SOIL SURVEY OF

Union County, Iowa

United States Department of Agriculture
Soil Conservation Service
in cooperation with the
Iowa Agriculture and Home Economics Experiment Station
Cooperative Extension Service, Iowa State University
and the
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. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1969–72. Soil names and descriptions were approved in 1973. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service, the Iowa Agriculture and Home Economics Experiment Station Cooperative Extension Service, Iowa State University, and the Department of Soil Conservation, State of Iowa. It is part of the technical assistance furnished to the Union Soil and Water Conservation District. Funds appropriated by Union County were used to pay part of the cost of the survey.

Soil maps in this survey may be copied without permission, but any enlargement of these maps could cause misunderstanding of the detail of mapping and result in erroneous interpretations. Enlarged maps do not show small areas of contrasting soils that could have been shown at a larger mapping scale.

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, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation.

Locating Soils

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

On each sheet of the detailed map, soil areas are outlined and are identified by symbol. 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 "Index to Map Units" on page ii can be used to find information in the survey. It lists all the soils in the county in numerical order by map symbol and shows the page where each soil is described. The capability unit to which each soil has been assigned is specified at the end of the soil description.

Individual colored maps showing the relative suitability or limitations of soils for many specific purposes can be developed by using the soil map and information in the text. Interpretations not included in the text can be developed by grouping the soils according to their suitability or limitations for a particular use. 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 in the soil descriptions and in the discussions of the interpretive groupings.

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

Game managers, sportsmen, and others concerned with wildlife will find information about soils and wildlife in the section "Wildlife Habitat."

Engineers and builders will find under "Engineering" tables that give engineering descriptions of the soils in the county and that name soil features that affect engineering practices and structures.

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

Students, teachers, and others will find information about soils and their management in various parts of the text.

Newcomers in Union County may be especially interested in the section "General Soil Map" where broad patterns of soils are described.

Cover picture: Typical landscape in Gara-Ladoga association showing good conservation practices. Ladoga soils are on the ridgetops and Armstrong and Gara soils are mainly on the side slopes.

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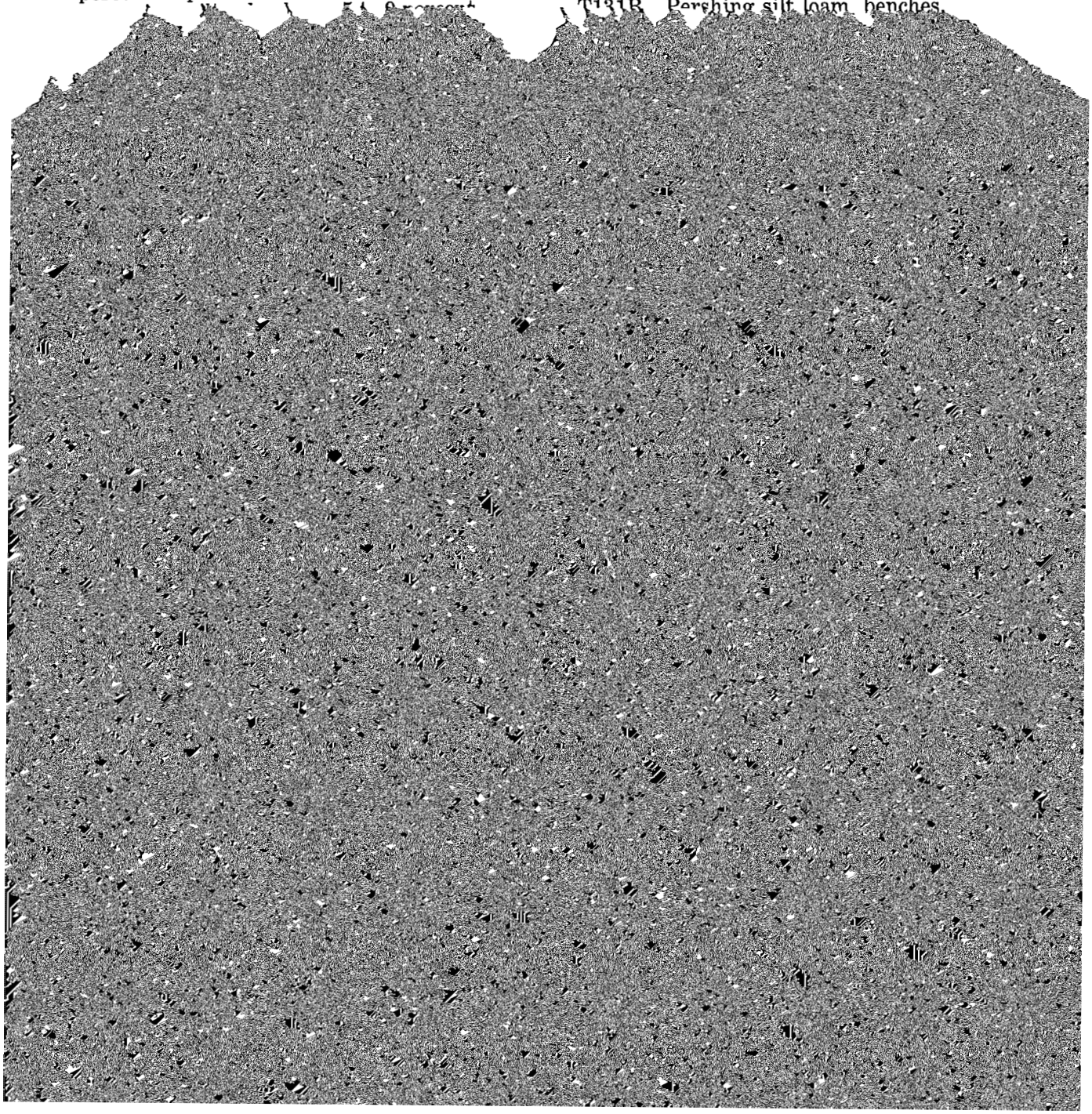

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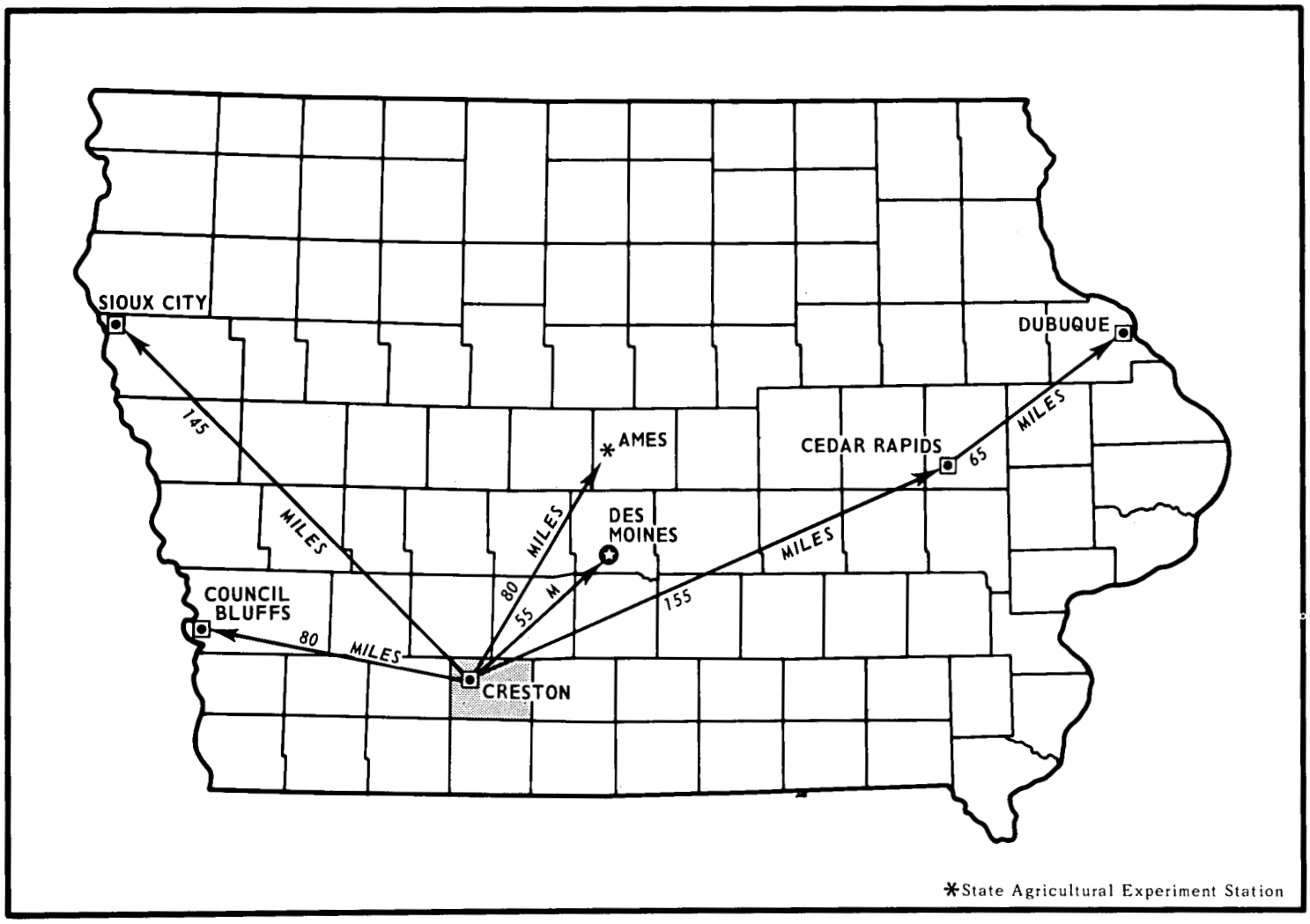


Location of Union County in Iowa.

SOIL SURVEY OF UNION COUNTY, IOWA

By John R. Nixon and Louis E. Boeckman

Fieldwork by John R. Nixon, Louis E. Boeckman, and Brian C. Peterson, Soil Conservation Service

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

UNION COUNTY is in the southwestern part of Iowa (see facing page). It is the second county north of the State of Missouri and the fourth county east of the Missouri River. It has a total land area of about 425 square miles, or 272,000 acres. Creston, the county seat, is about 55 airline miles southwest of Des Moines, the State capital.

Most of the acreage is agricultural, and the population is rural. Corn, soybeans, hay, and pasture are the main crops. Much of the corn and forage is fed to livestock.

Most soils of Union County formed under prairie vegetation. Some formed under timber vegetation. The climate is subhumid and continental. Winters are cold, and summers are warm. The growing season is long enough for crops to mature.

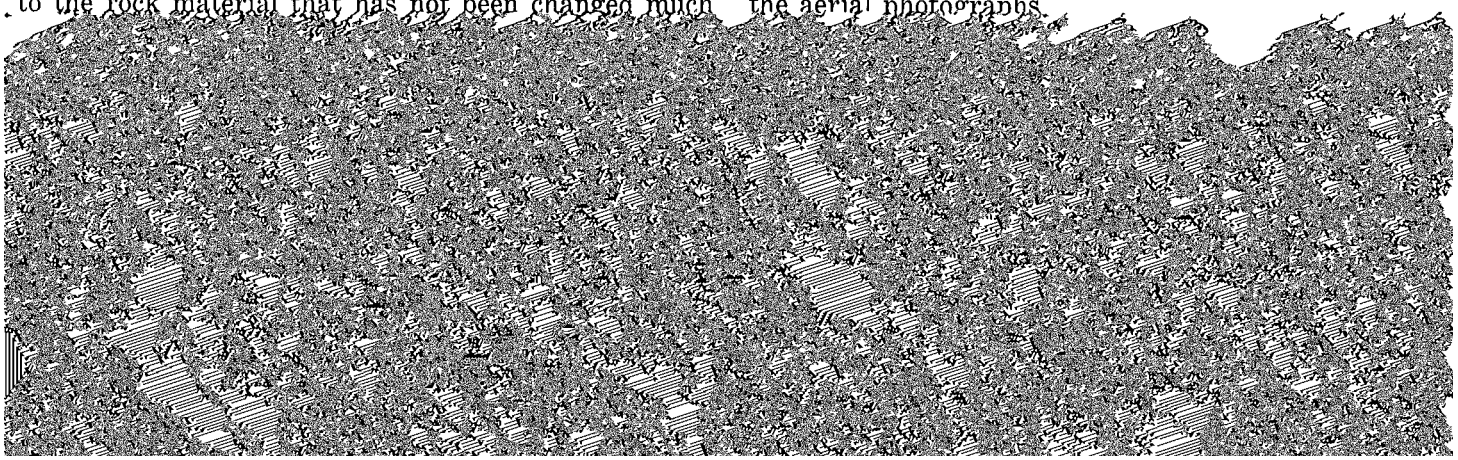
How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Union County, where they are located, and how they can be used. They went into the county knowing they likely would find many soils they had already seen and perhaps some they had not. As they traveled over the county, they observed steepness, length, and shape of slopes; size of streams; kinds of native plants or crops; kinds of rock, and many facts about the soils. They dug or bored 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 to the rock material that has not been changed much a soil of that series was first observed and mapped. Sharpsburg and Macksburg, 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 natural characteristics.

Many soil series contain soils that are alike except for texture of their surface layer. According to this difference in texture, separations called soil types are made. Within a series, all the soils having a surface layer in the same texture belong to one soil type. Wabash silty clay and Wabash silty clay loam are two soil types in the Wabash series. The difference in texture of their surface layers is apparent from their names.

Some soil types have a wide range of slope, degree of slope, degree of erosion, number and size of stones, or some other feature affecting their use, that practical suggestions about their management could not be made if they were shown on the map as one unit. Such soil types are divided into soil phases. The name of a soil phase indicates a feature that affects management. For example, Shelby clay loam, 9 to 14 percent slopes, is one of several phases of Shelby clay loam, a soil type that ranges from sloping to steep.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew soil boundaries on aerial photographs. They used photos for their base map because they show woodlands, buildings, field borders, trees, and similar detail that greatly help in drawing boundaries accurately. The soil map at the back of this survey was prepared from the aerial photographs.



ture of soils as one mapping unit and calls it a soil complex. Ordinarily, a soil complex is named for [illegible] soil series in it, for example, Colo-Ely silty

county. About 50 percent is Macksburg soils, 21 percent Winterset soils, and 29 percent minor soils.

The Macksburg soils, on broad nearly level to gently

Figure 1.—**Typical landscape in Sharpsburg-Shelby-Nira association. Sharpsburg soils are on the ridgetops, Nira soils on upper side slopes and at the heads of drainageways, and Shelby soils on the steeper side slopes.**

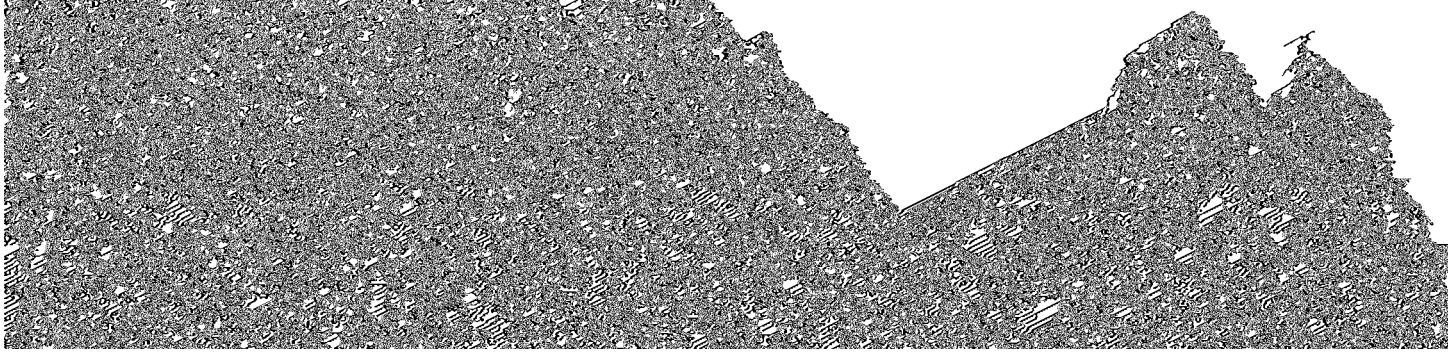
Minor in this association are the Clearfield, Clarinda, Lamoni, Adair, Dickinson, Colo, and Ely soils. The poorly drained Clearfield soils, which formed in loess over weathered glacial till, are at the heads of drainageways, on narrow bands on side slopes, and on slopes adjacent to Sharpsburg and Nira soils. The poorly drained Clarinda soils are at the heads of drainageways, on narrow bands on side slopes, and on narrow upland convex ridges generally below Clearfield or Nira soils. The moderately well drained to somewhat poorly drained Adair soils are on convex

tween the loess and the glacial till is seasonally wet and seepy. Interceptor tile can alleviate the wetness. Terraces reduce erosion.

