-100	0.63-2.0	.18	5.6-6.8	Moderate.
A-6(10) to A-7-6(14)	------	100	95-100	0.2-0.63	.17	5.1-6.5	Moderate to high.
A-7-6(16-20)	------	100	95-100	0.06-0.2	.15	5.1-6.0	High.
A-6(10) to A-7-6(14)	------	100	95-100	0.2-0.63	.16	6.1-6.8	Moderate to high.

TABLE 5.—*Estimates of soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification
				Unified
	Feet	*Inches*		
Radford: 467	1–3	0–21 21–60	Silt loam Silty clay loam	ML or CL CL or CH
Rathbun: 532B, 532B2, 532C, 532C2	1–3	0–13 13–36 36–65	Silt loam Silty clay Silty clay loam	ML CH CL or CH
Seymour: 312B, 312C2	1–3	0–8 8–15 15–31 31–60	Silt loam Silty clay loam Silty clay Silty clay loam	CL CL or CH CH CL or CH
Shelby: 24D2, 24D3, 24E2, 24E3	>10	0–11 11–34 34–60	Loam Clay loam Clay loam	CL CL CL
*Sogn: 413D2 For Gosport and Clanton parts, refer to Gosport and Clanton series.	>10	0–8 8–13 13	Loam Silty clay loam Hard limestone.	CL CL or CH
Tuskeego: 453A, 453B	1–3	0–15 15–24 24–35 35–60	Silt loam Silty clay loam Silty clay Silty clay loam	CL–ML CL or CH CH CH
Vesser: 51A, 51B	1–3	0–24 24–42 42–60	Silt loam Silty clay loam Silty clay loam	ML or CL CL or CH CL or CH
Wabash: 172	0–3	0–38 38–60	Silty clay Silty clay	OH or CH CH
Weller: 132B, 132B2, 132C2, 132D2, T132B, T132C2	1–3	0–19 19–32 32–60	Silt loam or silty clay loam Silty clay Silty clay loam	ML or CL CH CL or CH
Wiota: 7A	>5	0–14 14–46 46–60	Silt loam Silty clay loam Clay loam	ML or CL CL CL
Zook: 54A, 54B	0–3	0–17 17–44 44–60	Silty clay loam Silty clay Silty clay loam	MH or CH CH CL or CH

difficult to keep in good condition. Soil material accumulates in the channels, and some is blown out of ridges by wind.

Grassed waterways should be used in fertile soils that are easy to vegetate. In some places a topdressing may be required. Tile drainage is also needed in some places to control seepage until vegetation is established.

Soil features affecting highway work [4]

Many of the soils in Appanoose County formed in loess that overlies glacial till of Kansan age. The loess ranges from as much as 8 feet thick on the nearly level uplands, or what is often called the Edina or Haig flats, to a very thin layer in the more sloping dissected areas. In many places in the uplands there is no loess, and the parent material is weathered glacial till.

The nearly level and gently sloping Edina, Seymour, Grundy, Haig, and other soils that formed in loess have a B horizon, or subsoil, that is classified as A–7 (CH or CL) material. This material has a high group index and is not suitable for use in the upper 5 feet of embankments. The surface layer of these soils is high in organic-matter content and is hard to compact to good density. The subsoil is mainly plastic silty clay that expands readily and does not make a good upper subgrade. The Seymour, Grundy, Kniffin, Pershing, Rathbun, and Weller soils formed in loess on slopes that erode readily where runoff is concentrated. Sodding, paving, or check dams are needed in some gutters and ditches to prevent excessive erosion.

In the soils derived from loess, the seasonal high water table generally is above the contact of the loess and the highly weathered glacial till, which is called gumbotil. In the nearly level soils, such as Edina and Haig soils, a perched water table occurs above the subsoil in spring and in other wet periods. In these soils, the density of the loess in places is fairly low, and the

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significant in engineering—Continued

Classification—Continued	Percentage passing sieve—			Perme-ability	Available water capacity	Reaction	Shrink-swell potential
AASHTO	No. 4	No. 10	No. 200				
				Inches per hour	*Inches per inch of soil*	*pH*	
A-4(6) to A-6(10)	----	95–100	90–100	0.63–2.0	.19	6.1–6.8	Moderate.
A-7-6(14-19)	----	100	85–100	0.63–2.0	.19	6.1–6.8	Moderate to high.
A-4(6) to A-6(8)	----	100	95–100	0.63–2.0	.18	4.5–6.0	Moderate.
A-7-6(20)	----	100	95–100	<0.063	.15	4.5–6.0	High.
A-6(12) to A-7-6(15)	----	100	95–100	0.2–0.63	.17	5.1–7.0	Moderate to high.
A-7-6(10-14)	----	100	95–100	0.63–2.0	.19	5.6–6.5	Moderate.
A-7-6(18-20)	----	100	95–100	0.06–2.0	.17	5.1–6.0	High.
A-7-6(20)	----	100	95–100	<0.063	.15	5.1–6.5	Very high.
A-7-6(18-20)	----	100	95–100	0.06–2.0	.17	6.1–6.8	High.
A-4(8) to A-6(12)	90–95	80–90	55–65	0.63–2.0	.18	6.1–7.0	Moderate.
A-7-6(14)	85–95	80–90	50–65	0.20–0.63	.15	5.1–7.3	Moderate.
A-6(6) to A-7-6(10)	85–95	80–90	50–65	0.20–0.63	.16	6.6–7.8	Moderate.
A-4(8) to A-6(12)	90–100	80–90	55–65	0.63–2.0	.18	6.1–7.4	Moderate.
A-7-6(14-20)	----	100	90–100	0.63–2.0	.18	6.1–7.4	Moderate to high.
A-4(4-10)	----	100	95–100	0.63–2.0	.18	5.6–7.0	Moderate.
A-7-6(16-20)	----	100	95–100	0.06–0.2	.17	5.1–6.0	Moderate to high.
A-7-6(20)	----	100	95–100	<0.063	.16	5.6–6.5	High.
A-7-6(16-20)	----	100	95–100	0.06–0.2	.17	5.6–6.6	Moderate to high.
A-6(8-12)	----	100	95–100	0.63–2.0	.20	5.1–6.8	Moderate.
A-6(8) to A-7-6(12)	----	100	95–100	0.63–2.0	.18	5.1–6.0	Moderate to high.
A-7-6(14-17)	----	100	95–100	0.2–0.63	.19	5.1–6.0	Moderate to high.
A-7-6(18) to A-7-5(20)	----	100	95–100	<0.063	.17	6.1–7.3	Very high.
A-7-6(20)	----	100	95–100	<0.063	.16	6.1–7.3	Very high.
A-4 to A-6	----	100	95–100	0.63–2.0	.17	4.5–5.5	Moderate.
A-7(16-20)	----	100	95–100	0.06–0.2	.15	4.5–5.5	High.
A-6 to A-7	----	100	95–100	0.2–0.63	.16	5.1–6.8	Moderate to high.
A-6(6-10)	----	100	70–90	0.63–2.0	.18	5.6–6.8	Moderate.
A-7-6(10-14)	----	100	85–95	0.63–2.0	.18	5.1–6.5	Moderate.
A-6-6 to A-7-6(10)	----	100	70–80	0.63–2.0	.16	5.1–6.5	Moderate.
A-7-6(16) to A-7-5(20)	----	100	95–100	0.2–0.63	.20	5.6–7.0	High.
A-7-6(16-20)	----	100	95–100	0.06–0.2	.16	5.6–6.8	High.
A-7-6(16-20)	----	100	95–100	0.06–0.2	.18	5.6–6.8	High

moisture content is high. The moisture can cause instability in embankments unless it is controlled enough to permit the soil to be compacted to high density.

Underlying the loess is weathered Kansan till that is fairly uniform and of poor quality for construction work. On the nearly level to gently rolling uplands, this till is all that remains of the original Kansan till plains. The upper layer is very plastic clay, or is gumbotil, and is classified A-7-6(20). It is not stable enough to be used for highway subgrades, and it should not be used in parts of fills within 5 feet of a finished grade. This plastic clay crops out in sloping areas where the loess is thin. It is the parent material of the Adair and Clarinda soils. The Clarinda soils are not suitable for highway subgrade. The Adair, Armstrong, and Keswick soils have a clayey subsoil and generally are not suitable for highway subgrade. If this clayey material occurs at grade in a roadcut, it should be replaced with a backfill of less weathered glacial till, such as that in the Shelby, Gara, and Lindley soils.

Below these clayey layers is a heterogenous Kansan till that is classified primarily A-6 (CL). This till crops out on the lower part of slopes and is the parent material of the Gara, Shelby, and Lindley soils. If this till occurs in or along grading projects, it normally is placed in the upper subgrade in unstable areas. Pockets and lenses of sand are commonly interspersed throughout the till and in many places are water bearing. Frost heaving is likely if the road grade is only a few feet above these deposits of sand and the deposits are overlain by loess or loamy till. Frost heaving can be prevented by draining these deposits, or by replacing the soil above them with a backfill of coarse-textured material or with good glacial till.

The soils of the bottom land formed in recent alluvium. The Colo, Wabash, Zook, and Kennebec soils have a thick surface layer that is high in organic-matter content. These soils may consolidate erratically under the load of a heavy embankment. The Zook, Colo, Carlow, Chequest, Humeston, Tuskeego, and Wabash

TABLE 6.—*Engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. carefully the instructions for referring to other

Soil series and map symbol	Suitability as source of— Topsoil	Suitability as source of— Road fill [1]	Soil features affecting— Highway location	Soil features affecting— Foundations for low buildings	Farm ponds: Reservoir area	Farm ponds: Embankment
*Adair: 192C, 192C2, 192D2, 93D2, 93D3. For Shelby part of 93D2 and 93D3, refer to Shelby series.	Poor: limited amount of suitable material; subsoil high in clay content.	Very poor in subsoil: high shrink-swell potential and highly elastic. Fair in substratum: easily compacted to high density.	Rolling topography; seepage in cut can be expected seasonally; difficult to establish vegetation; highly susceptible to frost action.	Slight compressibility; uneven consolidation; seepy and wet in many areas; highly susceptible to frost action.	Low permeability when compacted; easily compacted; suitable sites common.	Impervious material; fair to good stability; moderate to high shrink-swell potential; good for impervious cores; easily compacted to high density.
Amana: 422	Good	Fair to poor: poor bearing capacity; difficult to compact to high density.	Nearly level topography; subject to flooding.	Subject to flooding; high compressibility.	Nearly level topography; fluctuating water table; seepage can be expected even if soil is compacted.	Fair stability; high compressibility; fair or poor compaction.
Appanoose: 261.	Poor: low organic-matter content; subsoil high in clay content.	Poor: subsoil has high shrink-swell potential; low bearing capacity when wet; difficult to compact to high density.	Nearly level topography; low borrow potential; seasonally wet and seepy; moderate to high potential for frost heave.	High shrink-swell potential; poor bearing capacity; uniform consolidation.	Nearly level topography; very slow permeability; suitable sites unlikely.	Fair stability; impervious when compacted; high volume change when wet; poor workability when wet.
*Armstrong: 792C2, 792C3, 792D2, 792D3, 993D2, 993D3, 993E2, 993E3. For Gara part of 993D2, 993D3, 993E2, and 993E3, refer to Gara series.	Poor: low organic-matter content; thin layer of suitable material.	Very poor in subsoil: highly elastic and high shrink-swell potential. Fair to good in substratum: fairly easily compacted to high density.	Rolling topography; seasonally seepy and wet; vegetation difficult to establish; good borrow potential in substratum.	Seepy and wet in many places; high shrink-swell potential; slight compressibility; susceptible to frost action.	Suitable sites comon; slow permeability; easily compacted.	Fair or good stability; high shrink-swell potential in subsoil; good for impervious cores; easily compacted to high density.
Ashgrove: 795C2, 795D2.	Very poor: very low fertility; subsoil high in clay content.	Poor: low borrow capacity; poor shear strength; elastic; high volume change with moisture; low stability at high moisture content.	Poor potential as borrow material; seasonal high water table; seepage in cuts in many places; low stability at high moisture content.	Poor shear strength; fair to poor bearing capacity; very high shrink-swell potential.	Suitable sites common; low permeability when compacted.	Fair stability; medium to high compressibility; high volume change when wet; very high shrink-swell potential.
Beckwith: 260	Poor: very low organic matter content; subsoil high content. in clay	Poor: low borrow capacity; poor shear strength; difficult to compact to high density; poor workability.	Nearly level topography; poorly drained; very slow permeability; high shrink-swell potential; difficult to compact to high density.	Poorly drained; very slow permeability; high shrink-swell potential; seasonal high water table; difficult to compact to high density.	Suitable sites unlikely; uniform material of very slow permeability.	Poor or fair stability; difficult to compact when too wet or too dry; medium to high compressibility; low permeability when compacted.

interpretations

The soils in such mapping units may have different properties and limitations, and for this reason it is necessary to follow series that appear in the first column of this table]

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Wetness caused by seepage; interceptor tile placed above the seepage areas is helpful.	Slow permeability; subject to erosion; limited value for farming.	Subsoil unfavorable for crops and difficult to vegetate if exposed; terrace channels likely to be seepy and wet.	Low fertility; tile helpful in erosion control.	Severe: slow permeability.	Severe if slope is 9 to 14 percent, moderate if 5 to 9 percent.
Subject to flooding; flood protection needed.	Medium intake rate; high available water capacity; subject to flooding.	Not needed because of topography.	Not needed because of topography.	Severe: subject to flooding, especially in spring.	Moderate: moderate permeability.
Poorly drained; very slow permeability; tile generally unsatisfactory.	Slow intake rate; very slow permeability; high available water capacity; adequate drainage difficult to obtain.	Not needed because of topography.	Not needed because of topography.	Severe: very slow permeability; seasonal high water table.	Slight.
Seasonally wet and seepy; interceptor tile placed above the seepage areas helps reduce wetness.	Slow intake rate; high available water capacity; subject to runoff and erosion on moderately steep slopes; low potential productivity.	Subsoil high in clay content, unfavorable for crops, and difficult to vegetate; terrace channels likely to be seepy and wet.	Low fertility; wet and seepy in many places.	Severe: slow permeability; seasonally wet and seepy.	Severe if slope is 9 to 18 percent, moderate if 5 to 9 percent.
Interceptor tile properly placed helps control seepage in some areas.	Slow intake rate; very slow permeability; low potential productivity.	Subsoil very low in fertility and difficult to vegetate if exposed where terraces are constructed; diversions properly placed can be beneficial.	Vegetation difficult to establish where subsoil is exposed; topdressing required in many areas.	Severe: very slow permeability; seasonally wet and seepy.	Severe if slope is more than 9 percent, moderate if less than 9 percent.
Tile generally unsatisfactory; poorly drained; seasonally wet; surface ditches and land grading useful in places.	Slow intake rate; very slowly permeable subsoil; high available water capacity; satisfactory drainage difficult to obtain.	Not needed because of topography.	Not needed because of topography.	Severe: very slow permeability; seasonal high water table.	Slight.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—		Soil features affecting—			
	Topsoil	Road fill[1]	Highway location	Foundations for low buildings	Farm ponds: Reservoir area	Farm ponds: Embankment
Belinda: 130, T130.	Poor: low organic-matter content; subsoil high in clay content.	Poor: low bearing capacity; poor shear strength; large volume change on compaction; difficult to compact; high shrink-swell potential.	Seasonal high water table; low borrow potential; poor workability and compaction when not at optimum moisture.	Poor shear strength and bearing capacity; seasonal high water table; high shrink-swell potential.	Suitable sites unlikely; very slow permeability.	Fair to poor stability; high compressibility; difficult to compact; low permeability when compacted.
Caleb ---------- Mapped only with Mystic soils.	Poor: very low fertility.	Good: fair to good bearing capacity and shear strength; slight compressibility; easily compacted to high density; moderate to low shrink-swell potential.	Good potential for borrow material; some cuts may be seasonally seepy; surface layer low in organic-matter content; need for cuts and fills; cuts difficult to vegetate.	Good bearing capacity and shear strength; slight compressibility; uneven consolidation.	Low permeability when compacted; coarse strata below a depth of 4 feet in some places.	Good stability; easily compacted to high density; moderate to low shrink-swell potential.
Cantril: 56B ----	Fair: low fertility.	Fair: moderate shrink-swell potential; fair bearing capacity.	Subject to flooding; low borrow potential.	Moderate shrink-swell potential; subject to flooding; seasonal high water table.	Suitable sites unlikely; subject to flooding; potential seepage below a depth of 3 feet.	Fair to poor stability; low permeability when compacted; potential seepage below a depth of 3 feet.
Carlow: 534 ----	Poor: high in clay content.	Unsuitable: subject to high volume change and loss of bearing capacity; highly elastic; difficult to compact properly.	Low borrow potential; seasonal high water table; poor foundation for high fills; subject to flooding.	High shrink-swell potential; seasonal high water table; very slow permeability; subject to flooding; difficult to compact to high density.	Suitable sites unlikely; subject to flooding.	Poor stability; poor compaction characteristics; high shrink-swell potential; low permeability when compacted; poor workability.
Chequest: 587.	Poor to fair: limited material; high in clay content.	Poor to unsuitable: high shrink-swell potential; poor bearing capacity when wet; difficult to compact to high density; high compressibility.	Poor potential for borrow material; seasonal high water table; subject to flooding; surface layer high in organic-matter content.	High shrink-swell potential; high compressibility; poor shear strength; seasonal high water table; subject to flooding; limitations severe.	Subject to flooding; fair for dugout ponds.	Poor compaction characteristics except at optimum moisture content; high shrink-swell potential.
Clanton -------- Mapped only with Gosport soils.	Fair to a depth of 13 inches, very poor below; very low fertility; high in clay content.	Very poor in the subsoil; unsuitable in the substratum, poor shear strength; high shrink-swell potential.	Very poor to unsuitable: borrow material often wet and seepy; high potential for slides of natural soil.	Poor shear strength and bearing capacity; high compressibility; high shrink-swell potential.	Very slow permeability; less than 2 feet deep to weathered shale.	Clayey subsoil and shaley substratum; high shrink-swell potential; may tend to creep in embankments; very slow permeability.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Very slow permeability; tile generally unsatisfactory; seasonally wet surface ditches.	Slow intake rate; high available water capacity; very slowly permeable subsoil; difficult to obtain satisfactory drainage.	Not needed because of topography.	Not needed because of topography.	Severe: very slow permeability; seasonal high water table.	Slight.
Generally not needed.	Medium available water capacity; fair suitability; soils have limited use for farming.	Commonly slopes are more than 10 percent; very low fertility in subsoil.	Tile needed in places to control seepage; very low fertility; difficult to vegetate.	Severe: slopes commonly more than 10 percent; poor filtering.	Severe: moderately rapid permeability below a depth of 3 feet.
Seasonal high water table; tile functions satisfactorily; subject to occasional flooding.	Medium intake rate; moderate to moderately slow permeability; subject to flooding by runoff from higher uplands.	Terraces not needed; properly placed diversions help prevent local flooding and siltation.	Generally not needed; seepage on sides of waterways; tile needed to permit vegetation to become established in places.	Severe: seasonal high water table; subject to flooding.	Moderate: moderate permeability; subject to flooding.
Surface drains suitable, but tile drainage is not; subject to flooding.	Slow intake rate; very slow permeability; high available water capacity; difficult to obtain adequate drainage.	Not needed because of topography.	Not needed because of topography.	Severe: very slow permeability; subject to flooding.	Slight.
Tiles function satisfactorily but outlets may be difficult to obtain; most areas need protection from flooding.	High available water capacity; drainage required before irrigation.	Diversions properly placed to control local runoff can reduce wetness in some areas; terraces not needed because of topography.	Not needed because of topography.	Severe: subject to flooding; moderately slow permeability; seasonal high water table.	Slight.
No drainage needed.	Slow intake rate; very slow permeability; strong slopes; low potential for farming.	Unsuitable because of low potential for farming and clayey, infertile subsoil.	Very difficult to vegetate; clayey subsoil is very low in fertility.	Severe: very slow permeability in subsoil and substratum.	Severe: slopes exceed 9 percent.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—		Soil features affecting—			
					Farm ponds	
	Topsoil	Road fill [1]	Highway location	Foundations for low buildings	Reservoir area	Embankment
Clarinda: 222C, 222C2, 222C3, 222D2.	Very poor to unsuitable: low fertility; high in clay content.	Unsuitable: highly elastic; moderate to high shrink-swell potential; difficult to compact to high density.	Poor potential for borrow material; seepage often occurs in cuts; surface layer high in organic-matter content.	Poor shear strength; fair to poor bearing capacity; moderate to very high shrink-swell potential; uneven consolidation; limitations severe.	Low permeability when compacted; good suitability.	Fair stability on flat slopes; moderate to very high shrink-swell potential; medium compressibility; fair suitability.
Colo: 133A, 133B, 133+.	Fair: moderately fine textured.	Very poor: poor bearing capacity and shear strength; seasonal high water table; high compressibility; high in organic-matter content to a depth of 3 feet or more.	Seasonal high water table; subject to flooding in places; poor foundation for high fills; poor potential for borrow material.	Seasonal high water table; subject to flooding; high compressibility with uneven consolidation.	High in organic-matter content; some areas have potential for dug-out ponds; fair to poor suitability.	High in organic-matter content in top 3 or more feet; poor embankment foundation; very poor suitability.
Coppock: 520	Good to a depth of 8 inches, fair below a depth of 8 inches: medium fertility.	Fair or poor: moderate to high shrink-swell potential; difficult to compact to high density; fair to poor bearing capacity.	Subject to flooding; seasonal high water table; poor for foundations and for fills; low borrow potential.	High compressibility; seasonal high water table; subject to flooding.	Suitable sites unlikely; low permeability when compacted.	Fair to poor stability; moderate to high shrink-swell potential; fair or poor compaction characteristics.
Edina: 211	Fair, but thin layer suitable; high clay content below a depth of 21 inches.	Unsuitable: poor shear strength; high plasticity; moderate to very high shrink-swell potential; elastic; poor bearing capacity when wet; difficult to compact to high density.	Level topography; poor potential for borrow material; seasonal high water table; surface layer high in organic-matter content; poor workability.	Poor shear strength; slight compressibility; uniform consolidation; moderate to very high shrink-swell potential.	Level topography on high elevation or stream divides; little watershed potential; poor suitability.	Fair stability; impervious when compacted; moderate to very high shrink-swell potential; high compressibility; slight creep can be expected in fills; poor workability when wet; fair to poor stability.
Gara: 179D2, 179D3, 179E, 179E2, 179E3, 179F2.	Fair: only thin layer with organic matter; subsoil high in bulk density.	Good: fair to good bearing capacity; good workability and compaction characteristics; easily compacted to high density.	Rolling topography; variable materials in cuts: some cuts may be seepy; good potential as borrow material.	Good bearing capacity and shear strength; slight compressibility; uneven consolidation.	Low permeability when compacted; good sites generally available.	Adequate stability; easily compacted to high density; good workability; good for cores; good suitability.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Use of properly placed interceptor tile helps control seepage in some areas.	Slow intake rate and very slow permeability; soils have limited use for farming.	Subsoil has low fertility and is difficult to vegetate if exposed where terraces are constructed; diversions properly placed are beneficial.	Difficult to vegetate where subsoil is exposed; topdressing required in many places.	Severe: very slow permeability; seasonal high water table.	Moderate or severe: moderate if slope is less than 9 percent; severe if more than 9 percent.
Moderately slow permeability; tile functions satisfactorily; in some places outlets may not be available; need protection from floods in places.	Medium intake rate; high available water capacity; artificial drainage generally needed; subject to flooding.	Diversions properly placed are beneficial in preventing local flooding and siltation.	Generally not needed because of topography.	Severe: seasonal high water table; subject to flooding; moderately slow permeability.	Moderate: high organic-matter content; subject to flooding.
Seasonal high water table; tile functions satisfactorily; subject to occasional flooding.	Medium intake rate; high available water capacity; tile drainage needed.	Terraces not needed; diversions properly placed help prevent local flooding and siltation.	Generally not needed; seepage on sides of waterways; tile needed to permit vegetation to become established.	Severe: seasonal high water table; moderately permeable; subject to flooding.	Moderate: subject to flooding.
Surface drains are suitable, but tile drainage is not.	Slow intake rate; high available water capacity; very slow permeability; difficult to obtain adequate drainage.	Not needed because of topography.	Not needed because of topography.	Severe: very slow permeability in subsoil; seasonal high water table.	Slight.
Drainage not needed.	Subject to high rate of runoff; high available water capacity; erosion control practices needed.	Suitable on lesser slopes; cuts should be held to a minimum because of less productive subsoil.	Tile needed to keep waterways dry so that vegetation can be established.	Severe: moderately slow permeability; many slopes more than 10 percent.	Severe: slopes 9 to 14 percent.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of— Topsoil	Road fill [1]	Soil features affecting— Highway location	Foundations for low buildings	Farm ponds Reservoir area	Embankment
*Gosport: 313D2, 313E2, 313F2: For Clanton part of 313D2, 313E2 and 313F2, refer to Clanton series.	Fair to a depth of 7 inches, poor below a depth of 7 inches; very low fertility; high in clay content.	Very poor: poor shear strength; high shrink-swell potential; difficult to compact to high density.	Borrow material often wet and seepy; landslides of natural soil or road fill over the sloping shale likely.	Poor shear strength and bearing capacity; high compressibility and high shrink-swell potential; seasonal high water table.	Very slow permeability; substratum consists of clayey material.	High shrink-swell potential; clayey subsoil and substratum; may tend to creep in embankment; very slow permeability.
Grundy: 364B	Fair to good in surface layer, poor in clayey subsoil.	Very poor: highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; poor shear strength; range of moisture content narrow for suitable compaction.	Poor potential as borrow material; seasonal high water table; surface layer high in organic-matter content.	Moderate to high shrink-swell potential; high compressibility; seasonal high water table.	Uniform material of slow permeability.	Low stability when wet; moderate to high shrink-swell potential; impervious when compacted; range of moisture content narrow for suitable compaction; slight creep of embankments can be expected; poor suitability.
Haig: 362	Fair in surface layer, poor in clayey subsoil.	Very poor: highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; poor shear strength; range of moisture content narrow for suitable compaction.	Poor potential as borrow material; seasonal high water table; surface layer high in organic-matter content; low relief; nearly level topography.	Moderate to high shrink-swell potential; high compressibility; seasonal high water table; fair bearing capacity; uniform consolidation.	Suitable sites unlikely; low permeability when compacted.	Moderate to low stability when wet; high shrink-swell potential; impervious when compacted; narrow moisture range for compaction.
Humeston: 269A, 269B.	Fair in surface layer, poor in clayey subsoil.	Very poor: highly elastic; moderate to high shrink-swell potential; poor bearing strength when wet; poor shear strength.	Poor potential as borrow material; nearly level topography; subject to flooding; seasonal high water table; moderately high in organic-matter content to a depth of 4 feet or more; poor foundation for high fills.	Subject to flooding; moderate to high shrink-swell potential.	Suitable sites unlikely; low permeability when compacted; subject to flooding.	Fair stability; very slow permeability; moderate to high shrink-swell potential; high compressibility; fair suitability.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Not needed	Slow intake rate; clayey subsoil and substratum; steep slopes; low farming potential; unsuitable.	Unsuitable because of a low farming potential and clayey infertile subsoil.	Very difficult to vegetate; clayey subsoil very low in fertility.	Severe: very slow permeability in the subsoil and substratum.	Severe: slopes 9 to 24 percent.
Tile may not drain all areas satisfactorily; blinding is required prior to backfilling.	High available water capacity; medium intake rate; slow permeability in the subsoil; irrigation should be limited to approximately 2 feet in depth; difficult to obtain adequate drainage.	Seepage water occurs in some terrace channels; cuts should be held to a minimum depth to prevent exposure of fine-textured subsoil.	Tile needed in places to prevent seepage so that vegetation can be established; few limitations.	Severe: seasonal high water table; slow permeability.	Moderate: slopes 2 to 5 percent.
Tile may not drain all areas satisfactorily; blinding is required prior to backfilling; surface drainage needed in depressional areas.	High available water capacity; medium to slow intake rate; adequate drainage difficult to obtain.	Not needed because of topography.	Not needed because of topography.	Severe: seasonal high water table; very slow permeability.	Slight.
Protection from stream overflow required; tile occasionally does not drain all areas satisfactorily; surface drains needed in depressional areas.	High available water capacity; susceptible to stream overflow; adequate drainage difficult to obtain.	Terraces not needed; diversions properly placed help to reduce local ponding and wetness.	Not needed because of topography.	Severe: subject to flooding; very slow permeability; seasonal high water table.	Moderate: subject to flooding.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—		Soil features affecting—			
					Farm ponds	
	Topsoil	Road fill [1]	Highway location	Foundations for low buildings	Reservoir area	Embankment
*Kennebec: 406. For Amana part refer to Amana series.	Excellent	Fair to poor: medium to high in organic-matter content in top 2 feet; fair to poor bearing capacity; difficult to compact to high density.	Subject to flooding; medium to high organic-matter content in top 2 to 3 feet.	Fair to poor bearing capacity; fair shear strength; subject to flooding; seasonal high water table above a depth of 4 feet.	Suitable sites unlikely; subject to flooding; seepage can be expected.	Medium to high organic-matter content to a depth of 2 or 3 feet; fair stability and fair compaction in the material below the surface layer; poor embankment facilities.