Row crops are grown on ridgetops and upper side slopes. The lower convex slopes are usually in meadow or permanent pasture.

3. *Gara-Ladoga association*

Gently sloping to steep, well drained and moderately well drained upland soils that have a loam or silt loam



cally is dark grayish brown loam about 5 inches thick. The subsoil is dark yellowish brown loam in the upper part. Below a depth of 17 inches, it is dark yellowish brown and yellowish brown clay loam. It extends to a depth of about 40 inches.

The gently sloping to moderately sloping Ladoga soils are on ridgetops. The strongly sloping Ladoga soils are on upper side slopes in the uplands and on

Nodaway soils, 22 percent Colo soils, 8 percent Wabash soils, and 21 percent minor soils.

Nodaway soils are moderately well drained. They are generally adjacent to the present stream channel but can occur at some distance from where the channel has been straightened. Some areas are channeled because of the cutting action of streams and rivers during flooding. The Nodaway soils typically are stratified

of the subsoil is very dark gray silty clay loam. The next part, below 24 inches, is dark gray silty clay that grades to olive gray with depth. The lower part is olive gray silty clay loam.

Minor in this association are the Sperry and Clarinda soils. The very poorly drained Sperry soils are in the depressional areas of the nearly level divides. They have a lighter colored surface layer than the Grundy and Haig soils. The very poorly drained Clarinda soils are at the heads of drainageways adjacent to the Grundy and Haig soils.

The soils in this association have a high available water capacity. The Haig soils on the flats may pond seasonally. Surface drainage can alleviate this problem if an outlet is available.

The soils in this association are well suited to row crops. Corn and soybeans are the major crops. Much of the corn is fed to livestock. Soybeans is a cash grain crop. Only a small part of this association is in permanent pasture, generally the small acreage near farmsteads.

6. *Shelby-Grundy association*

Gently sloping to strongly sloping, well drained to somewhat poorly drained upland soils that have a clay loam and silty clay loam surface layer and formed in glacial till or loess

This soil association occupies the gently sloping lower ridgetops and divides, and the strongly sloping side slopes. Some areas of this association are in drainageways.

This association makes up about 8 percent of the county. About 19 percent is Shelby soils, 16 percent Grundy soils, (fig. 2) and 65 percent minor soils.

The Shelby soils, on convex side slopes and some narrow ridgetops, are moderately well drained or well drained. The surface layer typically is black and very dark grayish brown clay loam about 15 inches thick. The subsoil is dark brown, dark yellowish brown, and brown clay loam extending to a depth of about 38 inches.

The gently sloping Grundy soils, on side slopes and ridgetops that surround nearly level upland divides, are somewhat poorly drained. The surface layer typically is black silty clay loam about 11 inches thick. The upper part of the subsoil is very dark gray to grayish brown silty clay loam, the next part, from 17 to 47 inches, is silty clay, and the lower part, to a depth of about 4 feet, is heavy silty clay loam.

Minor in this association are the Clarinda, Lamoni, Adair, Lineville, Colo, and Ely soils. The very poorly drained Clarinda soils occupy the heads of drainageways, narrow bands on side slopes, and narrow convex ridgetops on uplands below the Grundy soils. The

Figure 2.—**Typical landscape in Shelby-Grundy association. Shelby soils, in pasture, are on the side slopes. Grundy soils are on the narrow ridgetops.**

moderately well to somewhat poorly drained Adair soils are on convex ridgetops, commonly in bands at the shoulders of side slopes. The moderately and strongly sloping, somewhat poorly drained Lamoni

and rivers, are moderately well drained. The Caleb and Mystic soils, on benches along major streams and tributaries, are moderately well drained or somewhat poorly drained. The Nodaway and Vesser soils in local

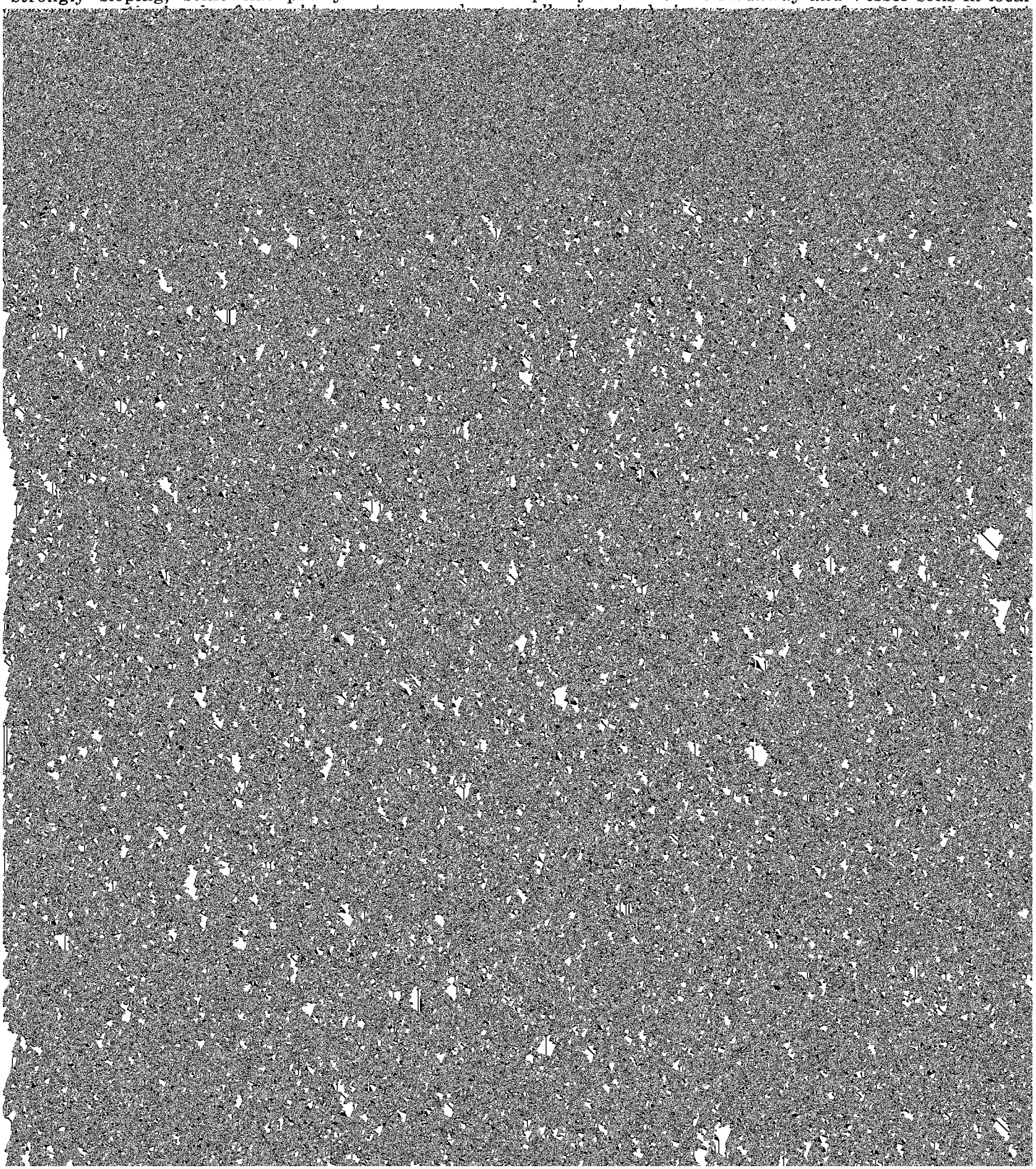


TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
8B	Judson silty clay loam, 2 to 5 percent slopes	421	0.2
11B	Colo-Ely silty clay loams, 2 to 5 percent slopes	39,045	14.4
13B	Nodaway-Vesser silt loams, 2 to 5 percent slopes	3,325	1.2
23C	Arispe silty clay loam, 5 to 9		
133B	Colo silty clay loam, 2 to 5 percent slopes	1,175	0.4
175D	Dickinson fine sandy loam, 5 to 14 percent slopes	268	0.1
179D	Gara loam, 9 to 14 percent slopes	1,038	0.4
179D2	Gara loam, 9 to 14 percent		

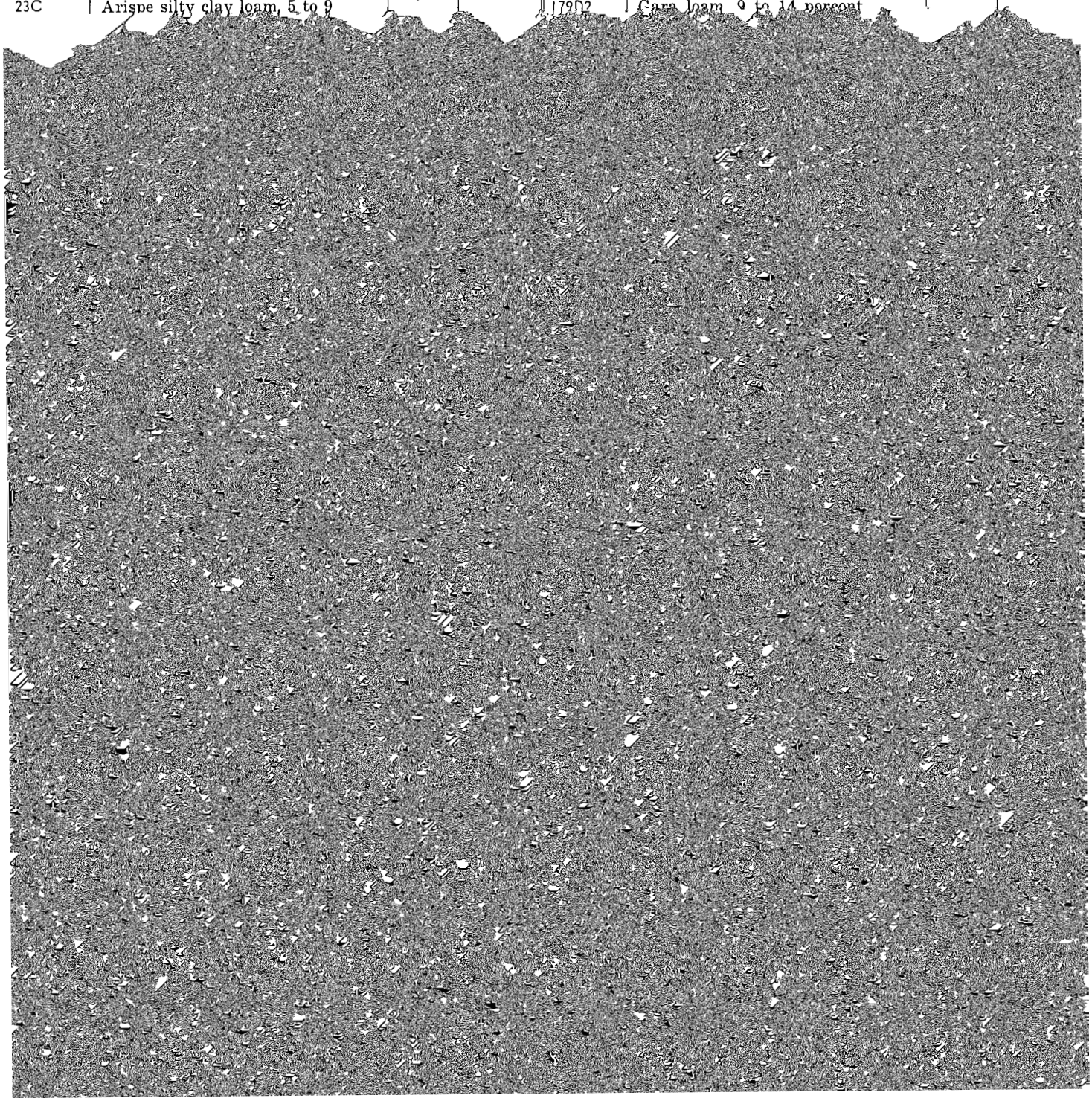


TABLE 1.—*Acreage and proportionate extent of the soils*—Continued

Map symbol	Soil name	Acres	Percent	Map symbol	Soil name	Acres	Percent
452C	Lineville silt loam, 5 to 9 percent slopes	226	0.1	822D	Lamoni silty clay loam, 9 to 14 percent slopes	495	0.2
592C2	Mystic silt loam, 5 to 9 percent slopes, moderately eroded	880	0.3	822D2	Lamoni silty clay loam, 9 to 14 percent slopes, moderately eroded	539	0.2

very dark gray (10YR 3/1). It is dominantly clay loam, but the range includes silt loam. The A horizon ranges from medium acid to slightly acid.

The IIB2t horizon ranges from clay loam to clay and from strongly to slightly acid.

The moderately eroded units of Adair clay loam and Adair-Shelby clay loams are outside the defined range for the series because they lack a mollic epipedon. This difference, however, does not alter the use and behavior of the soils.

Adair soils are associated on the landscape with Sharpsburg, Grundy, and Shelby soils. They formed in parent material similar to that of Armstrong and Keswick soils. They have more clay in the B horizon than Sharpsburg, Grundy, and Shelby soils. They have a thicker A horizon than Armstrong and Keswick soils.

192C—Adair clay loam, 5 to 9 percent slopes. This moderately sloping soil is on side slopes and ridges. It occurs as long, narrow and irregularly shaped bands in the uplands. The profile is the one described as representative of the series.

Included with this soil in mapping are small areas of Shelby, Clarinda, and Lineville soils. Also included are small eroded areas, which are identified by spot slopes. It is 50 percent Adair soil and 40 percent Shelby soil. Areas are irregular in size and shape.

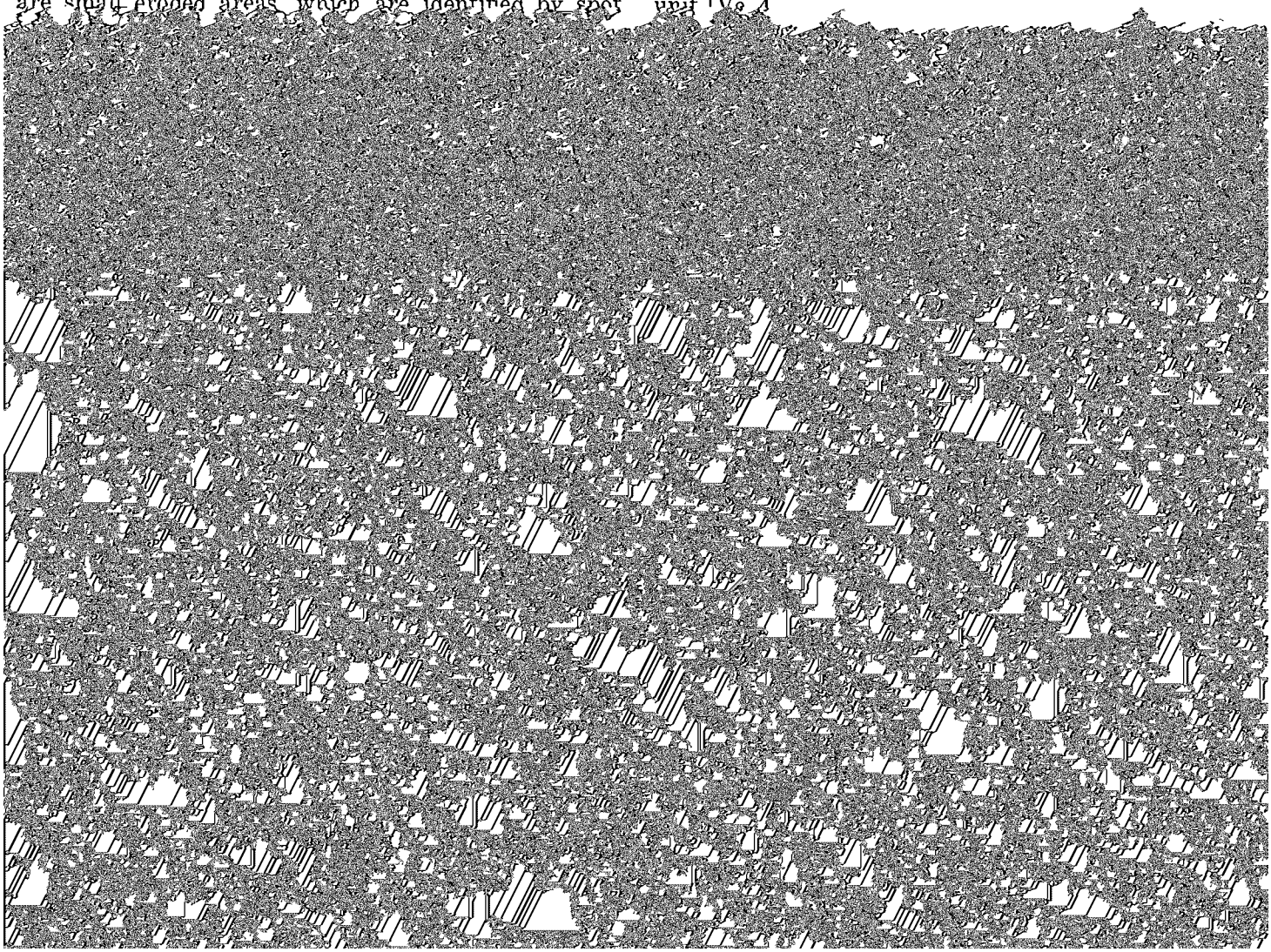
Included with this unit in mapping are small areas of Gara, Clarinda, and Lamoni soils. Gara soils are on the lower parts of slopes, and Clarinda and Lamoni soils are on the upper parts.