Keswick: 425C, 425C2, 425D, 425D2, 425D3.	Fair to a depth of 10 inches: low in organic-matter content; poor below a depth of 10 inches; low fertility; high clay content.	Poor to a depth of about 4 feet, good in substratum: elastic; high shrink-swell potential; high density material in substratum; good workability and compaction characteristics.	Rolling topography; seepage in some cuts; high susceptibility to frost action in sand pockets; difficult to establish vegetation on slopes.	Low compressibility; good bearing capacity below a depth of 4 feet; highly expansive if subject to wide fluctuation in moisture.	Slow permeability; slow seepage.	Fair to good stability; usually used for impervious cores; moderate to high shrink-swell potential; good compaction at or near optimum moisture content; slight compressibility.
Kniffin: 531B, 531C, 531C2.	Poor: low fertility; high clay content in subsoil.	Very poor: highly elastic; moderate to high shrink-swell potential; poor bearing capacity when wet; difficult to compact to high density.	Poor potential as borrow material; seasonal high water table; high moisture content in cuts.	Moderate to high shrink-swell potential; high compressibility; uniform consolidation; seasonal high water table.	Uniform material of very slow permeability.	Low stability when wet; moderate to high shrink-swell potential; narrow moisture range for suitabile compaction; slight creep of embankments can be expected; poor suitability.
Lamoni: 822D2, 822D3.	Very poor: low fertility; high clay content.	Poor: elastic; moderate to high shrink-swell potential; difficult to compact properly; low stability at high moisture content.	Seasonal high water table; moderately high in organic-matter content; high moisture content in cuts; poor potential as borrow material.	Moderate to high shrink-swell potential; fair bearing capacity; uneven consolidation.	Low permeability when compacted.	Fair to good stability on slopes; impervious when compacted; suitable for cores; moderate to high shrink-swell potential.
Landes variant: 208.	Fair: moderately high sand content in surface layer.	Fair in upper 2 feet, poor below: low shrink-swell potential; good workability but lacks stability	Subject to flooding; poor stability; material below a depth of about 2 feet poor foundation for high fills.	Subject to flooding; fair shear strength and bearing capacity in upper 2 feet.	Suitable sites unlikely; moderately slow permeability below a depth of 3 feet.	Upper 2 feet highly erodible; low to moderate shrink-swell potential; difficult to vegetate.
Lindley: 65E2, 65E3, 65F, 65F2, 65F3, 65G2.	Poor: very low fertility; subsoil high in bulk density.	Good: fair to good bearing capacity; slight compressibility; easily compacted to high density; moderate shrink-swell potential.	Rolling and steep topography; good source of borrow material; some cuts seepy; surface layer low in organic-matter content.	Fair to good bearing capacity and shear strength; slight compressibility; uneven consolidation.	Good sites likely; moderately slow permeability.	Good stability; easily compacted to high density; usable for core material; low permeability when compacted; good workability.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Subject to stream overflow.	High available water capacity; medium intake rate; subject to overflow.	Not needed because of topography.	Generally not needed; soil features favorable.	Moderate to severe: subject to flooding; moderate permeability.	Moderate: moderate permeability.
Slowly permeable layer causes seepage; interceptor tile needed at contact of loess and till.	High available water capacity; slow permeability; subject to runoff and erosion; low production potential.	Subsoil unfavorable, high clay content; some terrace channels wet and seepy; cuts should be held to a minimum.	Seepage on sides of waterway; tile needed to establish good vegetation.	Severe: slow permeability; seasonally wet and seepy.	Severe or moderate: severe if slope is more than 9 percent; moderate if less than 9 percent.
Tile not recommended; clayey subsoil.	High available water capacity; slow intake rate; difficult to obtain adequate drainage; erosion-control practices needed.	Seepage water occurs in some terrace channels; cuts should be held to a minimum to prevent exposure of the fine-textured subsoil that is low in fertility.	Tile may be needed on sides of waterways to control seepage so that vegetation can be established.	Severe: very slow permeability.	Moderate: slope is 2 to 9 percent.
Interceptor tile properly placed helps control seepage in some areas.	Slow intake rate and very slow permeability; limited value in farming.	Subsoil is very low in fertility and is difficult to vegetate where exposed.	Difficult to vegetate where subsoil is exposed; topdressing required in many places.	Severe: very slow permeability; seasonally seepy and wet.	Severe: slope is 9 to 14 percent.
Not needed	Available water capacity medium in upper 2 feet, medium to high below.	Not needed because of topography.	Not needed because of topography.	Severe: subject to flooding.	Severe: moderate permeability in upper part.
Generally not needed.	High available water capacity; subject to high rate of runoff and erosion; very low in natural fertility.	Slopes are generally irregular and steep.	Difficult to vegetate; very low in fertility.	Severe: slopes exceed 10 percent in most places; moderately slowly permeable subsoil.	Severe: slope is 18 to 40 percent.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—		Soil features affecting—			
					Farm ponds	
	Topsoil	Road fill [1]	Highway location	Foundations for low buildings	Reservoir area	Embankment
Lineville: 452B, 452C, 452C2.	Poor: low fertility; subsoil at a depth of about 3 feet; high clay content.	Poor: poor bearing capacity when wet; moderate to high shrink-swell potential; elastic subsoil difficult to compact properly.	Poor potential as borrow material; generally high need for cuts and fills; seasonally seepy and wet; highly susceptible to frost action.	Moderate to high shrink-swell potential; fair shear strength; uneven consolidation.	Low permeability when compacted.	Low stability; moderate to high shrink-swell potential; impervious when compacted.
Lineville variant: 752C, 752C2.	Poor: low fertility.	Poor: poor bearing capacity when wet; moderate to high shrink-swell potential.	Poor potential as borrow material; seasonally seepy and wet; highly susceptible to frost action.	Moderate to high shrink-swell potential; fair shear strength; uneven consolidation.	Low permeability when compacted.	Low stability; moderate to high shrink-swell potential; impervious when compacted.
Marsh: 354	Unsuitable: covered with water or very wet much of the time.	Unsuitable: very wet or under water much of the time.	Very poor location; under water or very wet much of the time.	Under water or very wet much of the time.	Not suitable for conventional pond sites.	Unsuitable
*Mystic: 592C2, 592C3, 592D2, 592D3, 94D2, 94D3, 94E2, 94E3. For Caleb part of 94D2, 94D3, 94E2, and 94E3, refer to the Caleb series.	Poor: low fertility; clayey subsoil.	Fair to poor in subsoil; subsoil has poor bearing capacity when wet; moderate to high shrink-swell potential; good in substratum; easily compacted to high density.	Substratum makes good borrow material; high moisture in some cuts; highly susceptible to frost action; seasonally wet and seepy; difficult to vegetate cuts.	Good bearing capacity in substratum; highly susceptible to frost heave and loss of bearing capacity on thawing.	Low permeability when compacted; coarse-textured strata below a depth of 4 to 5 feet in some places.	Good stability; semiimpervious to impervious when compacted; good workability; slight compressibility.
*Nodaway: 220, 315. No estimates for Alluvial land part of 315.	Excellent	Very poor: low bearing capacity and moderate shrink-swell potential; low stability when wet; difficult to compact to high density.	Nearly level topography; subject to frequent flooding; high in organic-matter content below a depth of about 3 feet; poor foundation for high fills.	High compressibility; subject to frequent flooding; low bearing capacity.	Reservoir area needs to be compacted; some seepage can be expected.	Low stability at high moisture content; poor compaction above optimum moisture content; suitable for shell but not for core; moderate shrink-swell potential; poor resistance to piping.
*Olmitz: 273B, 13B. For Colo and Vesser parts of 13B, refer to Colo and Vesser series.	Good: thick surface layer that is high in organic-matter content.	Poor: high in organic-matter content to a depth of 2 to 3 feet; fair to poor bearing capacity; moderate shrink-swell potential.	High in organic-matter content to a depth of 2 to 3 feet; poor source of embankment material.	Fair to poor bearing capacity; fair shear strength; medium to high compressibility.	Reservoir area needs to be compacted.	High in organic-matter content to a depth of 2 to 3 feet; fair stability, fair to poor workability and compaction; medium to high compressibility.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Interceptor tile properly placed helps control seepage.	High available water capacity; very slow permeability in lower part of subsoil; very difficult to obtain adequate drainage.	Cuts should be held to a minimum to prevent exposure of subsoil that has low fertility.	Generally not needed because of topography.	Severe: seasonal high water table; very slow permeability in lower part of subsoil.	Severe or moderate: moderate if slope is less than 9 percent, severe if more than 9 percent.
Interceptor tile properly placed helps control seepage.	High available water capacity; moderately slow permeability; very difficult to obtain adequate drainage.	Cuts should be held to a minimum to prevent exposure of subsoil that has low fertility; sidehill seeps may be exposed in channels.	Difficult to vegetate where subsoil is exposed; topdressing required in many places.	Severe: seasonal high water table.	Moderate: slope is 5 to 9 percent.
Some potential for draining; outlets generally difficult to obtain.	Not applicable	Not applicable	Not applicable	Very severe: under water or very wet most of the time.	Not applicable.
Generally not needed but interceptor tile properly placed reduces seepage.	High available water capacity; slow permeability in subsoil; soil has limited value for farming.	Subsoil has very low fertility and poor tilth where exposed.	Generally not needed because of topography.	Severe: slow permeability in subsoil; poor filtering material below a depth of 5 feet.	Severe or moderate: moderate if slope is less than 9 percent, severe if more than 9 percent.
Most areas do not need tile; needs protection from flooding in places.	Medium intake rate; high available water capacity; subject to flooding.	Not needed because of topography.	Not needed because of topography.	Severe: subject to frequent flooding.	Moderate: moderate permeability.
Not needed	High available water capacity; medium intake rate; subject to erosion and gullying.	Soil properties are favorable; no limitations.	No limitations; soil properties are favorable.	Moderate: moderate permeability.	Moderate: moderate permeability; slope is 2 to 5 percent.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of— Topsoil	Suitability as source of— Road fill [1]	Soil features affecting— Highway location	Soil features affecting— Foundations for low buildings	Farm ponds: Reservoir area	Farm ponds: Embankment
Pershing: 131B, 131C, 131C2, T131B, T131C.	Poor: low fertility; limited amount of suitable material.	Very poor: highly elastic; moderate to high shrink-swell potential; low bearing capacity when wet; poor workability; difficult to compact properly.	Poor potential as borrow material; generally needs cuts; much moisture can be expected in cuts.	Moderate to high shrink-swell potential; high compressibility; uniform consolidation.	Good sites common; uniform material of slow permeability.	Low stability when wet; moderate to high shrink-swell potential; difficult to compact properly; slight creep in fills can be expected.
Radford: 467	Good	Fair to poor: moderate shrink-swell potential in upper 2 feet; high shrink-swell potential below a depth of 2 feet; low bearing capacity when wet.	Subject to flooding; poor potential as borrow material; high organic-matter content.	Moderate to high shrink-swell potential; subject to flooding; poor bearing capacity.	Suitable sites uncommon; may be sites for dugout ponds; subject to flooding.	Fair to poor stability; moderate to high shrink-swell potential; moderate to low permeability when compacted.
Rathbun: 532B, 532B2, 532C, 532C2.	Poor: low fertility.	Very poor: highly elastic; moderate to high shrink-swell potential; low bearing capacity when wet; poor workability; difficult to compact properly.	Poor potential as borrow material; generally needs cuts and fills; high moisture can be expected in some cuts.	Moderate to high shrink-swell potential; high compressibility; uniform consolidation.	Suitable sites common; uniform material of very slow permeability.	Low stability when wet; very slow permeability; slight creeps can be expected in fills.
Seymour: 312B, 312C2.	Fair to poor; limited amount; clayey subsoil.	Very poor: highly elastic; moderate or high to very high shrink-swell potential; low bearing capacity when wet; poor shear strength; difficult to compact properly.	Poor potential as borrow material; seasonal high water table; surface layer high in organic-matter content.	Moderate or high to very high shrink-swell potential; seasonal high water table; poor shear strength.	Uniform material of very slow permeability.	Low stability when wet; impervious; moderate to very high shrink-swell potential; slight creep can be expected in fills.
Shelby: 24D2, 24D3, 24E2, 24E3.	Fair: medium fertility; high bulk density in subsoil.	Good: fair to good bearing capacity; slight compressibility; good workability and compaction; easily compacted to high density.	Rolling topography; variable material in cuts; some cuts may be seepy; good potential as borrow material.	Good bearing capacity and shear strength; slight compressibility; uneven consolidation.	Low permeability when compacted; good sites generally available.	Adequate stability; easily compacted to high density; good workability; suitable for cores.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Interceptor tile properly placed reduces seepage.	High available water capacity; slow permeability; difficult to obtain adequate drainage; erosion-control practices needed.	Subsoil has low fertility and is fine textured; cuts need to be held to a minimum to prevent exposure of subsoil.	Tile needed in places on sides of waterways to control seepage so that suitable vegetation can be established.	Severe: slow permeability; seasonally wet and seepy.	Slight: slope is 2 to 9 percent.
Tile functions satisfactorily where outlets can be obtained.	Medium intake rate; high available water capacity; subject to flooding.	Not needed because of topography.	Not needed because of topography.	Severe: subject to flooding.	Moderate: moderate permeability; subject to flooding.
Interceptor tile properly placed reduces seepage.	High available water capacity; slow intake rate; very slow permeability; difficult to obtain adequate drainage.	Subsoil has low fertility and is fine textured; cuts must be held to a minimum to prevent exposure of subsoil.	Tile in places helpful on sides of waterways to control seepage so that suitable vegetation can be established.	Severe: very slow permeability in subsoil; seasonally wet and seepy.	Slight: slope is 2 to 9 percent.
Tile not recommended because subsoil is very slowly permeable, but interceptor tile properly placed can reduce seepage.	High available water capacity; very slow permeability in subsoil; difficult to provide adequate drainage.	Subsoil is highly plastic and fine textured; cuts must be held to a minimum.	Difficult to vegetate; waterways tend to be wet and seepy; tile carefully placed helps control seepage.	Severe: very slow permeability; seasonal high water table.	Slight: slope is 2 to 9 percent.
Not needed ------	High available water capacity; erosion-control practices needed; medium intake rate.	Cuts should be held to a minimum due to less productive subsoil; suitable if slope is less than 14 percent.	Tile needed to keep waterways dry so vegetation can be established.	Severe: moderately slow permeability; most slopes are more than 10 percent.	Severe: slope is 9 to 18 percent.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of—		Soil features affecting—			
	Topsoil	Road fill [1]	Highway location	Foundations for low buildings	Farm ponds: Reservoir area	Farm ponds: Embankment
*Sogn: 413D2. For Gosport and Clanton parts in 413D2, refer to Gosport and Clanton series.	Unsuitable: very limited material; shallow depth over limestone; rocky in places.	Unsuitable: limestone bedrock at a depth of about 1 foot.	Shallow over limestone bedrock; moderately steep slopes.	Shallow over limestone bedrock; moderately steep slopes.	Shallow over limestone bedrock.	Borrow material limited; low stability.
Tuskeego: 453A, 453B.	Fair in upper 15 inches, poor below a depth of 15 inches; high clay content.	Poor: highly elastic; large volume change and low bearing capacity when wet; difficult to compact properly.	Low borrow potential; seasonal high water table; subject to occasional flooding.	Subject to occasional flooding; seasonal high water table; high shrink-swell potential; poor bearing capacity and shear strength.	Suitable sites for dugout ponds in places; very slow permeability.	Fair to poor stability; high volume change with moisture; moderate to high compressibility.
Vesser: 51A, 51B.	Fair to good; medium fertility.	Fair to poor: poor bearing capacity; moderate to high shrink-swell potential; difficult to compact to high density; range of moisture content narrow for satisfactory compaction.	Subject to flooding; seasonal high water table; poor potential as borrow material; surface layer high in organic-matter content.	High compressibility; subject to short duration flooding and seasonal high water table.	Low permeability when compacted but good site locations unlikely; some areas satisfactory for dugout ponds.	Fair to poor stability; moderate to high shrink-swell potential; poor compaction when wet; some areas may be susceptible to piping.
Wabash: 172	Not suitable: high clay content.	Unsuitable: poor bearing capacity; very high shrink-swell potential; elastic; difficult to compact; range of moisture content narrow for suitable compaction.	Surface layer high in organic-matter content; seasonal high water table; subject to flooding; poor potential as borrow material; poor foundation for high fills.	Poor bearing capacity and shear strength; medium to high compressibility; very high shrink-swell potential.	Suitable sites unlikely; suitable for dugout ponds in places; subject to flooding; very slow permeability.	Impervious: fair stability on flat slopes; poor compaction and workability; very high shrink-swell potential.
Weller: 132B, 132B2, 132C2, 132D2, T132B, T132C2.	Poor: low fertility; high clay content in subsoil.	Unsuitable: moderate to high shrink-swell potential; highly elastic; high volume change and loss of bearing capacity when wet; difficult to compact.	Rolling topography; cuts and fills common; low borrow potential; much moisture can be expected in cuts.	Poor bearing capacity when wet; moderate to high shrink-swell potential; uniform consolidation.	Suitable sites common; uniform material of slow permeability.	Low stability when wet; high volume change when wet; some creep in fills can be expected; moderate to high shrink-swell potential.

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Nonarable	Nonarable	Nonarable	Nonarable	Severe: shallow over limestone bedrock.	Severe: shallow over limestone bedrock.
Tile requires close spacing; surface drainage needed in places to drain ponded areas.	Slow intake rate; high available water capacity; difficult to provide adequate drainage.	Terraces not needed because of topography; diversions properly placed can help control runoff from uplands and reduce wetness.	Not needed because of topography.	Severe: very slow permeability; seasonal high water table.	Slight.
Tile functions satisfactorily where outlets can be obtained.	Medium water intake; high available water capacity; tile drainage needed before irrigation.	Diversions properly placed are beneficial in preventing local flooding and siltation; terraces not needed because of topography.	Generally not needed; tile needed along sites to prevent seepage until vegetation is established.	Severe: subject to flooding; seasonal high water table.	Moderate: high organic-matter content in surface layer; subject to flooding.
Tile not recommended because subsoil is very slowly permeable; surface ditches are needed.	Water intake rate varies with amount of vertical cracking; high available water capacity; very slow permeability; difficult to obtain suitable drainage.	Not needed because of topography.	Not needed because of topography.	Severe: very slow permeability; seasonal high water table.	Moderate: high organic-matter content; subject to flooding.
Tile may not drain all areas satisfactorily; slow permeability.	Slow intake rate; high available water capacity; slowly permeable; difficult to provide adequate drainage.	Clayey subsoil of low fertility exposed in cuts and fills.	Tile needed in places to help reduce wet and seepy areas; difficult to vegetate waterways.	Severe: slow permeability; seasonally wet and seepy.	Slight to severe: slight if slopes are less than 9 percent; severe if more than 9 percent.

TABLE 6.—*Engineering*

Soil series and map symbol	Suitability as source of— Topsoil	Suitability as source of— Road fill [1]	Soil features affecting— Highway location	Soil features affecting— Foundations for low buildings	Soil features affecting— Farm ponds: Reservoir area	Soil features affecting— Farm ponds: Embankment
Wiota: 7A	Good	Fair to poor in lower part of strata; fair bearing capacity; moderate shrink-swell potential.	Surface layer high in organic-matter content; nearly level topography.	Fair bearing capacity; high compressibility.	Suitable sites unlikely; high seepage potential below a depth of about 4 feet.	Fair to good stability; fair to good compaction characteristics; low permeability when compacted.
Zook: 54A, 54B	Not suitable: high clay content.	Unsuitable: high shrink-swell potential; bearing capacity reduced when wet; highly elastic; difficult to compact properly.	Level to depressed topography; high organic-matter content in upper layers; seasonal high water table; poor potential borrow material; poor foundation for high fills.	Poor bearing capacity and shear strength; medium to high compressibility; seasonal high water table; high shrink-swell potential.	Suitable sites unlikely; level to depressed topography; subject to flooding; slow permeability.	Impervious material; low stability when wet; poor compaction characteristics; high shrink-swell potential.

[1] Engineers and others should not apply specific values to bearing capacity of soils.