This map unit is generally better suited to pasture and hay than to cultivated crops. It is susceptible to erosion. Erosion control is needed. The organic-matter content is 2 to 4 percent. Capability unit IVe–4.

93D2—Adair-Shelby clay loams, 9 to 14 percent slopes, moderately eroded. This strongly sloping map unit is on side slopes. It is 50 percent Adair soil and 40 percent Shelby soil. It occurs in almost all parts of the county. Areas are irregular in size and shape. The clay loam surface layer is less than 7 inches thick.

Included with this unit in mapping are small areas of Gara, Clarinda, and Lamoni soils. Gara soils are on the lower parts of slopes, and Clarinda and Lamoni soils are on the upper parts.

This map unit is generally better suited to pasture and hay than to cultivated crops. It is susceptible to further erosion. Erosion control is needed. The organic-matter content is 2 to 4 percent. Capability unit IVe–4.



parting to moderate fine granular; friable; many roots; slightly acid; clear smooth boundary.

B1—7 to 13 inches; very dark gray (10YR 3/1) medium silty clay loam; very dark grayish brown (10YR 3/2) crushed; moderate and strong very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21t—13 to 18 inches; dark grayish brown (10YR 4/2) medium silty clay loam; [illegible] tles; massive; friable; few fine dark bodies; neutral.

The Ap horizon ranges from heavy silt loam to light silty clay loam. It is 6 to 10 inches thick.

Arispe soils are associated on the landscape with Grundy and Clarinda soils. They formed in parent material similar to that of Grundy soils. Arispe soils have a less clayey B horizon than Clarinda and Grundy soils.

23C—Arispe silty clay loam, 5 to 9 percent slopes. This moderately sloping soil is on side slopes in the [illegible]

subangular blocky; friable; medium acid; clear smooth boundary.

B1—10 to 15 inches; dark yellowish brown (10 YR 4/4) light clay loam; few fine faint yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; very dark gray (10YR 3/1) stains on some peds; strongly acid; clear smooth boundary.

B21t—15 to 18 inches; brown (7.5YR 4/4) medium clay loam; few fine distinct reddish brown (5YR 4/4) and yellowish red (5YR 4/6) mottles; moderate fine subangular blocky structure; firm; very dark gray (10YR 3/1) stains on some peds; few thin discontinuous clay films; few small pebbles; strongly acid; gradual smooth boundary.

IIB22t—18 to 24 inches; mottled brown (7.5YR

and a thinner A1 horizon than Adair soils. They have more sand than the loess-derived Pershing soils and a more clayey B horizon than Gara soils.

792C—Armstrong loam, 5 to 9 percent slopes. This moderately sloping soil is on narrow ridges and upper side slopes. It occurs as long, narrow, and irregularly shaped bands in the uplands. The profile is the one described as representative of the series.

Included with this soil in mapping are small areas of Gara and Keswick soils. Some large areas of less clayey glacial till soils are identified by spot symbols on the soil map.

This soil is moderately well suited to row crops, but it is susceptible to erosion. Most areas are in timber pasture. Some are used for pasture and hay. A small acreage is in crops. The organic-matter content is 2 to 4 percent. Capability unit IIIe-4.

792C2—Armstrong loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on nar-

Belinda soils are used primarily for cultivated crops and hay. The major hazard for crops is wetness.

Representative profile of Belinda silt loam, benches, 0 to 2 percent slopes, 1,850 feet west and 1,150 feet north of southeast corner of sec. 26, T. 71 N., R. 28 W. in a bluegrass pasture:

Ap—0 to 7 inches; very dark gray (10YR 3/1) silt loam; grayish brown (10YR 5/2) dry; weak very thin platy structure parting to weak very fine granular; friable; medium acid; abrupt smooth boundary.

A21—7 to 10 inches; grayish brown (10YR 5/2) silt loam; light gray (10YR 7/3) dry; moderate medium platy structure; few fine faint yellowish brown (10YR 5/4) mottles; friable; medium acid; clear smooth boundary.

A22—10 to 14 inches; grayish brown (10YR 5/2) [illegible] films on peds; few fine dark bodies; medium acid; gradual smooth boundary.

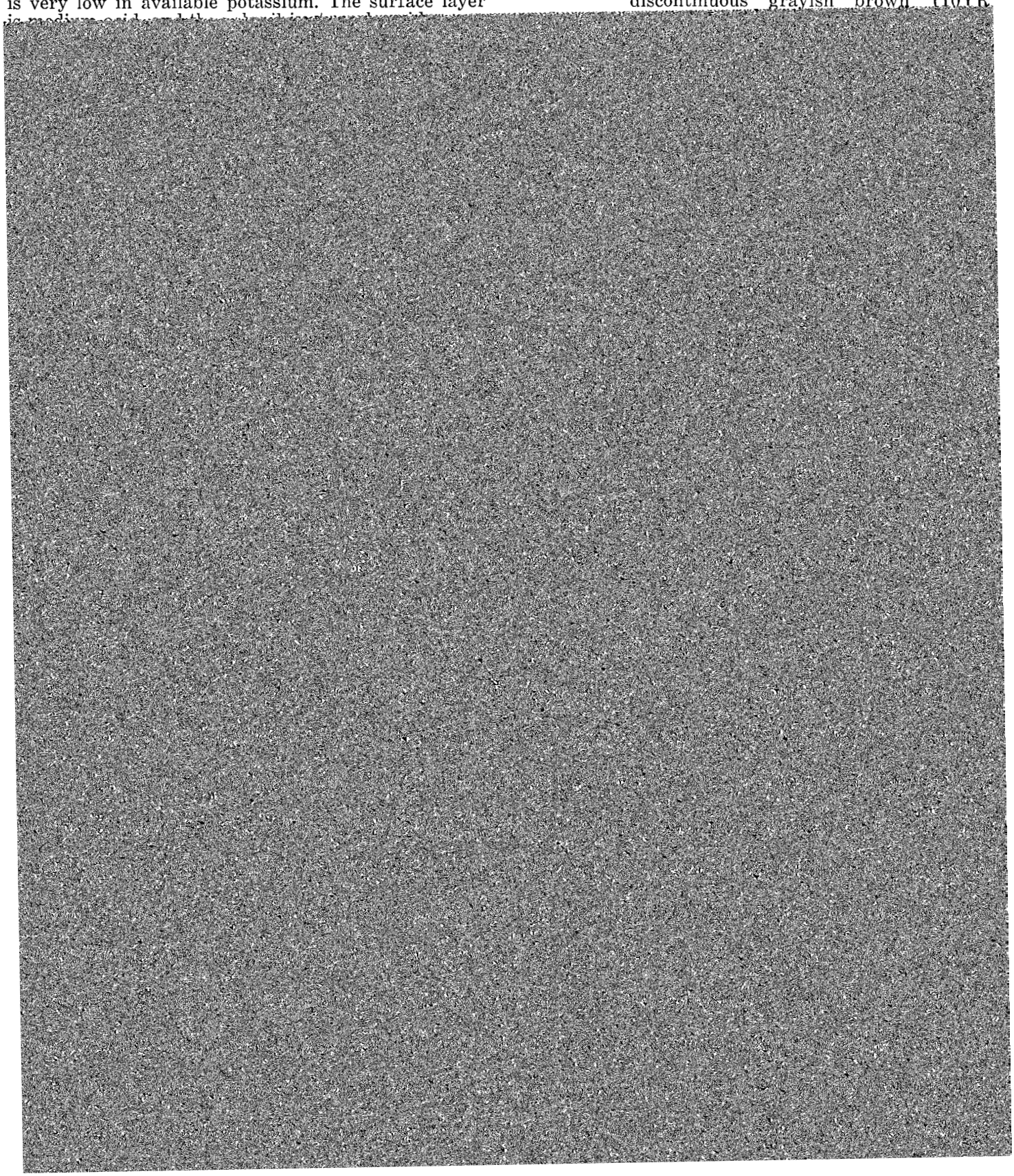
B31t—43 to 51 inches; mottled gray (5Y 5/1) and yellowish brown (10YR 5/4, 5/6, and 5/8) silty clay loam; common medium brown (7.5YR 4/4) mottles; weak medium prismatic structure; dark gray (10YR 4/1) thin discontinuous clay films; medium acid; gradual smooth boundary.

B32t—51 to 80 inches; mottled gray (5Y 5/1) and yellowish brown (10YR 5/4, 5/6, and 5/8) silty clay loam; few fine brown (7.5YR 4/4) mottles; weak medium prismatic structure; firm; few thin dark gray (10YR 4/1) discontinuous clay films; medium acid.

The Ap horizon ranges from very dark gray (10YR

The subsoil is very low in available phosphorus and is very low in available potassium. The surface layer

prismatic structure; friable; few thin discontinuous grayish brown (10YR



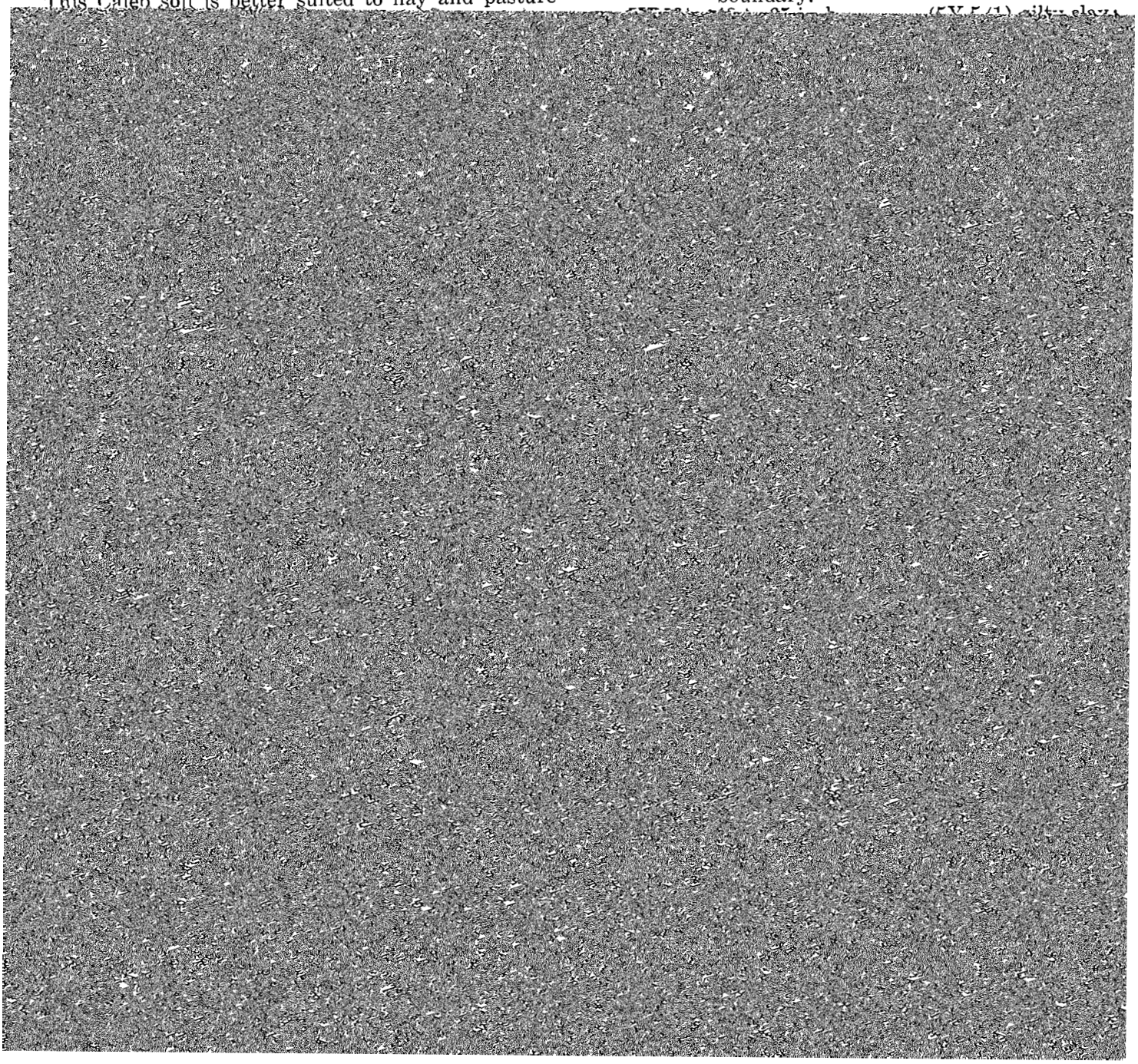
slopes of high benches near major streams and tributaries. Areas are irregular in size and shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown.

Included with this soil in mapping are small areas of Gara, Armstrong, and Mystic soils; a few areas of less sloping soils; and small areas of soils that are either more eroded or less eroded. Also included, if significant in management, are spots of sand which are identified by spot symbols on the soil map. Some areas of severely eroded soils are also indicated by spot symbols on the soil map.

This Caleb soil is better suited to hay and pasture

few fine distinct brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; very firm; thick continuous gray clay films on peds; common fine white sand grains; medium acid; gradual smooth boundary.

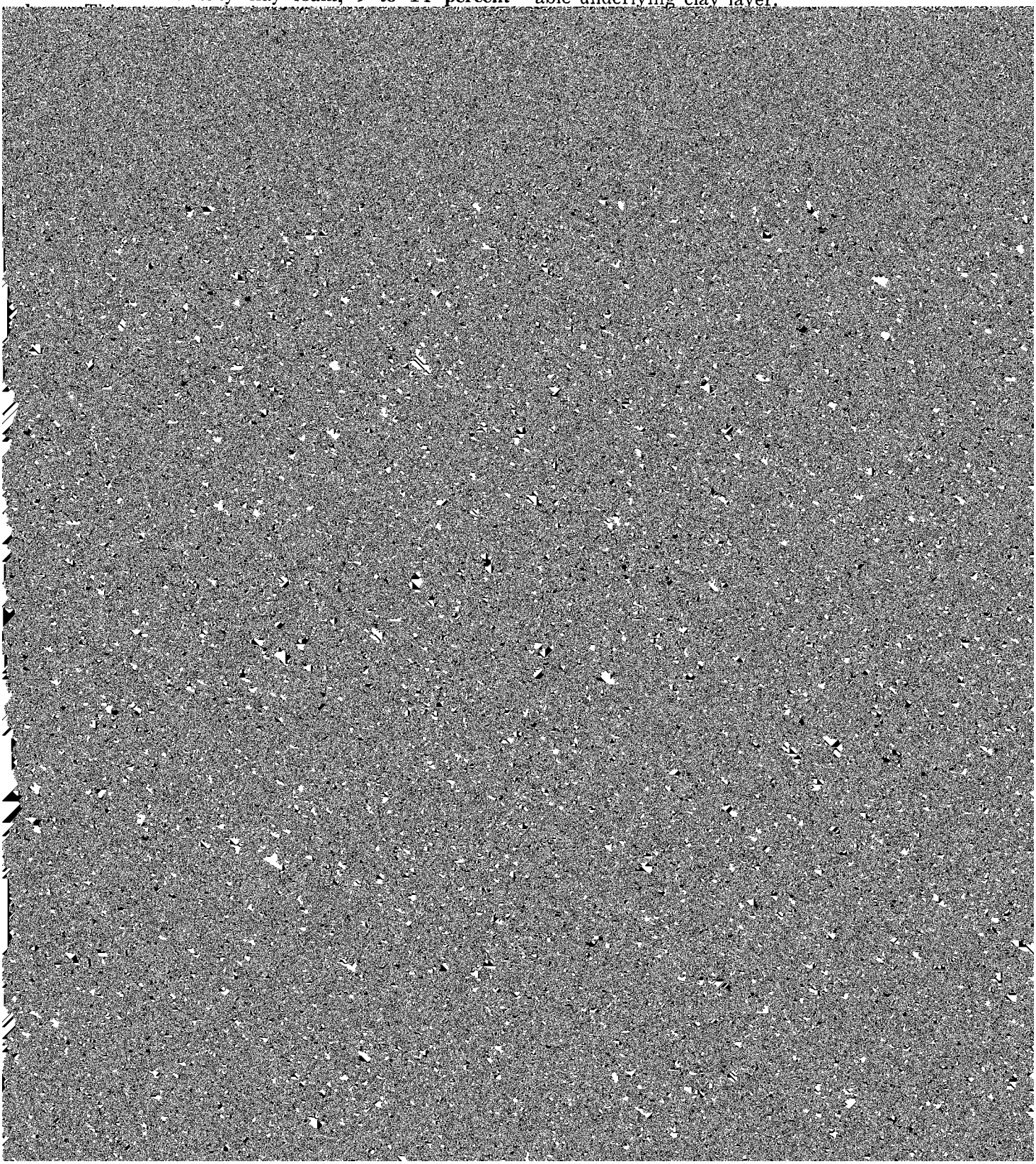
IIB22t—33 to 48 inches; gray (5Y 5/1) silty clay; few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to coarse subangular blocky; very firm; thick continuous gray clay films; few white sand grains; medium acid; gradual smooth boundary.



and erosion. Erosion control is needed in cultivated areas. The organic-matter content is 2 to 4 percent. Capability unit IVw-1.