TABLE 7.—

[Tests performed by the Iowa State Highway Commission according to standard procedures

Soil name and location	Parent material	Iowa report number AAD—	Depth	Moisture density [1]: Maximum dry density	Moisture density [1]: Optimum moisture	Mechanical analysis [2]: Percentage passing sieve— 3/8 in.	Mechanical analysis [2]: Percentage passing sieve— No. 4 (4.7 mm.)
			In	*Lb/cu ft*	*Pct*		
Appanoose silt loam: 460 feet east and 300 feet south of northwest corner of NW¼SW¼ sec. 25, T. 68 N., R. 19 W. Modal.	Wisconsin loess.	0–1594	0–8	98	21		
		1595	8–14	101	20	--	--
		1596	15–20	86	29	--	--
		1597	41–59	97	20	--	--
Armstrong loam: 50 feet west and 320 feet south of northeast corner of NW¼SE¼ sec. 13, T. 67 N., R. 16 W. Modal.	Glacial till.	9–1015	0–7	107	15	--	
		1016	18–26	103	19	100	99
		1017	41–51	108	16	100	99
Beckwith silt loam: 80 feet west and 207 feet north of southeast corner of NE¼SW¼ sec. 10, T. 70 N., R. 16 W. Modal.	Loess.	9–1007	0–6	93	19		100
		1008	6–15	104	16		--
		1009	21–25	95	25		--
		1010	39–45	95	23		--
Chequest silty clay loam: 50 feet west and 35 feet north of southeast corner of NE¼NE¼ sec. 13, T. 68 N., R. 17 W. Modal.	Alluvium.	9–1021	0–7	97	23		
		1022	18–25	99	20		--
		1023	35–43	98	22		
Coppock silt loam: 600 feet east and 910 feet north of southwest corner of sec. 25, T. 68 N., R. 17 W. Modal.	Alluvium.	9–1011	0–8	103	17	--	
		1012	14–20	107	16		--
		1013	32–37	102	19		--
		1014	43–48	101	19		
Tuskeego silt loam: 525 feet west of southeast corner of NE¼SW¼ sec. 1, T. 68 N., R. 17 W. Modal.	Alluvium.	9–1018	0–9	98	28	--	--
		1019	30–35	93	23	--	--
		1020	41–51	94	23	--	--

[1] Based on AASHTO Designation T 99-61 Method A (*1*).
[2] Mechanical analyses according to AASHTO Designation T 88-61. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis

interpretations—Continued

Soil features affecting—Continued				Soil limitations for sewage disposal	
Agricultural drainage	Irrigation	Terraces and diversions	Grassed waterways	Septic tank filter field	Sewage lagoons
Moderately well drained; drainage not needed.	Medium intake rate; high available water capacity; high potential for farming.	Length of slopes makes terrace construction difficult; terraces not needed in most areas; diversions properly placed can help protect areas from runoff from uplands.	Soil features favorable.	Slight	Moderate to severe: moderate permeability; some areas have seepage in substratum.
Tile may not drain all areas satisfactorily; proper spacing and depth important; most areas need flood protection.	Intake rate varies with amount of vertical cracking; high available water capacity; requires drainage before irrigation.	Terraces not needed because of topography; diversions properly placed can improve wetness and reduce siltation.	Not needed because of topography.	Severe: slow permeability; subject to flooding.	Moderate: high organic-matter content; subject to flooding.

Engineering test data

of the American Association of State Highway [and Transportation] Officials (AASHTO)]

Mechanical analysis [2]—Continued							Liquid limit	Plasticity	Classification	
Percentage passing sieve—Continued			Percentage smaller than—						AASHTO [3]	Unified
No. 10 (2.0 mm.)	No. 40 (0.42 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.	Pct.			
--	100	98	86	62	28	17	32	8	A-4(8)	ML
--	100	98	92	74	40	30	37	12	A-6(9)	ML
--	--	100	96	79	49	40	56	31	A-7-6(19)	CH
--	--	100	97	91	68	61	66	32	A-7-5(20)	MH
100	95	64	49	38	22	16	28	9	A-4(6)	CL or CL-ML
99	95	75	66	57	47	43	48	25	A-7-6(16)	CL
99	93	65	57	46	36	31	38	20	A-6(10)	CL
99	99	95	80	60	21	14	34	6	A-4(8)	ML
--	100	96	88	62	26	16	26	5	A-4(8)	CL-ML
--	--	100	96	81	58	51	61	36	A-7-6(20)	CH
--	--	100	96	79	50	42	59	37	A-7-6(20)	CH
--	100	95	94	76	48	36	44	17	A-7-6(11)	CL-ML
--	100	93	89	70	44	34	44	20	A-7-6(13)	CL-ML
--	100	95	86	68	43	35	44	22	A-7-6(14)	CL
100	99	95	84	61	32	26	37	12	A-6(9)	CL-ML
--	100	97	86	63	32	24	33	13	A-6(9)	CL or CL-ML
--	100	99	92	70	36	31	40	20	A-6(12)	CL
--	100	99	92	70	40	34	41	22	A-7-6(13)	CL
--	100	96	86	60	27	18	32	10	A-4(8)	CL-ML
--	100	99	93	81	54	46	58	33	A-7-6(20)	CH
--	100	99	94	78	52	45	61	37	A-7-6(20)	CH

of all the material, including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soil.

[3] Based on AASHTO Designation M 145-49.

soils are classified A–7 (CH). They have low densities in place and a high content of moisture.

If an embankment is to be more than 15 feet high, these alluvial soils should be carefully analyzed to ensure that they are strong enough to support the embankment. Roadways through bottom lands should be constructed on continuous embankments that extend above the level of floods.

Limestone and shale are the kinds of bedrock underlying the glacial till. On slopes where shale crops out below loess or glacial till, Gosport and Clanton soils formed. These soils are clayey and not suited to use in grades. Where embankments are constructed over sloping areas of shale, moisture must not be left free to lubricate the surface of the shale and thus possibly create a slide, or the shale can be stepped to form a level foundation. Likewise, if a cut is necessary through shale that has an overburden of glacial till or loess, the cut slope must be designed so that it is flat enough to eliminate a backslope slide if the shale surface is lubricated by moisture from natural infiltration areas. Sogn soils formed in limestone. They are underlain at a depth of about 13 inches by lime rock and have fragments on the surface and in the soil.

Formation and Classification of the Soils

In this section the factors that affected the formation of the soils in Appanoose County are described. Also described are the four basic processes of soil formation. The current classification system is explained and the soils of Appanoose County are classified by higher categories of that system. Detailed descriptions of profiles considered representative of the series are given in the section "Descriptions of the Soils."

Factors of Soil Formation

Soil is produced by the action of soil-forming processes on materials deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material; (2) the climate under which the soil material has accumulated and existed since accumulation; (3) the plant and animal life on and in the soil; (4) the relief, or lay of the land; and (5) the length of time the forces of soil development have acted on the soil material (*4*).

Climate and vegetation are the active factors in the formation of soil. They act on the parent material that has accumulated through the weathering of rocks and slowly change it into a natural body with genetically related horizons. The effects of climate and vegetation are conditioned by relief. The parent material also affects the kind of profile that can be formed and, in extreme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil. It may be much or little, but some time is always required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material and geology

Most of the soils in Appanoose County formed in glacial till, or ice-laid material; loess, or windblown material; and alluvium, or water-laid material (fig. 30). A few small areas of eolian sands are along the Chariton River, and in some places limestone and shale are parent materials. In this county parent material has been less effective in forming the general character of the profile than other factors of soil formation.

Glacial till.—In Appanoose County the major Pleistocene deposits of pre-Wisconsin age are Nebraskan and Kansan Drift (*15*). The Kansan Drift is identifiable throughout the county, and on side slopes it forms an extensive part of the landscape. The Nebraskan Drift, however, is not readily identifiable on the surface in Appanoose County.

In some of the deep road cuts and along some of the major stream valleys, a gumbotil is present below the Kansan glacial till. This is called Aftonian gumbotil (*5, 6*). It consists mainly of glacial till made up of coarse fragments in a clay loam matrix. The upper part of this till consists of yellowish-brown material that is oxidized and leached. Below this zone is dark-gray material that is calcareous, contains limestone and dolomite particles, and is neither oxidized nor leached.

Soils formed on the Kansan till plain during the Yarmouth and Sangamon interglacial ages, before the loess was deposited. On nearly level interstream divides, the soils were strongly weathered and had a gray, plastic subsoil consisting of gumbotil. This gumbotil remains; it is several feet thick and is very slowly permeable. The Ashgrove and Clarinda soils formed in this gumbotil. The Clarinda soils are extensive throughout Appanoose County. The gumbotil in the Lamoni soils is partly truncated, therefore the clay material is not so thick as that in Clarinda soils. Geologic erosion has cut below the Yarmouth-Sangamon paleosol and into the Kansan till and older deposits. At the depth to which this erosion has cut, generally there is a stone line or subjacent till that is overlain by pedisediment (*9, 12*). A paleosol formed in the pedisediment stone line and in the subjacent till. The Adair, Armstrong, and Keswick soils formed in this material.

Geological erosion removed the loess from many slopes and exposed strongly eroded weathered paleosols. In some places the paleosols have been beveled or truncated, and only the lower part of the strongly weathered materials remains. In other places erosion removed all of the paleosols and exposed till that is only slightly weathered. The period during which erosion cut through below the Yarmouth-Sangamon paleosol is called Late Sangamon (*9, 11*). The material below the paleosols consists of loamy sediments over a stone line that, in turn, overlies a highly weathered, clayey, reddish-brown, acid till. Material that formed in the Late Sangamon stage is exposed on the narrow,

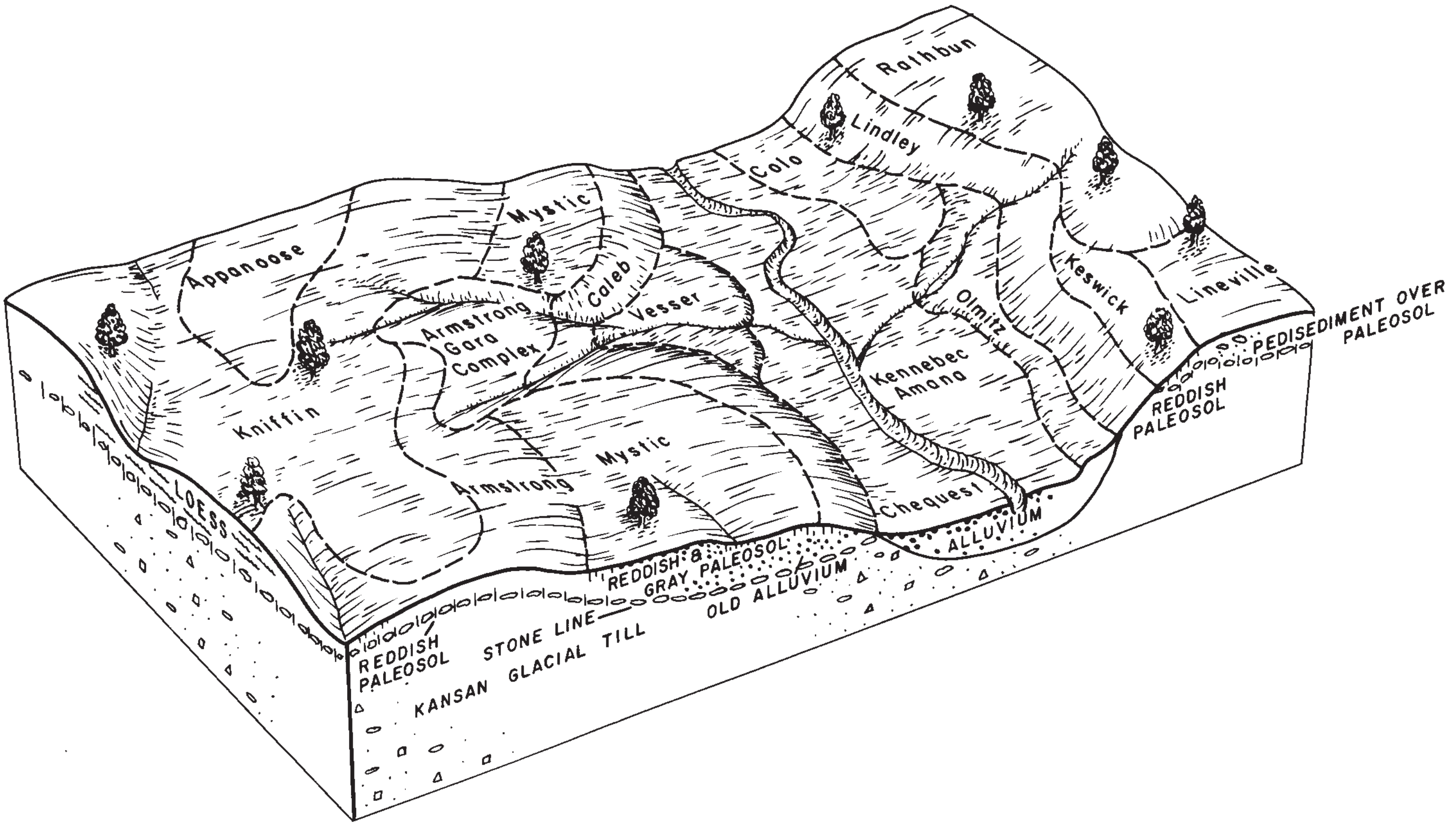

Figure 30.—**Typical pattern of soils and parent material in associations 3, 5, and 7.**

slightly lower interstream divides and on some side slopes.