222D—Clarinda silty clay loam, 9 to 14 percent

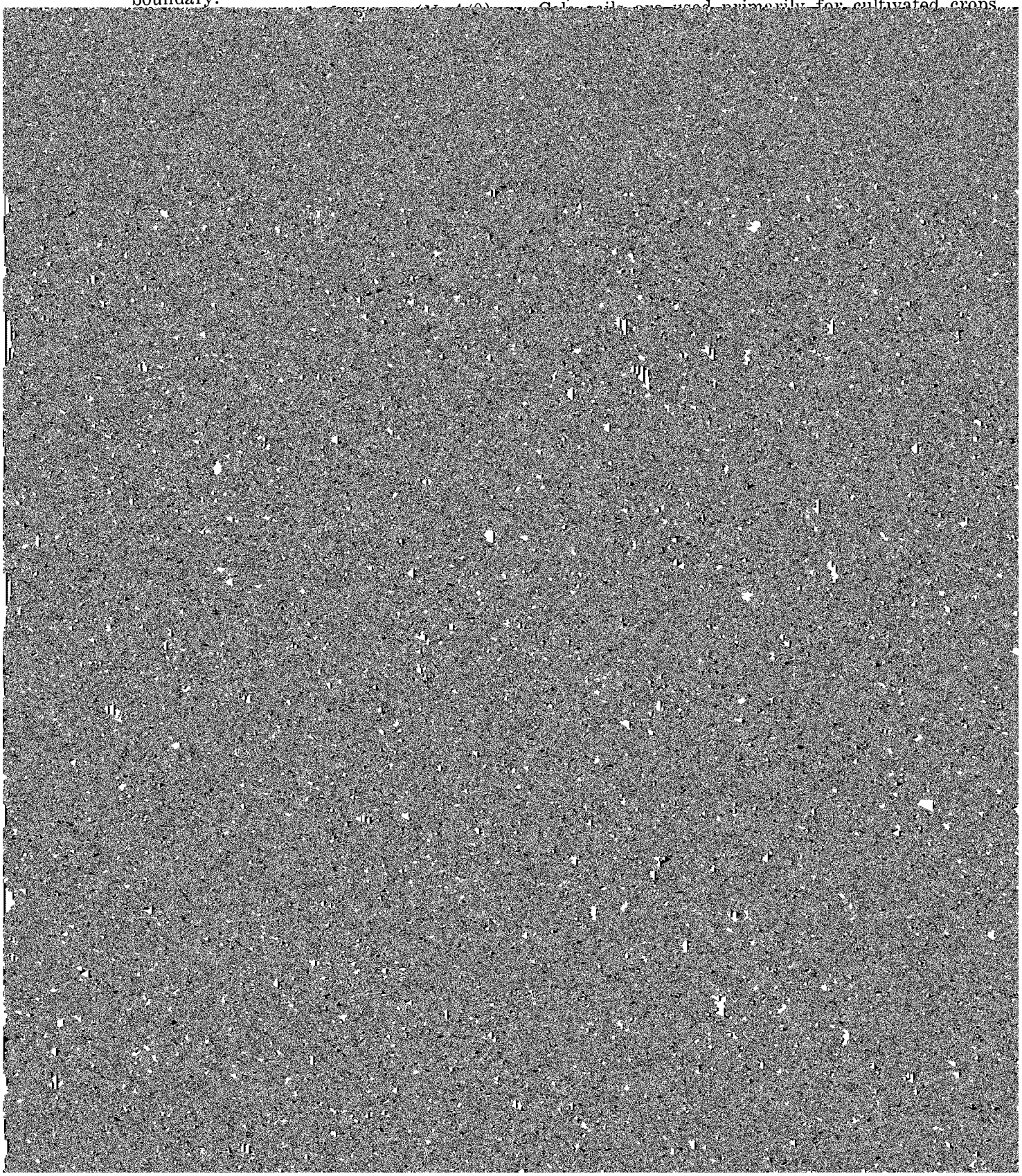
crops. The major limitation is wetness caused by drainage water, from areas of more permeable loess, which moves laterally over the compact, very slowly permeable underlying clay layer.



inches; slightly acid; abrupt smooth boundary.

medium in available phosphorus and potassium. Unless limed, the surface layer is generally slightly acid.

Soils of this series are used primarily for cultivated crops.



This gently sloping soil is on level to slightly concave

(10YR 2/2); moderate fine granular structure; friable; slightly acid; clear smooth boundary.

A3—15 to 24 inches; very dark gray (10YR 3/1) light silty clay loam; crushes to very dark grayish brown (10YR 3/2); weak fine subangular blocky structure parting to moderate fine granular; friable; medium acid; clear smooth boundary.

B1—24 to 32 inches; very dark gray (10YR 3/1) light silty clay loam; crushed to very dark grayish brown (10YR 3/2); few fine faint dark grayish brown (10YR 4/2) and dark yellowish brown (10YR 4/4) mottles; moderate fine and very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21—32 to 39 inches; dark grayish brown (10YR 4/2) light silty clay loam; dark gray (10 YR 4/1) coatings on peds; few fine faint dark brown (10YR 3/3) and few fine distinct yellowish brown (10YR 5/4) mottles; weak medium prismatic structure parting to weak medium and fine subangular blocky; friable; slightly acid; gradual smooth boundary.

B22—39 to 48 inches; brown (10YR 4/3) silty clay loam; gray (10YR 5/1) coatings on peds; brown (10YR 4/3) kneaded; common fine distinct dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/4) and few fine distinct yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark bodies; slightly acid; gradual smooth boundary.

B3—48 to 55 inches; grayish brown (10YR 5/2) light silty clay loam; few fine faint gray (10YR 5/1) mottles; common fine distinct yellowish brown (10YR 5/4) and strong brown (7.5YR 5/6) mottles; brown (10YR 5/3) kneaded; weak medium prismatic structure parting to weak medium subangular blocky; friable; few fine dark bodies; neutral; gradual smooth boundary.

C—55 to 60 inches; mixed gray (10YR 5/1) and brown (10YR 5/3) light silty clay loam; common fine faint strong brown (7.5YR 5/6) mottles; massive; friable; common fine dark bodies; neutral.

The A horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/2). It is neutral to medium acid.

The B horizon ranges from very dark gray (10YR 3/1) in the upper part to brown (10YR 5/3) in the lower part.

Ely soils are associated on the landscape with Colo soils and formed in similar parent material. Ely soils have a silty clay loam B horizon that Colo soils lack. They are somewhat poorly drained, but Colo soils are poorly drained.

Gara Series

The Gara series consists of well drained to moderately well drained soils. These strongly sloping to steep soils are on side slopes in the uplands. They formed in glacial till under native vegetation of trees and grasses. Slopes are 9 to 25 percent.

In a representative profile the surface layer is very dark gray loam about 7 inches thick. The subsurface layer is dark grayish brown and very dark grayish brown loam about 5 inches thick. The subsoil extends to a depth of 40 inches. It is dark yellowish brown, medium loam in the upper part; dark yellowish brown, medium clay loam in the next part; and yellowish brown, medium clay loam in the lower part. The substratum is yellowish brown light clay loam. It is mildly alkaline.

Gara soils have moderately slow permeability and a high available water capacity. The subsoil is very low to low in available phosphorus and very low in available potassium. Unless limed, the surface layer is generally medium acid.

The Gara soils are highly erodible if used for row crops.

Representative profile of Gara loam, 9 to 14 percent slopes, 960 feet north and 140 feet east of the southwest corner of sec. 7, T. 73 N., R. 28 W. on a northwest-facing slope of 12 percent:

A1—0 to 7 inches; very dark gray (10YR 3/1) loam; dark gray (10YR 4/1) dry; weak very fine granular structure; friable; medium acid; clear smooth boundary.

A2—7 to 12 inches; dark grayish brown (10YR 4/2) and very dark grayish brown (10 YR 3/2) loam; light brownish gray (10 YR 6/2) dry; weak fine subangular blocky structure; friable; few ¼- to ½-inch pebbles; medium acid; clear smooth boundary.

B21t—12 to 17 inches; dark yellowish brown (10 YR 4/4) medium loam; brown (10YR 4/3) coatings on peds; few very dark grayish brown peds; moderate fine subangular blocky structure; friable; thin discontinuous clay films; few pebbles and stones; strongly acid; clear smooth boundary.

B22t—17 to 24 inches; dark yellowish brown (10YR 4/4) medium clay loam; brown (10YR 4/3) coatings on peds; moderate medium subangular blocky structure; firm; common fine distinct yellowish brown (10YR 5/6), few fine faint dark grayish brown (10YR 4/2) mottles; thin continuous clay films; few pebbles and stones; strongly acid; gradual smooth boundary.

B23t—24 to 33 inches; dark yellowish brown (10 YR 4/4) medium clay loam; few fine faint grayish brown (10YR 5/2) mottles and common fine distinct yellowish brown (10YR 5/6)mottles; weak medium prismatic structure parting to moderate medium subangular blocky; firm; thin continuous clay films; few pebbles

and stones; few fine dark bodies; strongly acid; gradual smooth boundary.

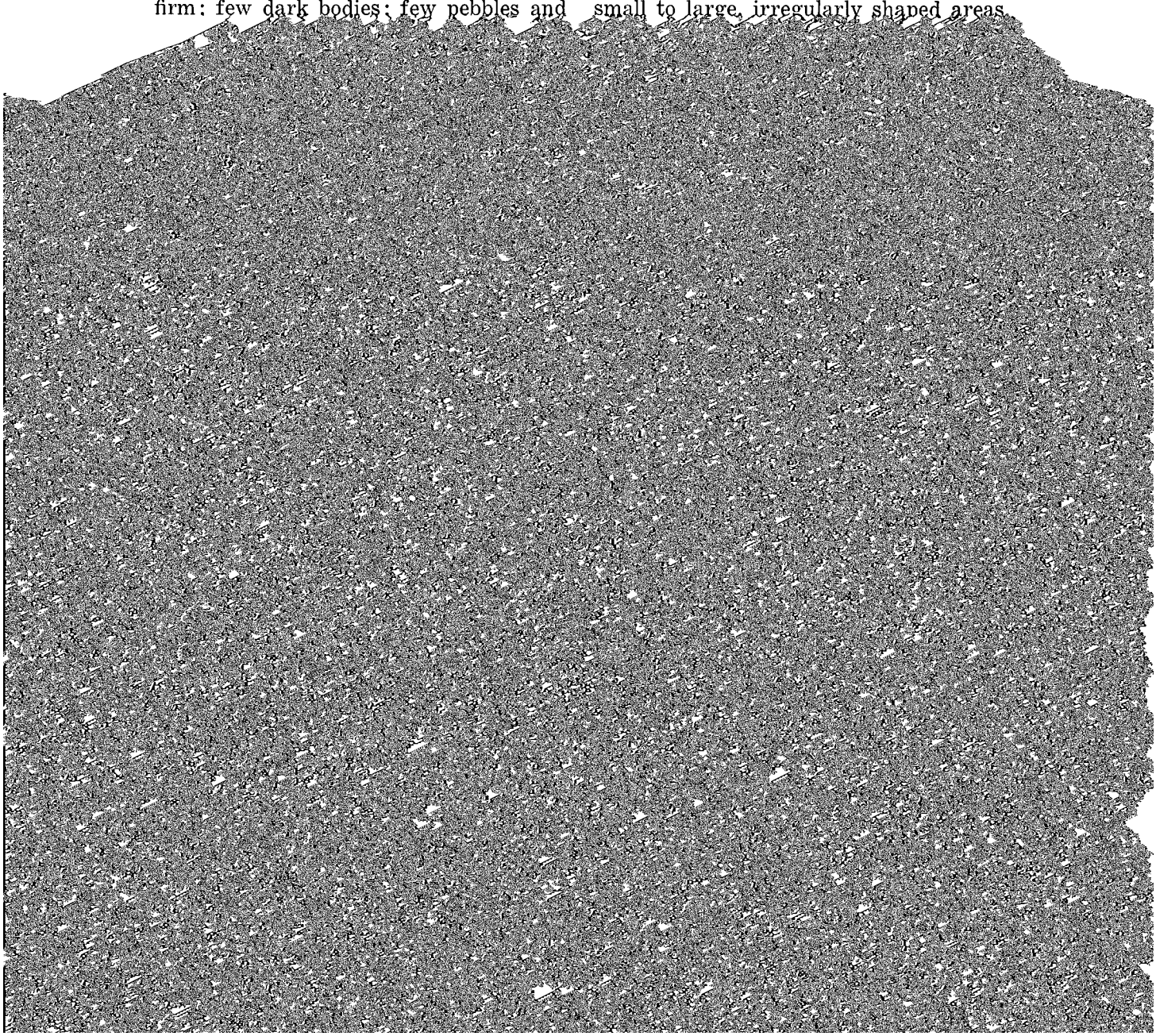
B3t—33 to 40 inches; yellowish brown (10YR 5/4 and 5/6) medium clay loam; common fine distinct grayish brown (2.5Y 5/2) mottles; weak medium prismatic structure parting to moderate coarse subangular blocky and angular blocky; firm; few thin discontinuous clay films on vertical faces and in pores; few pebbles and stones; common dark bodies; slightly acid; clear smooth boundary.

C—40 to 60 inches; yellowish brown (10YR 5/4 and 5/6) light clay loam; many medium distinct grayish brown (2.5Y 5/2) mottles; massive and some vertical cleavage; firm; few dark bodies; few pebbles and

This Gara soil is moderately suited to row crops and is well suited to hay and pasture. It becomes cloddy when tilled. It is more erodible than the uneroded Gara soil because it is in poorer physical condition. It crusts after a heavy rain, and seedling emergence is a problem. The organic-matter content in the plow layer is 1 to 2 percent. Fertility is more limiting. Seedbed preparation is more difficult, and a higher level of management is required.

Erosion from runoff is the main hazard. Good residue management and applications of manure are needed. Removing the topsoil causes severe problems because of the unfavorable subsoil properties. Most areas are used as pasture. Capability unit IVe–3.

179E—Gara loam, 14 to 18 percent slopes. This moderately steep soil is on side slopes. It occurs as small to large, irregularly shaped areas.



and shape. The loam surface layer is less than 7 inches thick.

Included with this unit in mapping are small areas of more severely eroded soils, which are identified by spot symbols on the soil map.

This map unit is very poorly suited to row crops and is poorly suited to small grain and meadow. It is moderately well suited to pasture or woodland. It is susceptible to further erosion. The organic-matter content is 1 to 2 percent. Capability unit IVe–5.

993E2—Gara-Armstrong loams, 14 to 18 percent slopes, moderately eroded. This moderately steep map unit is on side slopes. It is 70 percent Gara soils and 30 percent Armstrong soils. The loam surface layer is less than 7 inches thick. Included in mapping are small areas of less eroded soils.

This map unit is not suited to row crops. It is moderately well suited to pasture and is well suited to woodland or wildlife. It is susceptible to further erosion. The organic-matter content is 1 to 2 percent. Capability unit VIe–3.

Grundy Series

The Grundy series consists of somewhat poorly

B21t—17 to 24 inches; mixed very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) silty clay loam; strong very fine subangular blocky structure; firm; thin very dark grayish brown (10YR 3/2) and very dark gray (10YR 3/1) clay films; common dark reddish brown oxide stains; medium acid; clear smooth boundary.

B22t—24 to 30 inches; dark grayish brown (10YR 4/2) silty clay; few fine prominent reddish brown (5YR 4/4) and yellowish red (5YR 4/6) and few fine distinct dark yellowish brown (10YR 4/4) mottles; fine and very fine subangular blocky structure; firm; thick continuous very dark gray (10YR 3/1) clay films; few dark bodies; medium acid; clear smooth boundary.

B23t—30 to 37 inches; grayish brown (10YR 5/2) light silty clay; yellowish brown (10YR 5/4) kneaded; many medium distinct dark yellowish brown (10YR 4/4) and few fine distinct brown (7.5YR 4/4) mottles; moderate medium

as Haig soils. They have a thicker, darker A horizon than Pershing soils.

364B—Grundy silty clay loam, 2 to 5 percent slopes. This gently sloping soil is on ridgetops in the uplands. Areas vary greatly in size and shape. Included in pres

firm; discontinuous very dark gray (10YR 3/1) coatings on some peds; thick continuous clay films; few fine dark bodies; medium acid; gradual

thick. The subsoil is black, very dark gray, and dark grayish brown silty clay and silty clay loam. It extends to a depth of 5 feet or more.

Humeston soils have moderately slow permeability in the upper part and very slow permeability in the lower part. Available water capacity is high. The subsoil is medium to low in available phosphorus and very low in available potassium. Unless limed, the surface layer is slightly acid.

The Humeston soils are used primarily for cultivated crops. The major limitation is wetness. The Humeston soils are seasonally wet because the water table is high or the soils are flooded. Drainage and protection from flooding are needed.

Representative profile of Humeston silty clay loam, 0 to 2 percent slopes, 2,190 feet south and 1,970 feet west of the northeast corner of sec. 30, T. 71 N., R. 31 W. on nearly level alluvium:

A11—0 to 8 inches; black (10YR 2/1) light silty clay loam; moderate fine subangular [illegible] fair; slightly acid;

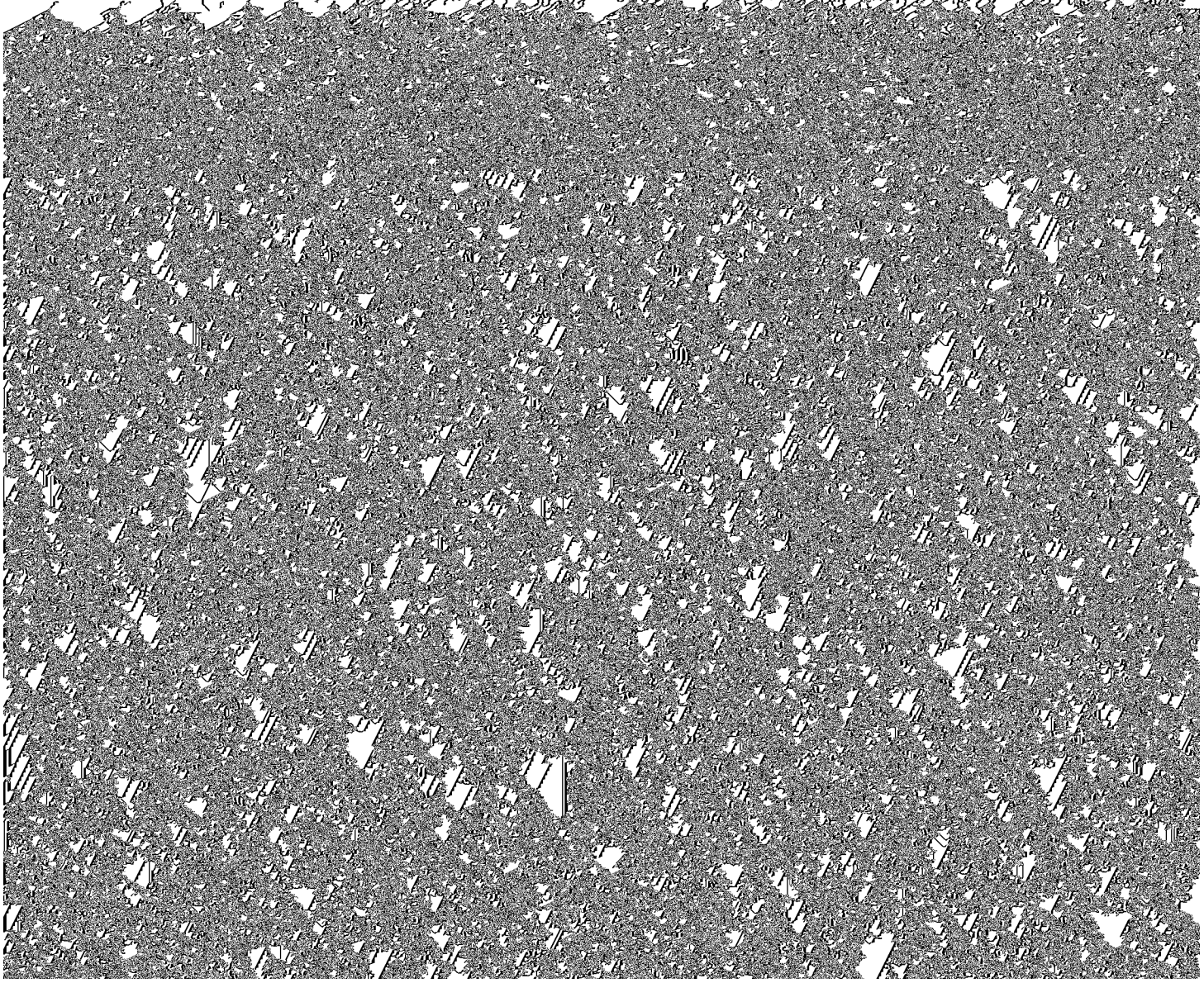
The A1 horizon ranges from black (10YR 2/1) to very dark grayish brown (10YR 3/1). Texture is dominantly light silty clay loam but ranges to include heavy silt loam.

The A2 horizon ranges from dark gray (10YR 4/1) to gray (10YR 5/1).

The B2t horizon ranges from black (N 2/0) to very dark gray (10YR 3/1). The texture ranges from heavy silty clay loam to silty clay.

Humeston soils are associated on the landscape with Colo, Nodaway, and Wabash soils. They formed in parent material similar to that of Vesser soils. Humeston soils have a dark gray silt loam A2 horizon that is lacking in Colo, Nodaway, and Wabash soils. They have a thinner A2 horizon and a more clayey B horizon than Vesser soils.

269—Humeston silty clay loam, 0 to 2 percent slopes. This nearly level soil is on low bottom land benches and alluvial areas in larger drainageways. Areas are generally 5 to 20 acres in size and vary in shape. Included in mapping are small areas of Colo and Wabash



angular blocky structure; friable; slightly acid; clear smooth boundary.

A13—15 to 22 inches; mixed very dark brown (10YR 2/2) and very dark grayish brown (10YR 3/2) light silty clay loam; very dark grayish brown (10YR 3/2) kneaded; grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—22 to 28 inches; mixed very dark grayish brown (10YR 3/2) and dark brown (10YR 3/3) silty clay loam; dark brown (10YR 3/3) kneaded; brown (10YR 5/3) dry; weak fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B2—28 to 35 inches; dark brown (10YR 3/3) silty clay loam; dark yellowish brown (10YR 4/4) kneaded; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate medium subangular blocky structure; friable; very few thin clay coats; few fine dark bodies; slightly acid; gradual smooth boundary.

B3—35 to 46 inches; brown (10YR 4/3) silty clay loam; dark yellowish brown (10YR 4/4) kneaded; few fine faint grayish brown (10YR 5/2) and few fine distinct yellowish brown (10YR 5/6) mottles; weak coarse and medium subangular

This soil is well suited to row crops. Most areas are used for row crops. Some are used for pasture and hay. The soil is susceptible to erosion. The organic-matter content is 4 to 6 percent. Capability unit IIe–2.

Kennebec Series

The Kennebec series consists of moderately well drained soils. These nearly level soils are on bottom land. The Kennebec soils formed in alluvium under vegetation of tall prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black to very dark gray silt loam about 30 inches thick. The substratum is very dark gray silt loam with few dark brown mottles.

The Kennebec soils have moderate permeability and a high available water capacity. The subsoil is low in available phosphorus and is very low to low in available potassium. Unless limed, the surface layer is generally slightly acid.

The Kennebec soils are used primarily for cultivated crops. The major hazard for crops is occasional flooding.

Representative profile of Kennebec silt loam, 0 to 2 percent slopes, 610 feet west and 2,500 feet south of the northeast corner of sec. 24, T. 73 N., R. 29 W. in a pasture on the bottom land of the Thompson branch of the Grand River:

A11—0 to 2 inches; very dark gray (10YR 3/1)

Colo and Nodaway soils. They are less clayey than Colo soils. In contrast with Nodaway soils, they are not stratified.

212—Kennebec silt loam, 0 to 2 percent slopes. This nearly level soil is on bottom land in the stream valleys. Areas vary widely in size, and some are as large as 60 inches or more. Included in mapping are small areas of Colo and Nodaway soils.

This Kennebec soil is well suited to row crops. It is subject to common flooding. The organic-matter content is 4 to 6 percent. Capability unit I–2.

Keswick Series

The Keswick series consists of moderately well drained soils. These moderately sloping soils are on upper side slopes and narrow ridges of the uplands. They formed in highly weathered glacial till under native vegetation of trees. Slopes are 5 to 9 percent.

In a representative profile the surface layer is very dark gray friable loam about 3 inches thick. The subsurface layer is grayish brown to brown friable loam about 8 inches thick. The subsoil extends to a depth of 64 inches. It is brown, firm clay loam in the upper part; brown, strong brown, grayish brown, and reddish brown, very firm clay in the next part; and mottled yellowish brown, grayish brown, and brown, firm clay loam in the lower part.

Keswick soils have slow permeability and a moderate available water capacity. The subsoil is very low in available phosphorus and available potassium. Unless limed, the surface layer is slightly acid.

The Keswick soils are used primarily for timber and pasture. The major limitations are low fertility and the clay subsoil.

Representative profile of Keswick loam, 5 to 9 percent slopes, 660 feet north and 3,240 feet west of the southeast corner of sec. 12, T. 71 N., R. 28 W. on an east-facing ridgetop of 7 percent:

[illegible] (10YR 2/1)

IIB23t—24 to 29 inches; mottled brown (7.5YR 5/4) and reddish brown (5YR 4/4) clay; medium subangular blocky structure; very firm; thin continuous clay films on some peds; very strongly acid; clear smooth boundary.

IIB24t—29 to 35 inches; mottled strong brown (7.5YR 5/6), grayish brown (10YR 5/2), and yellowish brown (10YR 5/4) clay; medium prismatic structure parting to weak fine subangular blocky; very firm; few soft dark bodies; few thin discontinuous clay films on peds and old root channels; strongly acid; clear smooth boundary.

IIB31—35 to 45 inches; mottled yellowish brown (10YR 5/6), grayish brown (10YR 5/2), and brown (7.5YR 4/2) clay loam; medium prismatic structure parting to weak medium subangular blocky; very firm; few soft dark bodies; few thin discontinuous clay films in some old root channels; slightly acid; gradual smooth boundary.

IIB32—45 to 64 inches; yellowish brown (10YR 5/6) clay loam; brown (10YR 5/3) coatings on peds; weak medium prismatic structure parting to medium angular blocky; firm; few thin discontinuous clay films in root channels; some dark coatings on prism and cleavage faces; neutral.

The A1 horizon ranges from very dark brown (10YR 2/2), and very dark gray (10YR 3/1) to very dark grayish brown (10YR 3/2). Texture is typically loam but ranges to include silt loam.

The A2 horizon ranges from grayish brown (10YR 5/2) to yellowish brown (10YR 5/4). Texture ranges from loam to silt loam.

Keswick soils are associated on the landscape with

entiated glacial till. If large enough to affect management, these areas are identified by spot symbols on the soil map.

This Ladoga soil is suited to cultivated crops if erosion is controlled. Erosion is a hazard. Capability unit IIIe–2.

76C2—Ladoga silt loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil is on high, convex ridgetops and in narrow bands downslope from the gently sloping Ladoga soils. The slopes are dominantly complex because side slope drainageways run into this soil. This soil has a profile similar to the one described as representative of the series, but it has a 7-inch plow layer. Erosion has removed part of the surface and subsurface layers. In places plowing has mixed what is left of these layers with material from the subsoil. The present plow layer is generally very dark grayish brown silt loam but ranges to light silty clay loam. It contains 1 to 3 percent organic matter. The subsurface layer has been lost in most places.

Included with this soil in mapping are very small areas of less sloping Ladoga soils and areas of adjacent Gara soils.

This soil is suited to crops. Most of the acreage is cultivated. Some areas are managed with adjacent pasture. The thin surface layer and moderate slopes slow the water absorption rate and increase runoff. Sheet erosion is the major management problem. The rapid runoff forms small gullies in areas where heads of drainageways extend into this soil. Tilth is poor in a few areas and the plow layer becomes cloddy if the extend into the bottom land. The loess on benches differs from that on uplands. It is underlain at a depth of 6 to 8 feet by sandy alluvial sediments. Areas are generally small.

This Ladoga soil is suited to cultivated crops if erosion is controlled. Erosion is a hazard. Management is difficult because of the short, irregular slopes. The soil has low potential for landfill and sewage lagoon sites because of the danger of ground water pollution. The organic-matter content is 2 to 4 percent. Capability unit IIIe–2.

Lamoni Series

The Lamoni series consists of somewhat poorly drained soils. These moderately sloping and strongly sloping soils are on side slopes. The Lamoni soils formed in weathered glacial till under native vegetation of prairie grasses. Slopes are 5 to 14 percent.

In a representative profile the surface layer is black and very dark grayish brown, friable silty clay loam about 12 inches thick. The subsoil extends to a depth of 52 inches. It is brown and dark grayish brown to grayish brown, firm clay in the upper part; grayish brown, very firm clay in the next part; and light gray, yellowish brown and light brownish gray, very firm clay loam in the lower part. The substratum is mottled strong brown and light gray, firm medium clay loam.

Lamoni soils have slow to very slow permeability and a high available water capacity. The subsoil is low in available phosphorus and low to medium in avail-

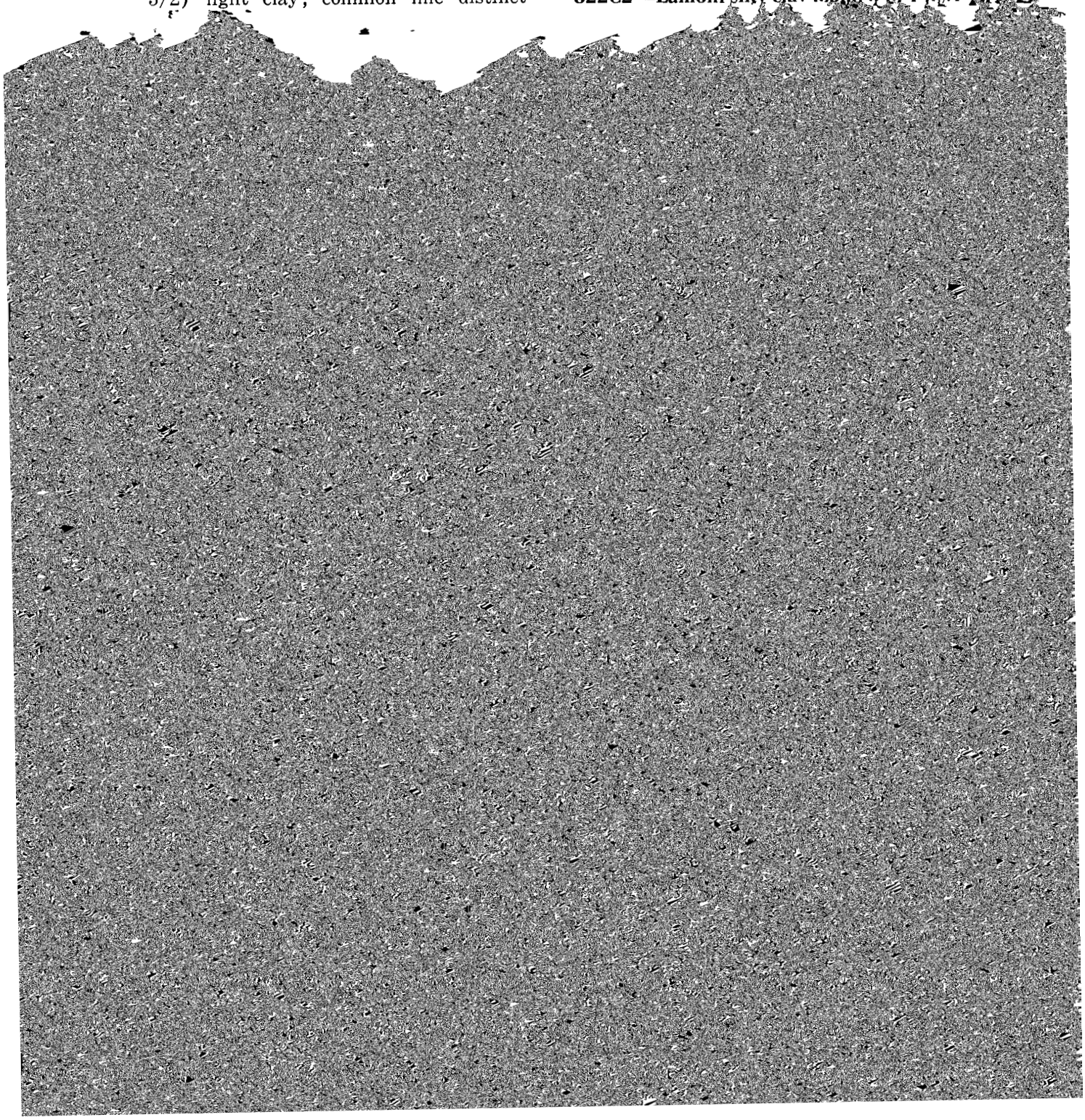
5/2) clay; common fine distinct yellowish brown (10YR 5/6) and few fine distinct strong brown (7.5YR 5/6) mottles; strong fine and medium subangular blocky structure; very firm; thick continuous clay films; medium acid; gradual smooth boundary.