Adair, Armstrong, and Keswick soils formed in this Late Sangamon material. Lineville soils formed where the loamy pedisediment is 2 feet or more thick over the glacial till. Caleb and Mystic soils formed in pre-Sangamon sediments of valley fills. These sediments are of glacial origin, and they have variable texture (*11*). Caleb and Mystic soils formed in low, stepped interfluves above the present drainage system. They owe their landscape partly to valley fill, but their surface merges with the present erosional uplands. Caleb and Mystic soils are in distinctly higher landscape positions than the soils on the flood plain, but they are in lower positions than Gara, Shelby, and Lindley soils that formed in dissected slopes of Late Wisconsin age. These pre-Sangamon erosional sediments appear to have been angularly truncated in many places. As a result, they generally consist of an irregular mixture of materials that have contrasting textures.

Loess.—Wisconsin-age loess is an extensive parent material that covers most of Appanoose County (*13, 14*). It consists of accumulated particles of silt and clay that have been deposited by wind. Variations in soils are related to their distance from the source of loess. The source of loess in Appanoose County is probably the Missouri River bottom in the western part of Iowa (*3*).

On the stable upland divides the loess is about 8 feet thick. It is slightly thicker in the northwestern part of the county, where Grundy and Haig soils are the dominant loess soils, than it is in the southeastern part, where Edina and Seymour soils are the dominant loess soils. In this county, Appanoose, Belinda, Beckwith, Kniffin, Pershing, Rathbun, and Weller soils also were derived from loess. Many of the high benches along the South Fork, Chariton River are covered with loess. The loess on these benches contains slightly less clay and slightly more sand than does the loess covering the uplands. The soil material underlying the loess in these areas is stratified alluvium that is generally high in sand and gravel content.

Alluvium.—Sediments that have been removed and laid down by water are called alluvium. As they move, these sediments are sorted to some extent, but they are as well sorted as loess in only a few places. Also, alluvium does not have the wide range of particle sizes that occurs in glacial drift. The alluvium in Appanoose County is derived from loess and glacial drift, and it is largely a mixture of silt and clay, of silt and sand, or of sand and gravel. The coarse sand and gravel generally are only in the pre-Sangamon alluvial sediments on the stream benches. Sediments accumulated at the foot of the slope on which they originated are called colluvium, or local alluvium.

Alluvial sediments are the parent materials of the soils on flood plains, on terraces, and along drainageways. As the river overflows its channels and the water spreads over the flood plains, coarse-textured materials such as sand and coarse silt are deposited first. As the flooding water continues to spread, it moves more slowly, and finer textured sediments are deposited. After the flood has passed, the finest particles, or clay, settle from the water that is left standing on the lowest part of the flood plain.

Kennebec, Landes, and Nodaway soils commonly are closest to the stream channel and are coarser textured than the other soils on bottom land. Vesser, Coppock, Amana, and Chequest soils are fairly extensive along the Chariton River where commonly they are away from the meanders of the stream. Colo, Humeston, and Tuskeego soils are mainly along the smaller streams in the county. Wabash, Carlow, and Zook soils commonly are on the lower part of the bottom land and are the finest textured soils derived from alluvium in the county. Colo and Vesser soils are widely distributed throughout the county. In some places they formed in local alluvium at the base of upland slopes. Olmitz soils are the dominant soils that formed in colluvium, or local alluvium, and they commonly contain more sand than the other soils that formed in alluvium.

In some areas where streams are still cutting through lime rock and shale, flood plains are narrower and have a steeper gradient. The Kennebec-Amana complex and the Nodaway soils are commonly on these flood plains.

Limestone and shale.—The oldest parent material in the county is a series of beds deposited during the Des Moines sedimentary cycle in the Pennsylvanian period. These beds consist of limestone, shale of different colors and textures, conglomerate, and a few organic layers such as coal. There is a very wide range in thickness of these layers or beds. In Appanoose County, coal veins are generally 100 feet or more below the surface.

Observations of roadbanks and cuts in the survey area showed 4 to 6 layers of shale and limestone exposed on the present land surface. The layer of lime rock commonly exposed is about 3 or 5 feet thick and has red and gray or brown shale above and below. Fragments of the lime rock layer are commonly on the surface of the side slope below their outcropping. These materials outcrop mainly on slopes of the lower part of tributaries of the Chariton River, north and west of Centerville, and along the lower part of Shoal Creek and its tributaries in the south-central part of the county.

The limestone beds range from a few inches to several feet in thickness. Sogn soils formed in material derived from hard limestone. Some of the thicker limestone beds are very good sources of road aggregate and agricultural lime. Much of this limestone will be covered with water by the Rathbun Reservoir.

A study by Slusher [5] indicates a wide range of texture, reaction, and other characteristics in profiles of soils that formed in shale in southern Iowa. Colors of the shale range from nearly black to red, but red, brown, and grayish colors are dominant. Thin beds of sandstone and coal are between layers of shale in places.

The Gosport soils formed in brownish and grayish colored shales, and the Clanton soils formed in red shales. The gray shales west of Centerville are used in the production of field tile and of haydite for building blocks.

Climate

The soils in Appanoose County have been forming under a midcontinental, subhumid climate for the past 5,000 years (*9, 13*). The morphology and properties of most of the soils indicate that this climate was similar to the present climate. From 16,000 to 6,500 years ago, however, the climate probably was cool and moist and was conducive mostly to growth of forest vegetation (*9, 13*). Pollen studies (*7*) indicate that the climate during the Sangamon stage of the Pleistocene epoch was cool and moist and conducive mostly to growth of conifers.

The influence of the general climate in a region is modified by local conditions in or near the developing soils. For example, soils on south-facing slopes formed under a microclimate that was warmer and drier than the average climate of nearby areas. The low-lying, poorly drained soils on bottom lands formed under a wetter and colder climate than that in most areas around them. These local differences influenced the characteristics of the soil and account for some of the differences among soils in the same general climatic region.

Vegetation

Many changes in climate and vegetation took place in Iowa during the postglacial period (*7, 9*). Spruce grew on the soils from 12,000 to 8,000 years ago and was followed by coniferous-deciduous forest that lasted until about 6,500 years ago. Then grass began to dominate in the State.

For the past 5,000 years, the soils of Appanoose County appear to have been influenced by two main kinds of vegetation, prairie grasses and trees. Big bluestem and little bluestem were the main prairie grasses. The main trees were deciduous—mainly oak, hickory, ash, elm, and maple.

The effects of vegetation on soils similar to those in Appanoose County have been studied recently.[6]

Evidence shows that vegetation shifted while soils formed in areas bordering trees and grasses. The morphology of Armstrong, Belinda, Appanoose, Caleb, Kniffin, Gara, Lineville, Mystic, and Pershing soils reflects the influence of both trees and grasses. The Ashgrove, Keswick, Lindley, and Rathbun soils formed under the influence of trees (*8*). Grasses influenced the formation of Grundy, Haig, Seymour, Edina, Adair,

[5] Unpublished M.S. thesis in the Iowa State University Library, Ames, Iowa. SLUSHER, D. F., Morphology of Some Shale-Derived Soils in Southern Iowa. 1960.

[6] These are unpublished Ph.D. theses in the Iowa State University Library, Ames, Iowa. They are:

CARDOS(, J. Sequence Relationships of Clarion, Lester, and Hayden Soil Catenas. 1957.

CORLISS, J. F. Genesis of Loess-derived Soils in Southeastern Iowa. 1958.

MCCRACKEN, R. Soil Classification in Polk County, Iowa. 1956.

PRILL, R. Variations in Forest-derived Soils Formed from Kansan Till. 1955.

Clarinda, Colo, Lamoni, Olmitz, Shelby, Wabash, and Zook soils.

Soils that formed under trees are lighter colored, more acid, and have a thinner surface layer than soils that formed under grasses. The few soils in the county that formed under shifting vegetation or mixed grasses and trees have properties that are intermediate between the properties of soils that formed under grasses and those of soils that formed under trees.

Relief

Relief is an important cause of differences among soils. It indirectly influences soil formation through its effect on drainage. In Appanoose County soils range from level to steep. In many areas of the bottom lands the nearly level soils are frequently flooded and have a permanently or periodically high water table. In depressions, water soaks into the nearly level soils that are subject to flooding. Much of the rainfall runs off the steep soils.

Level soils are on the broad upland flats and on the stream bottoms. The steepest soils in the county are generally on the southern and western 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.

Generally, the soils in Appanoose County that formed where the water table is high have a subsoil that is dominantly grayish. Examples are Haig, Chequest, Edina, Wabash, and Zook soils. Grundy, Adair, Pershing, Seymour, and similar soils formed where the water table fluctuated and was periodically high. Gara, Lindley, and other soils formed where the water table was below the subsoil, and their subsoil is yellowish brown. Colo, Haig, Wabash, and Zook soils that developed under prairie grasses and that have a high water table contain more organic matter in the surface layer than well-drained soils that formed under prairie grasses. Clay accumulates in the subsoil of soils such as Edina, which are slightly depressional or nearly level, because a large amount of water enters the soils and carries clay particles downward. Edina soils are commonly called "claypan" soils because of their very slowly permeable subsoil where the greatest amount of clay accumulates.

A study of Seymour soils was made to determine the effect of the relief on the soils. Tests showed an increase in content of clay in the A horizon and a decrease in thickness of the A1 horizon from stable to unstable slopes. In the unstable landscape the zone of maximum clay accumulation was at a shallow depth. The Seymour soils on the most stable landscape have some grainy coatings in the lower part of the A horizon and the upper part of the B horizon and they have more dark clay films in the B2 horizon. This indicates that more soil development has taken place on the most stable kind of landscape.

In Shelby, Gara, Lindley, and similar soils that have wide slope range and many kinds of slopes, depth to carbonate is shallowest where slopes are steepest, are convex, or are most unstable.

Time

The length of time required for a soil to form affects the kind of soil that forms. An older or more strongly developed soil shows well-defined genetic horizons. A less well-developed soil shows no horizons, or only weakly defined ones. Most soils on the flood plains are weakly developed because they have not been in place long enough for distinct horizons to form. Radiocarbon dating of a red elm log beneath 10 feet of alluvium on the Chariton River flood plain (sec. 27, T. 69 N., R. 11 W.) indicates the alluvial soils in this area are less than 1,830 years old, plus or minus a hundred years (*10*).

On steeper soils, material is generally removed before there has been time to develop a thick profile that has strong horizons. Even though the material has been in place for a long time, the soil may still be immature because much of the water runs off the slopes rather than through the soil material. Shelby, Gara, and Lindley soils formed in recently dissected slopes of late Wisconsin age (*9, 11*). These soils, therefore, are no older than 11,000 to 14,000 years and probably are much younger.

Adair, Armstrong, Keswick, Lineville, Clarinda, Lamoni, and Mystic are among the oldest soils in the county (*11, 14*). Clarinda and Lamoni soils formed in Kansan glacial till during the Yarmouth-Sangamon period. Adair, Armstrong, Keswick, Lineville, and Mystic soils formed in materials deposited during the Late Sangamon interglacial stage. These materials are much older than the loess parent material of Appanoose, Beckwith, Belinda, Edina, Kniffin, Rathbun, Pershing, Seymour, and Weller soils. These soils are no older than 14,000 to 16,000 years, and they may be considerably younger (*11*).

Radiocarbon studies of wood fragments and soil organic matter found in the loess and glacial till have made it possible to determine the approximate ages of soils and of the loessial and glacial deposits in Iowa. In Appanoose County the loess is thickest in the nearly level soils on stable upland divides, and it is underlain by a Yarmouth-Sangamon paleosol that is on the Kansan till surface. In many places below the stable uplands, an organic layer is at the base of the loess. Recent studies show that the loess and organic matter below the solum of the Edina and Haig soils in neighboring Wayne County, Iowa, have radiocarbon ages of 19,000 to 20,000 years. The Kansan till surface is 8 feet below the present land surface.

Man's influence on the soil

Important changes take place in the soil when it is cultivated. Some of these changes have little effect on productivity; others have drastic effect.

Changes caused by water erosion generally are the most apparent. On many of the cultivated soils in the county, particularly the gently rolling to hilly ones, part or all of the original surface layer has been lost through sheet erosion. In some places shallow to deep gullies have formed.