IIB23t—25 to 31 inches; grayish brown (10YR 5/2) light clay; common fine distinct

tative profile because it has been mixed with the clay subsoil.

This Lamoni soil is suited to occasional row crops if erosion is controlled, but it is better suited to hay and pasture. Erosion is a hazard. Wetness is a problem in some areas because the soil is slowly permeable. The organic-matter content is 2 to 4 percent. Capability unit IIIe–4.

822C2—Lamoni silty clay loam, 5 to 9 percent slopes



mostly 15 percent or steeper. The strongly sloping soils are on ridges, and the moderately steep to steep soils are on side slopes. Areas are large and occur mostly in the steeper, more densely timbered areas. The present vegetation is dominantly oak timber.

The surface layer is very dark grayish brown, fri-

planes; firm; calcareous; calcium carbonate concretions; mildly alkaline.

The A1 horizon ranges from very dark gray (10YR 3/1) to dark grayish brown (10YR 4/2). Texture of the A1 horizon is typically loam but ranges to include light clay loam.

than in the uncleared areas because of the tree cover. The organic-matter content is less than 1 percent.

Pastured areas of this soil generally are not productive. The soil is best suited to woodland and wildlife habitat. Tree growth is slow. Some areas in pasture would be more productive if they were renovated. Operating farm machinery is hazardous because of the steep slopes, gullies, and generally rough terrain. Capability unit VIIe–1.

Lineville Series

The Lineville series consists of soils that are moderately well drained in the upper part and somewhat poorly drained in the lower part. These moderately sloping soils are on narrow ridgetops. Lineville soils formed in loess over pedisediment, which overlies a highly weathered glacial till, under native vegetation of prairie grasses and trees. Slopes are 5 to 9 percent.

ings; moderate fine subangular blocky structure; friable; many sand grains; few dark bodies; strongly acid; clear smooth boundary.

IIB22t—23 to 28 inches; brown (10YR 4/3) light clay loam; common medium faint dark yellowish brown (10YR 4/4), yellowish brown (10YR 5/6), and grayish brown (10YR 5/2) mottles; many light gray (10YR 7/2) silt coatings; moderate medium subangular blocky structure; friable; hard when dry; few discontinuous clay films; many dark bodies; medium acid; gradual smooth boundary.

IIB23t—28 to 36 inches; mottled grayish brown (10YR 5/2), yellowish brown (10YR 5/6), and dark yellowish brown (10YR 4/4) light clay loam; light gray (10YR 7/2)

The IIIB horizon ranges from brown (7.5YR 4/4) to strong brown (7.5YR 5/6). Texture ranges from heavy clay loam to clay.

Lineville soils are associated on the landscape with Armstrong and Pershing soils. They have less sand in the A horizon then Armstrong soils and have more sand in the B horizon than Pershing soils.

452C—Lineville silt loam, 5 to 9 percent slopes. This moderately sloping soil is on narrow ridgetops.

Included with this soil in mapping are some small areas of Armstrong, Ladoga, Pershing, Weller, Adair, and Clarinda soils. Also included are small, severely eroded areas that are identified by spot symbols on the soil map.

This Lineville soil is suited to crops, but it is severely limited by low fertility and the clayey subsoil. It produces average hay and pasture. It is not too sloping for tillage, but erosion is a hazard. The organic-matter content is 1 to 2 percent. Capability unit IIIe–5.

Macksburg Series

The Macksburg series consists of somewhat poorly drained soils. These nearly level and gently sloping soils are on divides and wide ridges in the uplands. The Macksburg soils formed in loess under native vegetation of prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is black to very dark grayish brown silty clay loam about 22 inches thick. The subsoil extends to a depth of 55 inches. It is dark grayish brown silty clay loam in the upper part and grayish brown silty clay loam in the lower part. The substratum is grayish brown silty clay loam with strong brown and yellowish brown mottles.

Macksburg soils have moderately slow permeability and a high available water capacity. The subsoil is low in available phosphorus and is medium in available potassium. Unless limed, the surface layer is generally slightly acid.

The Macksburg soils are used primarily for cultivated crops. The hazard of erosion is slight on the gently sloping soils.

Representative profile of Macksburg silty clay loam, 0 to 2 percent slopes, 770 feet east and 2,400 feet south of the northwest corner of sec. 27, T. 72 N., R. 30 W. southeast of buildings in an alfalfa field:

brown (10YR 3/2) coatings on peds; moderate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—28 to 37 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; weak medium prismatic structure parting to moderate fine subangular blocky; firm; few to common fine distinct yellowish brown (10YR 5/4) mottles; few fine black (10YR 2/1) bodies; thin discontinuous clay films; medium acid; gradual smooth boundary.

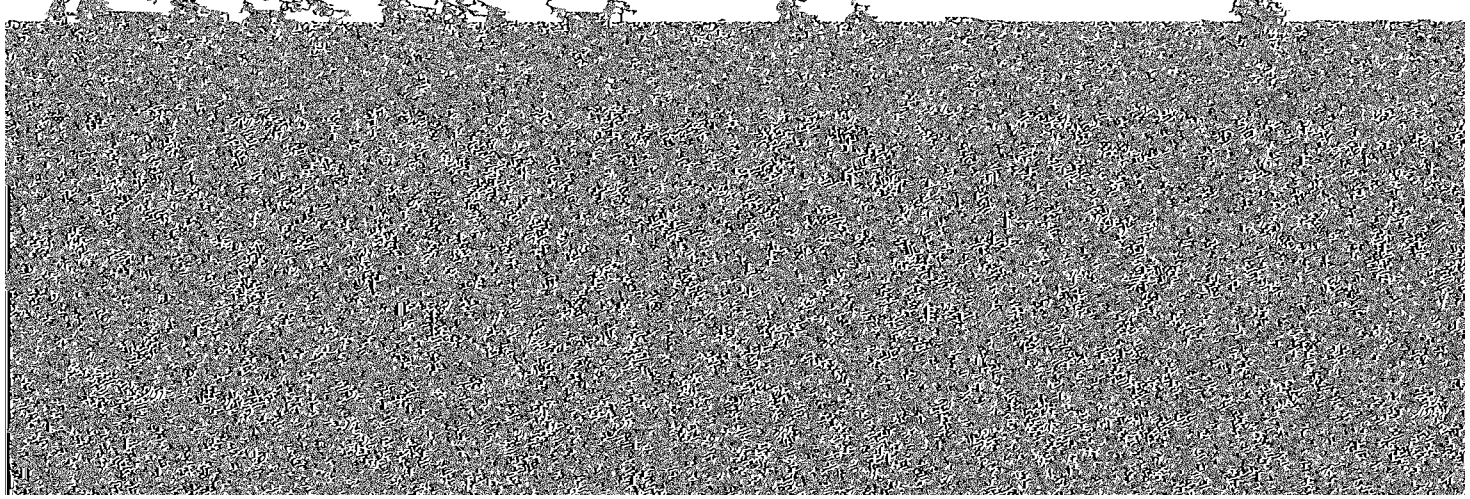
B22t—37 to 43 inches; grayish brown (2.5Y 5/2) heavy silty clay loam; weak medium prismatic structure parting to moderate medium subangular blocky; firm; common fine faint brown (10YR 4/3) and yellowish brown (10YR 5/4) mottles; common fine black (10YR 2/1) bodies; thin discontinuous clay films; slightly acid; gradual smooth boundary.

B3t—43 to 55 inches; grayish brown (2.5Y 5/2) silty clay loam; weak coarse prismatic structure parting to weak medium and coarse subangular blocky; friable; many fine faint yellowish brown (10YR 5/4 and 5/6) mottles; very thin discontinuous clay films; slightly acid; gradual smooth boundary.

C—55 to 67 inches; grayish brown (2.5Y 5/2) silty clay loam; massive; friable; many fine distinct strong brown (7.5YR 5/6) and common fine distinct yellowish brown (10YR 5/6) mottles; many fine soft bodies; slightly acid.

The Ap or A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The A horizon ranges from neutral to medium acid. The B horizon is 24 to 48 inches thick.

Macksburg soils formed in parent material similar to that of Winterset and Sharpsburg soils. Macksburg soils have more clay in the B horizon than Sharpsburg soils and darker colors are deeper. In contrast with Winterset soils, they have less clay in the B horizon. They have two chroma colors in the upper B horizon;



Erosion is a slight hazard because of the gentle slopes. The organic-matter content is 4 to 6 percent. Capabil-

B23t—27 to 33 inches; brown (7.5YR 4/4) light

percent Caleb soil. Included in mapping are small areas of Ladoga, Pershing, Armstrong, and Gara soils and small sandy areas.

If well managed, this map unit is suited to row crops. If used for row crops, it is susceptible to erosion. It is usually managed with other soils as cropland or pasture. Gullies form readily in some waterways. The organic-matter content is 1 to 2 percent. Capability unit IVe–4.

Nira Series

The Nira series consists of moderately well drained soils. These moderately sloping soils are on upper side slopes and narrow ridgetops of the uplands. Nira soils formed in loess under native vegetation of prairie grasses. Slopes are 5 to 9 percent.

In a representative profile the surface layer is black and very dark gray silty clay loam about 13 inches thick. The subsoil extends to a depth of 44 inches. It is brown silty clay loam in the upper part and grayish brown silty clay loam in the lower part. The substratum is grayish brown silty clay loam mottled with brown.

Nira soils have moderately slow permeability and a high available water capacity. The subsoil is very low in available phosphorus and available potassium. Unless limed, the surface layer is generally slightly acid.

The Nira soils are used primarily for crops. The major hazard is erosion. Erosion control is needed.

Representative profile of Nira silty clay loam in an area of Nira-Sharpsburg silty clay loams, 5 to 9 percent slopes, about 2,140 feet west, 1,490 feet south of northeast corner of sec. 23, T. 73 N., R. 31 W. just west of the park road:

A1—0 to 8 inches; black (10YR 2/1) silty clay loam; moderate fine and very fine subangular blocky structure parting to weak fine subangular blocky; friable; slightly acid; clear smooth boundary.

A3—8 to 13 inches; very dark gray (10YR 3/1) silty clay loam; weak fine and very fine subangular blocky structure; friable; few brown (10YR 4/3) peds in lower [illegible] medium acid; clear [illegible] bodies; thin discontinuous clay films; medium acid; gradual smooth boundary.

B3t—30 to 44 inches; grayish brown (2.5Y 5/2) silty clay loam; weak medium prismatic to moderate coarse subangular blocky structure; friable; common medium distinct brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; few dark bodies; thin discontinuous clay films; medium acid; gradual smooth boundary.

C—44 to 60 inches; grayish brown (2.5Y 5/2) silty clay loam; massive; friable; common medium distinct brown (7.5YR 4/4) mottles; medium acid.

The A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The A horizon ranges from neutral to medium acid.

Eroded units of Nira-Sharpsburg silty clay loams are outside the range defined for their respective series because they lack a mollic epipedon.

Nira soils formed in parent material similar to that of Sharpsburg and Clearfield soils. They have grayer colors in the lower part of the B horizon than Sharpsburg soils. The lower part of the solum formed in gray loess instead of the gray paleosol typical of Clearfield soils.

371C—Nira-Sharpsburg silty clay loams, 5 to 9 percent slopes. This moderately sloping map unit is on short, convex to straight side slopes surrounding the nearly level, stable upland divides. It is 60 percent Nira soil and 35 percent Sharpsburg soil. Areas are large in size and irregular in shape. The Nira soil has the profile described as representative of the series. The plow layer is 3 to 4 percent organic matter.

Included with this unit in mapping are small areas of Clearfield soils. Also included are some areas of gray clay, glacial till, reddish clay, sandy areas, and wet spots. These areas are identified by spot symbols on the soil map.

This unit is well suited to crops. It is susceptible to erosion. Erosion control is needed. Capability unit IIIe–2.

371C2—Nira-Sharpsburg silty clay loams, 5 to 9 percent slopes, moderately eroded. This moderately sloping map unit is on short, convex to straight side slopes

Nodaway Series

The Nodaway series consists of stratified and moderately well drained soils. These nearly level soils are on first bottoms along rivers and streams. Nodaway soils formed in silty alluvium under a native vegetation of prairie grasses and trees. Slopes are 0 to 2 percent.

In a representative profile the soil is stratified very dark gray and grayish brown silt loam about 80 inches thick. It has medium platy structure and some coarse sand strata below a depth of 70 inches.

Nodaway soils have moderate permeability and a high available water capacity. The subsoil is medium in available phosphorus and available potassium. Unless limed, the surface layer is slightly acid to neutral.

The Nodaway soils are used primarily for row crops. The major limitation is wetness from stream overflow.

Representative profile of Nodaway silt loam, 0 to 2 percent slopes, 2,450 feet north and 30 feet west of the southeast corner of sec. 24, T. 73 N., R. 29 W. on nearly level bottom land:

C—0 to 80 inches; stratified very dark gray (10YR 3/1) and grayish brown (10YR 5/2) silt loam; light gray (10YR 7/1) when dry; few fine distinct brown (7.5YR 4/4) mottles that increase with depth; medium platy structure; friable; common thin light brownish gray (10YR 6/2) and pale brown (10YR 6/3)

This Nodaway soil is usually in pasture or is left idle. It is susceptible to flooding. The organic-matter content is less than 1 percent. Capability unit Vw–1.

13B—Nodaway-Vesser silt loams, 2 to 5 percent slopes. This map unit is in narrow upland drainageways. It is 60 percent Nodaway soil and 30 percent Vesser soil. Areas are long and narrow.

Along narrow drainageways, the Nodaway soil is adjacent to the streams and the Vesser soil is at the base of the upland slopes. Some areas are dissected by gullies and cannot be crossed by machinery. This map unit commonly occurs in areas where the side slope soils formed under trees.

Most areas are managed along with the adjacent soils as pasture, woodland, or row crops. They can be used for intensive rowcropping if runoff from steeper soils is controlled and drainage is provided. The organic-matter content is less than 1 percent to 4 percent. Capability unit IIw–3.

Olmitz Series

The soils of the Olmitz series formed in loamy alluvial material washed off the adjacent slopes. These moderately well drained to well drained, gently sloping soils are on narrow foot slopes of 2 to 5 percent, below the steeper glacial till soils upslope and above the more level alluvial soils. They also occur on alluvial fan positions at the mouth of drainageways. The

light clay loam; very dark grayish brown (10YR 3/2) when kneaded; moderate very fine and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A3—24 to 33 inches; very dark grayish brown (10YR 3/2) light clay loam; very dark grayish brown (10YR 3/2) when kneaded; moderate fine and medium subangular blocky structure; friable; concentration of small pebbles at a depth of 27 inches; neutral; gradual smooth boundary.