In many continuously cultivated fields, the granular structure that was apparent when the grassland was undisturbed is no longer present. In these fields the surface tends to bake and harden when it dries. Fine-textured soils that have been plowed when too wet tend to puddle and are less permeable than similar soils in undisturbed areas.

Man has done much to increase productivity of the soils and to reclaim areas not suitable for crops. He has made large areas of bottom land suitable for cultivation by digging drainage ditches and constructing diversions at the foot of slopes. Broad flats of Edina and Haig soils have been greatly improved for cultivation by installing some kind of a drainage system.

By adding commercial fertilizers, man has counteracted deficiencies in plant nutrients and has made some soils more productive than they were in their natural state.

Processes of Soil Formation

Horizon differentiation is a result of four basic kinds of changes. These are additions, removals, transfers, and transformations in the soil system. These four kinds of changes affect the amount of organic matter, soluble salts, carbonates, sesquioxides, or silicate clay minerals in the soil.

In general, these processes tend to promote horizon differentiation, but some tend to offset or retard it. These processes and the changes brought about proceed simultaneously in soils, and the ultimate nature of the profile is governed by the balance of these changes.

The accumulation of organic matter is an early and important step in the process of horizon differentiation in most soils. Soils in Appanoose County range from high to very low in the amount of organic matter that has accumulated in their A1 horizon. Weller and Lindley soils, for example, have a thin A1 horizon and are low in organic matter. Haig and Colo are among those that have a thick A1 horizon and that are high in organic-matter content. Some soils that were formerly quite high in organic-matter content are now low because of erosion.

The removal of substances from parts of the soil profile is also very important in the differentiation of soil horizons. The movement of calcium carbonates and bases downward in soils is an example. All the soils in the county have been leached free of calcium carbonates in the upper part of their profiles, and some have been so strongly leached that they are strongly acid or very strongly acid in their A and B horizon.

A number of kinds of transfers of substances from one horizon to another are evident in the soils of Appanoose County. Phosphorus is removed from the subsoil by plant roots and transferred to parts of the plant growing above the ground. Then it is added to the surface layer in the plant residues. These processes affect the forms and profile distribution of phosphorus.

The translocation of silicate clay minerals is also important. The clay minerals are carried downward in suspension in percolating water from the A horizon. They accumulate in the B horizon in pores and root channels and as clay films on ped faces. In Appanoose County, this process has had an influence on the profiles of many of the soils, including the Grundy and Seymour series. In other soils, including the Nodaway and Colo series, the clay content of the A and B horizons is not markedly different and other evidence of clay movement is minimal.

Another kind of transfer that is minimal in most soils, but occurs to some extent in clayey soils, is that brought about by shrinking and swelling. This causes cracks to form and the incorporation of some materials from the surface layer into lower parts of the profile. Wabash and Clarinda are examples of soils that have potential for this kind of physical transfer.

Transformations are physical and chemical. For example, soil particles are weathered to smaller sizes. The reduction of iron is another example of transformation. This process is called gleying and involves the saturation of the soil with water for long periods in the presence of organic matter. It is characterized by the presence of ferrous iron and gray colors. Gleying is associated with such poorly drained soils as Haig soils.

Still another kind of transformation is the weathering of the primary apatite mineral of the in soil parent material to secondary phosphorus compounds.

Classification of Soils

Soils are classified so that we may more easily remember their significant characteristics (*18*). Classification enables us to assemble knowledge about the soils, to see their relationships to one another and to the whole environment, and to develop principles that help us in understanding their behavior and their response to manipulation. First through classification and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

Thus, in classification, soils are placed in narrow categories that are used in detailed soil surveys so that knowledge about the soils can be organized and applied in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. They are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system currently used to classify soils was adopted for general use by the National Cooperative Soil Survey in 1965. The current system is under continual study. Therefore, readers interested in developments of this system should search the latest literature available (*16, 18*). In table 8 the soil series represented in Appanoose County are placed in some categories of the current system. The classes in the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. They are Entisols, Vertisols, Inceptisols, Aridisols, Mollisols, Spodosols, Alfisols, Ultisols, Oxisols, and Histosols. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The two exceptions to this are the Entisols and Histosols, which occur in many different climates.

The four orders in Appanoose County are Mollisols, Alfisols, Inceptisols, and Entisols. Mollisols have a

TABLE 8.—*Soil series classified according to the current system of classification*

Series	Family	Subgroup	Order
Adair [1]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Amana [2]	Fine-silty, mixed, mesic	Aquic Hapludolls (Aquic Fluventic Hapludolls).	Mollisols.
Appanoose	Fine, montmorillonitic, mesic	Mollic Albaqualfs	Alfisols.
Armstrong	Fine, montmorillonitic, mesic	Aquollic Hapludalfs	Alfisols.
Ashgrove	Fine, montmorillonitic, mesic, sloping	Aeric Ochraqualfs	Alfisols.
Beckwith	Fine, montmorillonitic, mesic	Typic Albaqualfs	Alfisols.
Belinda	Fine, montmorillonitic, mesic	Mollic Albaqualfs	Alfisols.
Caleb [3]	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Cantril [4]	Fine-loamy, mixed, mesic	Udollic Ochraqualfs (Mollic Ochraqualfs).	Alfisols.
Carlow	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.
Chequest	Fine, montmorillonitic, noncalcareous, mesic	Typic Haplaquolls	Mollisols.
Clanton	Fine, illitic, mesic (Paleudalfs)	Mollic Hapludalfs	Alfisols.
Clarinda [5]	Fine, montmorillonitic, noncalcareous, mesic, sloping.	Typic Argiaquolls	Mollisols.
Colo	Fine-silty, mixed, noncalcareous, mesic	Cumulic Haplaquolls	Mollisols.
Coppock	Fine-silty, mixed, mesic	Mollic Ochraqualfs	Alfisols.
Edina	Fine, montmorillonitic, mesic	Typic Argialbolls	Mollisols.
Gara	Fine-loamy, mixed, mesic	Mollic Hapludalfs	Alfisols.
Gosport [6]	Fine, illitic, mesic	Typic Dystrochrepts	Inceptisols.
Grundy [7]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Haig	Fine, montmorillonitic, noncalcareous, mesic (Vertic).	Typic Argiaquolls	Mollisols.
Humeston	Fine, montmorillonitic, mesic	Argiaquic Argialbolls	Mollisols.
Kennebec [8]	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Keswick	Fine, montmorillonitic, mesic	Aquic Hapludalfs	Alfisols.
Kniffin	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols.
Lamoni [9]	Fine, montmorillonitic, mesic	Aquic Argiudolls	Mollisols.
Landes variant	Coarse-loamy, mixed, mesic (fine-loamy)	Fluventic Hapludolls	Mollisols.
Lindley	Fine-loamy, mixed, mesic	Typic Hapludalfs	Alfisols.
Lineville	Fine-loamy, mixed, mesic	Aquollic Hapludalfs	Alfisols.
Lineville variant	Fine-silty, mixed, mesic	Aquic Argiudolls	Mollisols.
Mystic [10]	Fine, montmorillonitic, mesic	Aquollic Hapludalfs	Alfisols.
Nodaway	Fine-silty, mixed, nonacid, mesic	Typic Udifluvents	Entisols.
Olmitz	Fine-loamy, mixed, mesic	Cumulic Hapludolls	Mollisols.
Pershing	Fine, montmorillonitic, mesic	Udollic Ochraqualfs	Alfisols.
Radford	Fine-silty, mixed, mesic	Fluventic Hapludolls (Aquic Fluventic Hapludolls).	Mollisols.
Rathbun	Fine, montmorillonitic, mesic	Aeric Ochraqualfs (Vertic)	Alfisols.
Seymour	Fine, montmorillonitic, mesic	Aquic Argiudolls (Vertic)	Mollisols.
Shelby [11]	Fine-loamy, mixed, mesic	Typic Argiudolls	Mollisols.
Sogn	Loamy, mixed, mesic	Lithic Haplustolls	Mollisols.
Tuskeego	Fine, montmorillonitic, mesic	Mollic Ochraqualfs	Alfisols.
Vesser	Fine-silty, mixed, mesic	Argiaquic Argialbolls	Mollisols.
Wabash	Fine, montmorillonitic, noncalcareous, mesic	Vertic Haplaquolls	Mollisols.
Weller	Fine, montmorillonitic, mesic	Aquic Hapludalfs	Alfisols.
Wiota	Fine-silty, mixed, mesic	Typic Argiudolls (Aquic Hapludolls).	Mollisols.
Zook	Fine, montmorillonitic, noncalcareous, mesic.	Cumulic Haplaquolls	Mollisols.

[1] The severely eroded Adair soils are taxadjuncts to the Adair series because they do not have a dark A horizon more than 10 inches thick.

[2] Included in mapping were areas of Amana soils where the A horizon is too thin to qualify as a mollic epipedon. These soils therefore, are taxadjuncts to the Amana series.

[3] In many areas Caleb soils have mottles with chroma of 2 or less in the upper 10 inches of the argillic horizon. In such areas the soils are taxadjuncts to the Caleb series.

[4] In some areas Cantril soils are taxadjuncts to the series because the B horizon is less than medium acid.

[5] The severely eroded Clarinda soils are taxadjuncts to the series because their dark-colored A horizon is not thick enough to qualify as a mollic epipedon.

[6] The Gosport soils in this county are taxadjuncts to the series because they are less acid below a depth of 2 feet than is commonly defined as the range for the series.

[7] The Grundy soils in this county are taxadjuncts to the series because they have lower chroma in the lower part of the A horizon and the upper part of the B horizon than is commonly defined as the range for the series.

[8] The Kennebec soils in this county are taxadjuncts to the series because they are more acid below a depth of 2 feet than is commonly defined as the range for the series.

[9] The Lamoni soils in this county are taxadjuncts to the series because they have a grayer B horizon than is commonly defined as the range for the series. Also the severely eroded Lamoni soils do not have the dark-colored A horizon needed to qualify as a mollic epipedon.

[10] The severely eroded Mystic soils and those mapped with Caleb soils are taxadjuncts to the series because they do not have a dark-colored A horizon thick enough to qualify as a mollic intergrade.

[11] In some areas Shelby soils are less acid in the B horizon than is commonly defined as the range for the series, and the severely eroded Shelby soils do not have a dark-colored A horizon thick enough to qualify as a mollic epipedon. Such soils are considered taxadjuncts to the Shelby series.

dark-colored surface horizon that has high base saturation and is at least 1 percent organic matter. They have a genetic subsurface horizon that varies in degree of development. Alfisols have a clay-enriched B horizon that is high in base saturation. Inceptisols have a genetic subsurface horizon that shows minimum development. They do not have a clay-enriched B horizon. Entisols have either no natural genetic horizon or only the beginnings of such a horizon.

SUBORDER. Each order is divided into suborders, primarily on the basis of those soil characteristics that seem to produce classes that have the greatest genetic similarity. The suborders narrow the broad climatic range permitted in the orders. The soil properties used to separate suborders mainly reflect either the presence or absence of wetness, or soil differences resulting from the climate or vegetation.

GREAT GROUPS. Each suborder is divided into great groups on the basis of uniformity in kinds and sequences of major soil horizons and features. The horizons used to make separations are those in which clay, iron, or humus have accumulated, or those that have pans that interfere with growth of roots or movement of water. The features used are the self-mulching properties of clays, soil temperature, major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium), and the like. The great group is not shown separately in table 8 because it is the last word in the name of the subgroup.

SUBGROUP. Each great group is divided into subgroups, one representing the central (typic) segment of the group and others, called intergrades, that have properties of the group and also one or more properties of another great group, suborder, or order. Subgroups may also be made in those instances where soil properties integrade outside of the range of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great groups. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY. Families are established within a subgroup primarily on the basis of properties important to the growth of plants or behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, thickness of horizons, and consistence. An example is the fine-loamy, mixed, mesic family of Typic Hapludalfs.

SERIES. The series consists of a group of soils that formed from a particular kind of parent material and have genetic horizons that, except for the texture of the surface soil, are similar in differentiating characteristics and in arrangement in the profile. Among these characteristics are color, structure, reaction, consistence, and mineralogical and chemical composition.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity (also termed available moisture capacity). The capacity of soils to hold water availble for use by most plants. It is commonly defined as the difference between the amount of soil water at field capacity and the amount of soil water at field capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil.

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

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 clay on the surface of a soil aggregate. Synonyms: clay coat, clay skin.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

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 and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artificially.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

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, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a coil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock usually underlies a C horizon but may be immediately beneath an A or B horizon.