B1—33 to 46 inches; dark brown (10YR 3/3) light clay loam that is the same color when kneaded; moderate coarse prismatic structure parting to weak fine subangular blocky; friable; very dark grayish brown (10YR 3/2) coats on peds; few pebbles; neutral; gradual smooth boundary.

B2—46 to 52 inches; dark brown (10YR 3/3) light clay loam; brown (10YR 4/3) [illegible] when kneaded; moderate coarse prisma-

Pershing Series

The Pershing series consists of moderately well drained to somewhat poorly drained soils. These gently to strongly sloping soils are on narrow ridgetops and convex side slopes of the uplands. They formed in loess under native vegetation of prairie grasses and trees. Slopes are 2 to 14 percent.

In a representative profile the surface layer is very dark grayish brown silt loam about 7 inches thick. The subsurface layer is dark grayish brown silt loam 3 inches thick. The subsoil extends to a depth of 48 inches. It is brown silty clay loam in the upper part, mottled yellowish brown and grayish brown silty clay in the next part, and mottled yellowish brown and grayish brown silty clay loam in the lower part. The substratum is grayish brown silt loam with yellowish brown mottles.

The Pershing soils have slow permeability and a high available water capacity. The subsoil is high in available phosphorus and very low in available potassium. Unless limed, the surface layer is generally neutral or slightly acid.

The Pershing soils are used primarily for cultivated

B23t—29 to 34 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay; weak fine prismatic structure parting to strong fine subangular blocky; firm; some dark gray (10YR 4/1) coatings on peds; few discontinuous clay films; common dark bodies; slightly acid; gradual smooth boundary.

B31t—34 to 41 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay loam; weak fine prismatic structure parting to strong fine subangular blocky; firm; some dark gray (10YR 4/1) coatings on peds; few discontinuous clay films; common dark bodies; slightly acid; gradual smooth boundary.

B32t—41 to 48 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) silty clay loam; weak fine prismatic structure; friable; thin discontinuous clay films on vertical cleavage faces; few dark bodies; slightly acid; gradual smooth boundary.

C—48 to 61 inches; grayish brown (2.5Y 5/2) silt loam; massive; friable; common fine distinct yellowish brown (10YR 5/6) mottles; few fine dark bodies; slightly acid.

The Ap horizon ranges from very dark gray (10YR

other soils are identified by spot symbols on the soil map.

This Pershing soil is suited to cultivated crops and pasture. Because the soil areas are small, this soil is generally managed with other adjacent soils. It is susceptible to erosion. The organic-matter content is 1 to 2 percent. Capability unit IIIe–3.

131D—Pershing silt loam, 9 to 14 percent slopes. This strongly sloping soil is on side slopes of the uplands. It occurs as wide and irregularly shaped areas. Included in mapping are small areas of Gara soils.

This soil is better suited to pasture or hay crops than to row crops because of its strong slopes. It is susceptible to erosion. Erosion control is needed. The organic-matter content is 2 to 4 percent. Capability unit IVe–1.

T131B—Pershing silt loam, benches, 2 to 5 percent slopes. This gently sloping soil is on high, loess-covered terraces along some of the major streams in the county. Areas vary in size and shape. The profile of this soil is similar to the one described as representative of the series, but the underlying material is more variable.

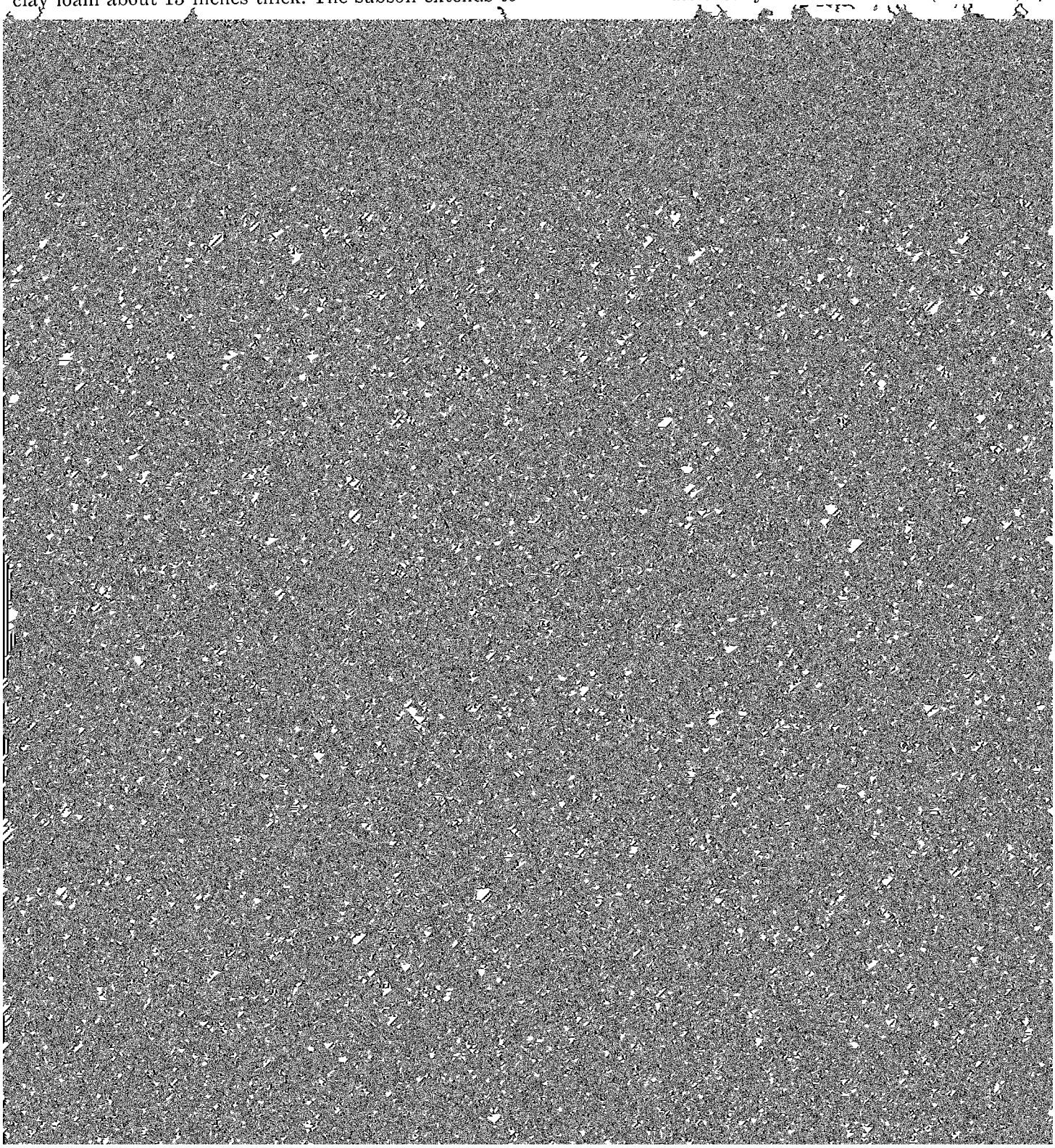
The surface layer is very dark gray and is 6 to 10 inches thick. The silty clay subsoil is somewhat less mottled than in Pershing soils of the uplands. The underlying material, at a depth of 6 to 10 feet, is commonly stratified, dominantly sandy alluvial sediments. Some of the loess parent material may have come from adjacent stream valleys. Included in mapping are a few small areas of Weller soils.

soils are on divides and side slopes of the uplands. They formed in loess under native vegetation of prairie grasses. Slopes are 2 to 14 percent.

In a representative profile the surface layer is black, very dark brown, and very dark grayish brown silty clay loam about 13 inches thick. The subsoil extends to

tinuous clay films; common dark bodies; slightly acid; gradual smooth boundary.

B3t—40 to 50 inches; grayish brown (2.5Y 5/2) silty clay loam; massive, with some vertical cleavage; friable; common medium distinct yellowish brown (10YR 5/6)



This soil is suited to row crops if erosion is controlled. It is generally managed with other soils. Erosion is a moderate hazard. Capability unit IIIe–2.

370C2—Sharpsburg silty clay loam, 5 to 9 percent slopes, moderately eroded. This moderately sloping soil occupies narrow divides and upper side slopes of broad upland divides. In most areas it is downslope from the Adair and Clarinda soils and the Adair-Shelby complex. This soil is adjacent to the Ladoga soil in areas where ridgetops extend toward major streams. Its profile is similar to the one described as representative of the Sharpsburg series, but the surface layer is very dark grayish brown silty clay loam, is 6 inches thick, and is 2 to 3 percent organic matter. Erosion has removed part of the original surface layer, and plowing has mixed what is left with material from the subsoil. The plow layer rests directly on the firm subsoil.

Included with this soil in mapping are small areas of Nira soils and some small slightly or severely eroded areas. Significant areas of glacial till, gray clay, reddish clay, or sand are identified by spot symbols on the soil map.

This soil is suited to row crops if erosion is controlled. It tends to be cloddy when tilled. Because of poorer physical condition, it is more erodible than the uneroded soil. Fertility is more limiting. Seedbed preparation is more difficult, and a higher level of management is required. The main hazard is erosion from runoff. Capability unit IIIe–2.

370D—Sharpsburg silty clay loam, 9 to 14 percent slopes. This strongly sloping soil is on the upper part of side slopes below narrow divides and forms part of the valley slopes.

Included with this soil in mapping are some small areas of Ladoga and Nira soils. Significant areas of glacial till, gray clay, and sand are identified by spot symbols on the soil map.

This Sharpsburg soil is suited to row crops if well managed. It is susceptible to erosion. Erosion control is needed in cultivated areas. The organic-matter content is 2 to 4 percent. Capability unit IIIe–2.

Shelby Series

The Shelby series consists of well drained to moderately well drained soils. These soils are moderately sloping on ridgetops and strongly sloping to steep on slopes of the uplands. The Shelby soils formed in glacial till under native vegetation of prairie grasses. Slopes are 5 to 25 percent.

In a representative profile the surface layer is black to very dark grayish brown light clay loam about 15 inches thick. The subsoil extends to a depth of 38 inches. It is dark brown, medium clay loam in the upper part; dark yellowish brown, medium to heavy clay loam in the next part; and brown light clay loam in the lower part. The substratum is mottled grayish brown and dark yellowish brown clay loam and is mildly alkaline.

Shelby soils have moderately slow permeability and a high available water capacity. The subsoil is low in available phosphorus and high in available potassium. Unless limed, the surface layer is generally medium acid.

The Shelby soils are used primarily for row crops and pasture. The major limitation is erosion.

Representative profile of Shelby clay loam, 9 to 14 percent slopes, 1,110 feet north and 80 feet east of the southwest corner of sec. 10, T. 72 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) light clay loam; very fine subangular blocky and fine granular structure; friable; medium acid; clear smooth boundary.

A3—8 to 15 inches; very dark grayish brown (10YR 3/2) and some very dark brown (10YR 2/2) light clay loam; very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21t—15 to 22 inches; dark brown (10YR 4/3) medium clay loam; very dark grayish brown (10YR 3/2) coating on peds; few fine distinct very dark gray (10YR 3/1) mottles; very fine and fine subangular blocky structure; friable; thin discontinuous clay films; medium acid; clear smooth boundary.

B22t—22 to 31 inches; dark yellowish brown (10YR 4/4) medium to heavy clay loam; few medium faint dark grayish brown (10YR 4/2) mottles; very dark gray (10YR 3/1) flows along root channels; strong fine subangular blocky structure; firm; few thin continuous clay films; few fine pebbles; slightly acid; clear smooth boundary.

B3t—31 to 38 inches; brown (10YR 4/3) light clay loam; very dark gray (10YR 3/1) along root channels; common fine distinct strong brown (7.5YR 5/6 and 5/8) and few fine faint grayish brown (10YR 5/2) mottles; weak medium and coarse subangular blocky structure; firm; few thin discontinuous clay films; neutral; abrupt smooth boundary.

C—38 to 65 inches; mottled grayish brown (2.5Y 5/2) and dark yellowish brown (10YR 4/4) heavy clay loam; few medium distinct strong brown (7.5YR 5/6 and 5/8) mottles; massive; some weak vertical cleavage; firm; thin discontinuous clay films decreasing with depth; few small stones and pebbles; common soft and hard carbonate nodules less than ¼-inch in diameter; mildly alkaline.

The Ap or A1 horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). Texture of the Ap horizon is typically light clay loam, but ranges to include loam.

The A3 horizon ranges from very dark grayish brown (10YR 3/2) to very dark brown (10YR 2/2) and from light clay loam to loam.

The B2t horizon ranges from dark brown (10YR 3/3) to dark yellowish brown (10YR 4/4).

Shelby soils are associated on the landscape with Sharpsburg and Lamoni soils. They formed in parent material similar to that of Gara and Lindley soils. They are more sandy than Sharpsburg soils and have less clay in the B2 horizon than Lamoni soils. They

have a thicker A1 horizon than Gara and Lindley soils.

24C—Shelby clay loam, 5 to 9 percent slopes. This moderately sloping soil is on low ridges and side slopes. It occurs as narrow and irregularly shaped areas that are 2 to 10 acres in size. The plow layer contains 3 to 4 percent organic matter.

Included with this soil in mapping are small areas of Adair and Lamoni soils and small areas of Shelby soils with a thinner surface layer.

This Shelby soil is suited to row crops and pasture [illegible] It is susceptible to erosion. Capability unit [illegible] the original surface layer, and plowing has mixed what is left with material from the subsoil. The present plow layer rests directly on the firm, dense subsoil. The subsoil is exposed in places at the shoulder of slopes or near drains in sidehills.

Included with this soil in mapping are small areas of Clarinda, Adair, and Lamoni soils. Many areas of Adair and Clarinda soils are identified by symbols on the soil map.

This Shelby soil is moderately suited to row crops and well suited to hay and pasture. Because of poorer physical condition, it is more erodible than the un-

The subsoil is exposed in places at the shoulder of slopes or near drains in sidehills.

Included with this soil in mapping are small areas of Adair, Clarinda, and less sloping Shelby soils. If they are of significant size, the Adair and Clarinda soils are identified by symbols on the soil map.

This Shelby soil is moderately suited to row crops and is well suited to hay and pasture crops. It becomes cloddy if tilled. Because of poorer physical condition, it is more erodible than the uneroded Shelby soil. Fertility is more limiting. Seedbed preparation is more difficult, and a higher level of management is required.

The main hazard is further erosion from runoff. Removing the topsoil causes severe problems because of the unfavorable subsoil properties. Most of the acreage is used for hay and pasture. Capability unit IVe–2.

24F2—Shelby clay loam, 18 to 25 percent slopes, moderately eroded. This steep soil is on side slopes. Areas are very irregular in size and shape. This soil has a profile similar to the one described as representative of the series, but the surface layer is very dark grayish brown clay loam, is about 6 inches thick, and is 1 to 3 percent organic matter. Erosion has removed part of the original surface layer, and plowing has mixed what is left with material from the subsoil. The plow layer rests directly on the firm, dense subsoil. The subsoil is exposed in places at the shoulder of slopes or near drains in the hillsides.

Included with this soil in mapping are small areas of Adair and Gara soils.

This Shelby soil is poorly suited to row crops. It is suited to hay and pasture. Most of the acreage is used for hay and pasture. The main hazard is further erosion. Because of poorer physical condition, this soil is more erodible than the uneroded Shelby soil. Removing the topsoil causes severe problems because of the unfavorable subsoil properties. Capability unit VIe–1.

Sperry Series

The Sperry series consists of very poorly drained soils. These soils are on broad, nearly level upland divides. The Sperry soils formed in loess under native vegetation of water-tolerant prairie grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silt loam about 11 inches thick. The subsurface layer is dark gray silt loam about 9 inches thick. The subsoil extends to a depth of 51 inches. It is dark gray silty clay in the upper part, grayish brown silty clay loam in the next part, and olive gray silty clay loam in the lower part. The substratum is mottled grayish brown and light brownish gray silty clay loam.

Sperry soils have very slow permeability and a high available water capacity. The subsoil is very low in available phosphorus and available potassium. Unless limed, the surface layer is slightly acid.

The Sperry soils are used primarily for crops. They are managed with the adjacent Winterset and Macksburg soils. The major limitation is wetness.

Representative profile of Sperry silt loam, 0 to 2 percent slopes, 1,790 feet east and 450 feet north of the southwest corner of sec. 31, T. 73 N., R. 30 W., on a level divide:

Ap—0 to 11 inches; black (10YR 2/1) silt loam; weak fine granular structure; friable; slightly acid; clear smooth boundary.