Leached soil. A soil from which most of the soluble material have been removed from the entire profile or have been removed from one part of the profile and have accumulated in another part.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of 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 these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimension; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Paleosol. A buried soil or formerly buried soil, especially one that formed during an interglacial period and was covered by deposits of later glaciers.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

Pedisediment. Water-sorted sediments at the top of a paleosol.

Permeability. The quality that enables the soil to transmit water or air. Terms used to describe permeability are as follows: *very slow, slow, moderately slow, moderate, moderately rapid, rapid,* and *very rapid.*

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

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

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

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

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The textural class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

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

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that 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.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stone line. A concentration of coarse rock fragments in soils that generally represents an old weathering surface. In a cross section, the line may be one stone or more thick. The line generally overlies material that weathered in place, and it is ordinarily overlain by sediment of variable thickness.

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

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

Substratum. Technically, the part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, about 5 to 8 inches in thickness. The plowed layer.

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

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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."

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

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which it belongs. Other information is given in tables as follows:

Acreage and extent, table 2, page 10.
Predicted yields, table 3, page 80.
Recreation, table 4, page 88.
Engineering, tables 5, 6, and 7, pages 96 to 119.

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Woodland suitability group Number
7A	Wiota silt loam, 1 to 3 percent slopes	65	IIe-2	68	5w2
13B	Olmitz-Vesser-Colo complex, 2 to 5 percent slopes	52	IIw-1	69	5w3
24D2	Shelby loam, 9 to 14 percent slopes, moderately eroded	57	IIIe-6	73	2o1
24D3	Shelby soils, 9 to 14 percent slopes, severely eroded	58	IVe-1	75	2o1
24E2	Shelby loam, 14 to 18 percent slopes, moderately eroded	58	IVe-1	75	2o1
24E3	Shelby soils, 14 to 18 percent slopes, severely eroded	58	VIe-3	78	2o1
51A	Vesser silt loam, 0 to 2 percent slopes	61	IIw-1	69	5w3
51B	Vesser silt loam, 2 to 5 percent slopes	61	IIw-1	69	5w3
54A	Zook silty clay loam, 0 to 2 percent slopes	66	IIw-1	69	5w3
54B	Zook silty clay loam, 2 to 5 percent slopes	66	IIw-1	69	5w3
56B	Cantril loam, 2 to 5 percent slopes	22	IIe-2	68	5w2
65E2	Lindley loam, 14 to 18 percent slopes, moderately eroded	43	VIe-1	77	2o1
65E3	Lindley soils, 14 to 18 percent slopes, severely eroded	43	VIIe-2	78	2o1
65F	Lindley loam, 18 to 24 percent slopes	43	VIIe-1	78	3r1
65F2	Lindley loam, 18 to 24 percent slopes, moderately eroded	43	VIIe-1	78	3r1
65F3	Lindley soils, 18 to 24 percent slopes, severely eroded	44	VIIe-2	78	3r1
65G2	Lindley loam, 24 to 40 percent slopes, moderately eroded	43	VIIe-1	78	3r1
93D2	Adair-Shelby complex, 9 to 14 percent slopes, moderately eroded	12	IVe-2	76	5c1
93D3	Adair-Shelby complex, 9 to 14 percent slopes, severely eroded	13	VIe-3	78	5c1
94D2	Mystic-Caleb complex, 9 to 14 percent slopes, moderately eroded	48	IVe-2	76	5c1
94D3	Mystic-Caleb complex, 9 to 14 percent slopes, severely eroded	48	VIe-3	78	5c1
94E2	Mystic-Caleb complex, 14 to 18 percent slopes, moderately eroded	48	VIe-2	77	5c1
94E3	Mystic-Caleb complex, 14 to 18 percent slopes, severely eroded	49	VIIe-2	78	5c1
130	Belinda silt loam	21	IIIw-3	74	5w3
T130	Belinda silt loam, benches	21	IIIw-3	74	5w3
131B	Pershing silt loam, 2 to 5 percent slopes	53	IIIe-3	71	4w1
131C	Pershing silt loam, 5 to 9 percent slopes	53	IIIe-4	72	4w1
131C2	Pershing silt loam, 5 to 9 percent slopes, moderately eroded	53	IIIe-4	72	4w1
T131B	Pershing silt loam, benches, 2 to 5 percent slopes	53	IIIe-3	71	4w1
T131C	Pershing silt loam, benches, 5 to 9 percent slopes	53	IIIe-4	72	4w1
132B	Weller silt loam, 2 to 5 percent slopes	63	IIIe-1	70	4w1
132B2	Weller silt loam, 2 to 5 percent slopes, moderately eroded	63	IIIe-1	70	4w1
132C2	Weller silt loam, 5 to 9 percent slopes, moderately eroded	63	IIIe-2	71	4w1
132D2	Weller silt loam, 9 to 14 percent slopes, moderately eroded	64	IVe-2	76	4w1
T132B	Weller silt loam, benches, 2 to 5 percent slopes	64	IIIe-1	70	4w1
T132C2	Weller silt loam, benches, 5 to 9 percent slopes, moderately eroded	64	IIIe-2	71	4w1
133+	Colo silt loam, overwash	28	IIw-1	69	5w3
133A	Colo silty clay loam, 0 to 2 percent slopes	28	IIw-1	69	5w3
133B	Colo silty clay loam, 2 to 5 percent slopes	28	IIw-1	69	5w3
172	Wabash silty clay	62	IIIw-2	73	5w3
179D2	Gara loam, 9 to 14 percent slopes, moderately eroded	31	IVe-1	75	2o1
179D3	Gara soils, 9 to 14 percent slopes, severely eroded	32	VIe-3	78	2o1
179E	Gara loam, 14 to 18 percent slopes	31	VIe-1	77	2o1
179E2	Gara loam, 14 to 18 percent slopes, moderately eroded	31	VIe-1	77	2o1

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Woodland suitability group Number
179E3	Gara soils, 14 to 18 percent slopes, severely eroded	32	VIIe-2	78	2o1
179F2	Gara loam, 18 to 24 percent slopes, moderately eroded	31	VIIe-1	78	3r1
192C	Adair clay loam, 5 to 9 percent slopes	12	IIIe-5	73	5c1
192C2	Adair clay loam, 5 to 9 percent slopes, moderately eroded	12	IIIe-5	73	5c1
192D2	Adair clay loam, 9 to 14 percent slopes, moderately eroded	12	IVe-2	76	5c1
208	Landes fine sandy loam, heavy subsoil variant	42	IIw-1	69	5w2
211	Edina silt loam	30	IIIw-3	74	5w3
220	Nodaway silt loam	50	I-1	68	5w2
222C	Clarinda silty clay loam, 5 to 9 percent slopes	26	IVw-1	76	5w1
222C2	Clarinda silty clay loam, 5 to 9 percent slopes, moderately eroded	26	IVw-1	76	5w1
222C3	Clarinda soils, 5 to 9 percent slopes, severely eroded	27	VIe-3	78	5w1
222D2	Clarinda silty clay loam, 9 to 14 percent slopes, moderately eroded	27	IVe-2	76	5w1
260	Beckwith silt loam	20	IIIw-3	74	5w3
261	Appanoose silt loam	15	IIIw-3	74	5w3
269A	Humeston silt loam, 0 to 2 percent slopes	36	IIIw-1	73	5w3
269B	Humeston silt loam, 2 to 5 percent slopes	36	IIIw-1	73	5w3
273B	Olmitz loam, 2 to 5 percent slopes	51	IIe-2	68	2o1
312B	Seymour silt loam, 2 to 5 percent slopes	56	IIIe-3	71	4w1
312C2	Seymour silt loam, 5 to 9 percent slopes, moderately eroded	56	IIIe-4	72	4w1
313D2	Gosport-Clanton silt loams, 9 to 14 percent slopes, moderately eroded	33	VIe-4	78	5w1
313E2	Gosport-Clanton silt loams, 14 to 18 percent slopes, moderately eroded	33	VIe-4	78	5w1
313F2	Gosport-Clanton silt loams, 18 to 24 percent slopes, moderately eroded	33	VIIe-3	78	5w1
315	Nodaway-Alluvial land complex	50	Vw-1	76	5w2
354	Marsh	46	VIIw-1	79	---
362	Haig silty clay loam	35	IIw-2	70	5w3
364B	Grundy silty clay loam, 2 to 5 percent slopes	34	IIe-1	68	4w1
406	Kennebec-Amana silt loams	37	I-1	68	5w2
413D2	Sogn-Gosport-Clanton complex, 9 to 18 percent slopes, moderately eroded	59	VIIe-3	78	5w1
422	Amana silt loam	14	IIw-1	69	5w2
425C	Keswick loam, 5 to 9 percent slopes	38	IIIe-5	73	5c1
425C2	Keswick loam, 5 to 9 percent slopes, moderately eroded	38	IIIe-5	73	5c1
425D	Keswick loam, 9 to 14 percent slopes	39	IVe-2	76	5c1
425D2	Keswick loam, 9 to 14 percent slopes, moderately eroded	39	IVe-2	76	5c1
425D3	Keswick soils, 9 to 14 percent slopes, severely eroded	39	VIe-3	78	5c1
452B	Lineville silt loam, 2 to 5 percent slopes	45	IIIe-3	71	5c1
452C	Lineville silt loam, 5 to 9 percent slopes	45	IIIe-4	72	5c1
452C2	Lineville silt loam, 5 to 9 percent slopes, moderately eroded	45	IIIe-4	72	5c1
453A	Tuskeego silt loam, 0 to 2 percent slopes	60	IIIw-1	73	5w3
453B	Tuskeego silt loam, 2 to 5 percent slopes	60	IIIw-1	73	5w3
467	Radford silt loam	54	IIw-1	69	5w2
520	Coppock silt loam	29	IIw-1	69	5w3
531B	Kniffin silt loam, 2 to 5 percent slopes	40	IIIe-3	71	4w1
531C	Kniffin silt loam, 5 to 9 percent slopes	40	IIIe-4	72	4w1
531C2	Kniffin silt loam, 5 to 9 percent slopes, moderately eroded	40	IIIe-4	72	4w1
532B	Rathbun silt loam, 2 to 5 percent slopes	55	IIIe-1	70	4w1
532B2	Rathbun silt loam, 2 to 5 percent slopes, moderately eroded	55	IIIe-1	70	4w1
532C	Rathbun silt loam, 5 to 9 percent slopes	55	IIIe-2	71	4w1
532C2	Rathbun silt loam, 5 to 9 percent slopes, moderately eroded	55	IIIe-2	71	4w1
534	Carlow silty clay	23	IIIw-2	73	5w3
587	Chequest silty clay loam	24	IIw-1	69	5w3

Map symbol	Mapping unit	Page	Capability unit Symbol	Capability unit Page	Woodland suitability group Number
592C2	Mystic silt loam, 5 to 9 percent slopes, moderately eroded-	47	IIIe-5	73	5c1
592C3	Mystic soils, 5 to 9 percent slopes, severely eroded-------	48	IIIe-5	73	5c1
592D2	Mystic silt loam, 9 to 14 percent slopes, moderately eroded--	48	IVe-2	76	5c1
592D3	Mystic soils, 9 to 14 percent slopes, severely eroded------	48	VIe-3	78	5c1
752C	Lineville silt loam, dark variant, 5 to 9 percent slopes---	46	IIIe-4	72	5c1
752C2	Lineville silt loam, dark variant, 5 to 9 percent slopes, moderately eroded--	46	IIIe-4	72	5c1
792C2	Armstrong loam, 5 to 9 percent slopes, moderately eroded---	16	IIIe-5	73	5c1
792C3	Armstrong soils, 5 to 9 percent slopes, severely eroded----	16	IIIe-5	73	5c1
792D2	Armstrong loam, 9 to 14 percent slopes, moderately eroded--	16	IVe-2	76	5c1
792D3	Armstrong soils, 9 to 14 percent slopes, severely eroded---	17	VIe-3	78	5c1
795C2	Ashgrove silt loam, 5 to 9 percent slopes, moderately eroded--	19	IVe-2	76	5w1
795D2	Ashgrove silt loam, 9 to 14 percent slopes, moderately eroded--	19	IVe-2	76	5w1
822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded--	41	IVe-2	76	5w1
822D3	Lamoni soils, 9 to 14 percent slopes, severely eroded------	41	VIe-3	78	5w1
993D2	Armstrong-Gara loams, 9 to 14 percent slopes, moderately eroded--	17	IVe-2	76	5c1
993D3	Armstrong-Gara complex, 9 to 14 percent slopes, severely eroded--	17	VIe-3	78	5c1
993E2	Armstrong-Gara loams, 14 to 18 percent slopes, moderately eroded--	17	VIe-2	77	5c1
993E3	Armstrong-Gara complex, 14 to 18 percent slopes, severely eroded--	18	VIIe-2	78	5c1

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