A2—11 to 20 inches; dark gray (10YR 4/1) silt loam; light gray (10YR 6/1) dry silt coats; weak fine subangular blocky structure parting to thin fine platy; friable; slightly acid; abrupt smooth boundary.

B21tg—20 to 28 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) coatings on peds, common fine distinct dark yellowish brown (10YR 4/4) mottles; strong fine subangular blocky structure; firm; continuous clay films; medium acid; clear smooth boundary.

B22tg—28 to 35 inches; dark gray (10YR 4/1) light silty clay; few very dark gray (10YR 3/1) coatings on peds, many fine and medium distinct yellowish brown (10YR 5/4 and 5/6) and dark yellowish brown (10YR 4/4) mottles; moderate fine and medium subangular blocky structure; firm; thick continuous clay films; slightly acid; gradual smooth boundary.

B23tg—35 to 43 inches; grayish brown (2.5Y 5/2) heavy silty clay loam; common fine distinct yellowish brown (10YR 5/6 and 5/8) and few distinct dark yellowish brown (10YR 4/4) and faint dark gray (10YR 4/1) mottles; moderate medium subangular blocky structure; firm; thin discontinuous very dark gray (10YR 3/1) clay films; few fine dark bodies; neutral; clear smooth boundary.

B3tg—43 to 51 inches; olive gray (5Y 5/2) medium silty clay loam; few distinct strong brown (7.5YR 5/6 and 5/8) mottles; weak medium prismatic structure parting to medium subangular blocky; friable; thin discontinuous very dark gray (10YR 3/1) clay films in root channels and on faces of peds; few fine dark bodies; neutral; gradual smooth boundary.

C1g—51 to 63 inches; mottled grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) silty clay loam; common fine distinct strong brown (7.5YR 5/6 and 5/8) mottles; massive parting to weak medium prismatic structure; friable; thin discontinuous clay films on vertical cleavage faces; dark organic-matter stains in root channels; neutral; gradual smooth boundary.

C2—63 to 72 inches; light brownish gray (2.5Y 6/2) silt loam; common fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; massive; friable; dark organic-matter stains in old root channels; neutral.

The Ap horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1).

Sperry soils are associated on the landscape with Winterset and Macksburg soils and formed in similar

parent material. They have an A2 horizon that those soils lack.

122—Sperry silt loam, 0 to 2 percent slopes. This nearly level to depressional soil is on broad upland divides. It occurs as small and irregularly shaped areas.

Included with this soil in mapping are very small areas of adjacent Winterset and Macksburg soils. Where associated with Haig soils, it has a higher clay content in the subsoil.

This Sperry soil is suited to row crops. It is generally farmed with adjacent Winterset and Macksburg soils. It is susceptible to wetness. The organic-matter content is 2 to 4 percent. Capability unit IIIw–2.

Vesser Series

The Vesser series consists of somewhat poorly drained to poorly drained soils. These soils are nearly level on bottom land and gently sloping on foot slopes. They formed in alluvium. The native vegetation was forest and prairie grasses. Slopes are 0 to 5 percent.

In a representative profile the surface layer is about 10 inches thick and consists of very dark gray friable silt loam. The subsurface layer is 15 inches thick and consists of dark gray friable silt loam. Mottling begins at a depth of 14 inches and continues through the subsoil. Mottles are predominantly reddish brown. The subsoil, which extends to a depth of about 70 inches, is dark gray, and very dark gray, dominantly firm silty clay loam.

Vesser soils have moderate permeability and a high available water capacity. The subsoil is medium in available phosphorus and low in available potassium. Unless limed, the surface layer is slightly acid.

Vesser soils are used primarily for cultivated crops and pasture. The major limitation is wetness.

Representative profile of Vesser silt loam, 0 to 2 percent slopes, 2,160 feet north and 150 feet east of the southwest corner of sec. 12, R. 71 N., R. 28 W. on nearly level bottom land:

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam; dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to weak fine granular; friable; slightly acid; abrupt smooth boundary.

A21—10 to 14 inches; dark gray (10YR 4/1) silt loam; light gray (10YR 7/1) dry silt coatings; weak fine subangular blocky structure; friable; medium acid; clear smooth boundary.

A22—14 to 25 inches; dark gray (10YR 4/1) silt loam; light gray (10YR 6/1 and 7/1) dry silt coatings; few fine distinct reddish brown (2.5YR 4/4) mottles; few thin black (10YR 2/1) coatings on peds; weak medium platy and weak medium subangular blocky structure; friable; strongly acid; gradual smooth boundary.

B21t—25 to 33 inches; mixed very dark gray (10YR 3/1) and dark gray (10YR 4/1) silty clay loam; few fine distinct reddish brown (2.5YR 4/4) mottles; gray (10YR 5/1) silt coatings; moderate to fine medium prismatic structure; firm; thin discontinuous black (10YR 2/1) clay films; strongly acid; gradual smooth boundary.

B22t—33 to 45 inches; dark gray (10YR 4/1) silty clay loam; few fine distinct reddish brown (2.5YR 4/4), brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium subangular blocky; common very dark gray (10YR 3/1) coatings on faces of peds; firm; medium acid; gradual smooth boundary.

B23t—45 to 70 inches; dark gray (10YR 4/1) silty clay loam; common fine faint brown (10YR 4/3), distinct dark yellowish brown (10YR 4/4) and distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to weak and moderate medium subangular blocky; firm; medium acid.

The Ap horizon ranges from black (10YR 2/1) to very dark gray (10YR 3/1). The Ap horizon is typically silt loam but ranges to include light silty clay loam.

The A2 horizon ranges from dark gray (10YR 4/1) to very dark grayish brown (10YR 5/2) and is 12 to 20 inches thick.

The B2t horizon ranges from very dark gray (10YR 3/1) to very dark grayish brown (10YR 5/2).

Vesser soils are associated on the landscape with Nodaway, Colo, and Olmitz soils. Vesser soils have a thick, gray A2 horizon that Nodaway, Colo, and Olmitz soils lack. Vesser soils generally contain less clay in the subsoil than Humeston soils.

51—Vesser silt loam, 0 to 2 percent slopes. This nearly level soil is on low second bottoms. It has the profile described as representative of the series. Some areas, however, have slightly more clay in the subsoil and are less permeable and more poorly drained than this soil.

Included with this soil in mapping are small areas of adjacent and associated alluvial soils. Also included are small areas of Humeston soils.

Wetness is the only limitation. The soil is suited to crops if adequately drained. Most areas are in crops and are managed with adjacent soils. In low level areas, water stands for moderately long periods. It overflows only when floodwaters are very high. Tilth is generally good, except where water stands. The soil can be row cropped often if it is tilled and surface drained. The organic-matter content is 2 to 4 percent. Capability unit IIw–1.

Wabash Series

The Wabash series consists of very poorly drained soils. These nearly level soils are on stream bottom land. They formed in alluvium under a native vegetation of water-tolerant grasses. Slopes are 0 to 2 percent.

In a representative profile the surface layer is black silty clay loam about 17 inches thick and black silty

clay to a depth of 40 inches. The subsoil, which extends to a depth of 50 inches, is very dark gray silty clay. The substratum is dark gray light silty clay that grades to gray in the lower part.

drained, it can be used for crops. It is susceptible to wetness, and artificial drainage is needed to remove excess water. The organic-matter content is 4 to 6 percent. Capability unit IIIw–3.

fine distinct brown (7.5Y 4/4) mottles; weak medium and fine subangular blocky structure; firm; light gray (10YR 7/1) silt coatings; common dark bodies; strongly acid; gradual smooth boundary.

B32t—41 to 48 inches; mottled yellowish brown (10YR 5/4) and light brownish gray (10YR 6/2) medium silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; firm; common dark bodies; medium acid; gradual smooth boundary.

B33—48 to 63 inches; mottled yellowish brown (10YR 5/4) and light brownish gray (10YR 6/2) light silty clay loam; few fine distinct brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; common dark bodies; medium acid.

The A1 horizon ranges from very dark gray (10YR 3/1) to grayish brown (10YR 4/2).

The B2t horizon ranges from dark yellowish brown (10YR 4/4) to yellowish brown (10YR 5/4). Because the Weller soils in Union County lack mottles with chroma of 2 or less within 10 inches below the top of the argillic horizon, they are outside the range defined for the series.

The Winterset soils are used primarily for row crops. The major limitation is wetness.

Representative profile of Winterset silty clay loam, 0 to 2 percent slopes, 100 feet north and 1,620 feet east of the southwest corner of sec. 31, T. 73 N., R. 30 W. on a level upland divide:

Ap—0 to 8 inches; black (10YR 2/1) light silty clay loam; weak medium subangular blocky structure; friable; slightly acid; clear smooth boundary.

A12—8 to 18 inches; black (10YR 2/1) silty clay loam; weak fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B21—18 to 26 inches; very dark gray (10YR 3/1) heavy silty clay loam; common fine faint dark grayish brown (10YR 4/2) and few fine distinct yellowish brown (10YR 5/6 and 5/8) mottles; moderate fine subangular blocky structure parting to very fine subangular blocky; friable to firm; slightly acid; clear smooth boundary.

B22tg—26 to 33 inches; dark grayish brown (10YR 4/2) heavy silty clay loam; few dark gray (10YR 4/1) coatings on peds; weak medium prismatic structure parting to moderate fine subangular blocky; [illegible]

Winterset soils are associated on the landscape with Macksburg and Sperry soils and formed in similar parent material. Winterset soils have more clay in the B2 horizon than Macksburg soils. In contrast with Sperry soils, they have a thicker dark A1 horizon and lack an A2 horizon.

369—Winterset silty clay loam, 0 to 2 percent slopes. This nearly level soil is on broad upland ridgetops. It occurs as broad and irregularly shaped areas.

Included with this soil in mapping are small areas of Macksburg and Sperry soils. Some small areas of Sperry soils are identified by spot symbols on the soil map.

This Winterset soil is well suited to row crops. It is susceptible to wetness. The organic-matter content is 4 to 6 percent. Capability unit IIw–2.

Use and Management of the Soils

The soil survey is a detailed inventory and evaluation of the most basic resource of the survey area—the soil. It is useful in adjusting land use, including urbanization, to the limitations and potentials of natural resources and environment. Also, it can help avoid soil-related failures in uses of the land.

While a soil survey is in progress, soil scientists, conservationists, engineers, and others keep extensive notes about the nature of the soils and [illegible] in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, and trees and shrubs are influenced by the nature of the soil.

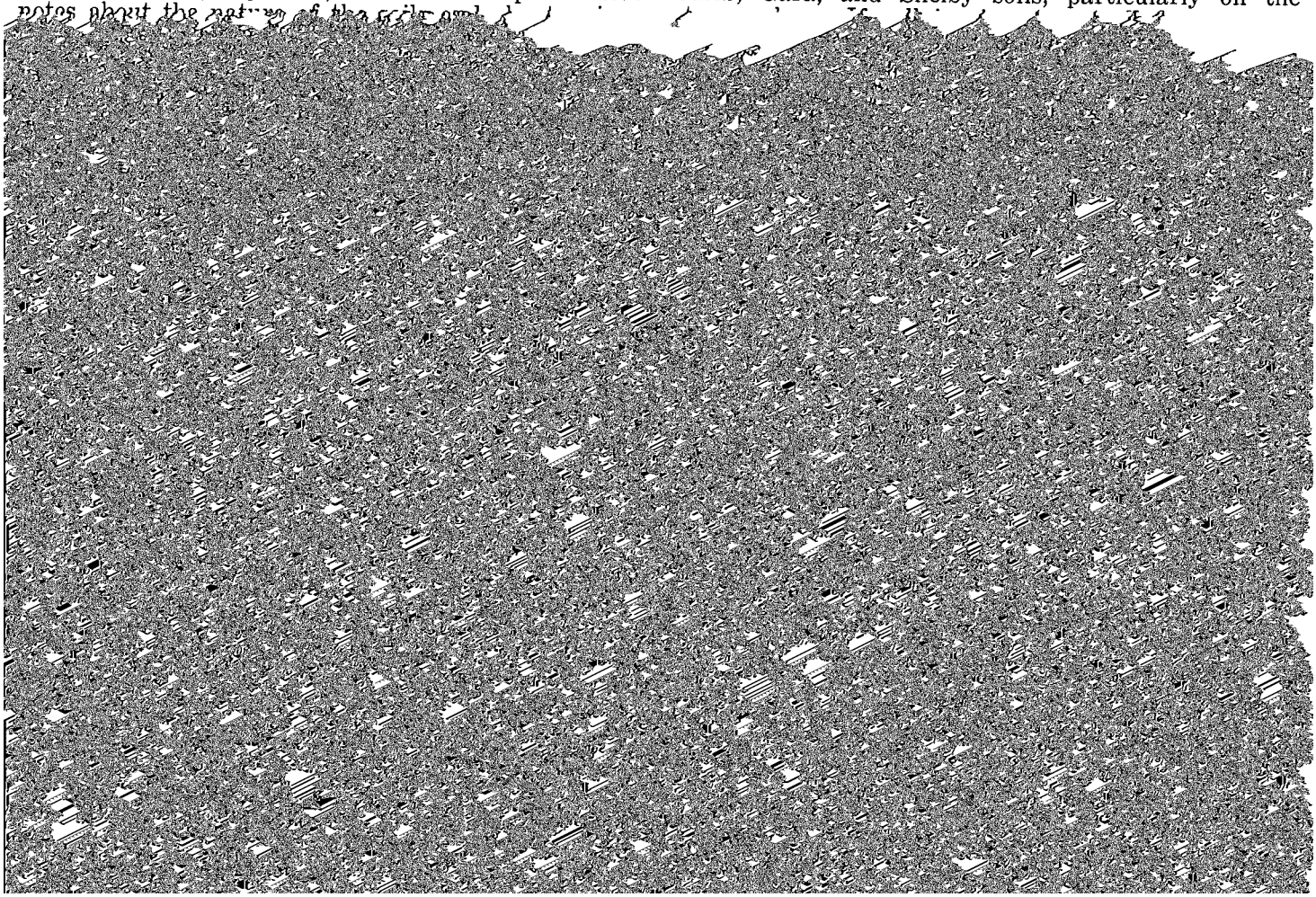
Crops and Pasture

About 110,269 acres in Union County is used for crops. About 115,000 acres is used for pasture. Much of the approximately 22,000 acres that is wooded is also used for pasture and is included in the pasture acreage.

Corn, soybeans, legumes, and legume-grass hay are the main crops. Oats and sorghums occupy a smaller acreage.

Many pastures in the county are in permanent bluegrass. Some have been renovated, and other pasture species have been introduced, for example, grasses and legumes, such as bromegrass, orchardgrass, birdsfoot trefoil, and other pasture plants.

Many soils in the county are subject to erosion. The erosion hazard is most severe on the Adair, Caleb, Gara, Grundy, Ladoga, Lamoni, Pershing, Sharpsburg, and Shelby soils. These soils erode easily because runoff is rapid on the steeper slopes. The moderately sloping Clarinda and Nira soils are also susceptible to erosion. Gullying is a serious hazard on the Adair, Caleb, Gara, and Shelby soils, particularly on the [illegible]



used for other purposes, but this classification is not [illegible] ity unit is a convenient grouping for making many [illegible] statements about management of soils. Capability

spring before crops are planted. The slope is enough to prevent ponding, and there is no hazard of erosion.

Most of the acreage is used for cultivated crops. Some areas are pasture or woodland. Some are large enough to be farmed separately, but most are managed along with adjacent soils. Corn, soybeans, grain sorghum, small grain, and hay are grown. Corn and soybeans are the main crops.

These soils are suited to row crops year after year if fertility and tilth are maintained and weeds and insects are controlled. An occasional meadow or green manure crop can be grown if tilth becomes poor or weeds or insects are problems. Some areas may need lime. All areas need additions of fertilizer if high yields are to be obtained under a cropping system that is mostly row crops.

Some areas need protection from overflow. Old bayous can be filled and stream channels straightened to reduce flooding. Diversion terraces protect areas at the base of slopes from runoff.

CAPABILITY UNIT IIe-1

This unit consists of gently sloping Ladoga, Macksburg, and Sharpsburg soils of the uplands and benches. Macksburg soils are somewhat poorly drained. Ladoga and Sharpsburg soils are moderately well drained.

These soils have a friable surface layer of silt loam and silty clay loam. The subsoil is friable or firm, moderately slowly permeable silty clay loam. The soils [illegible] clay loam surface layer and a friable to firm clay loam to silty clay loam subsoil. Permeability is moderate to moderately slow in most places, and available water capacity is high. These soils absorb much of the rainfall. They have properties favorable for good root development.

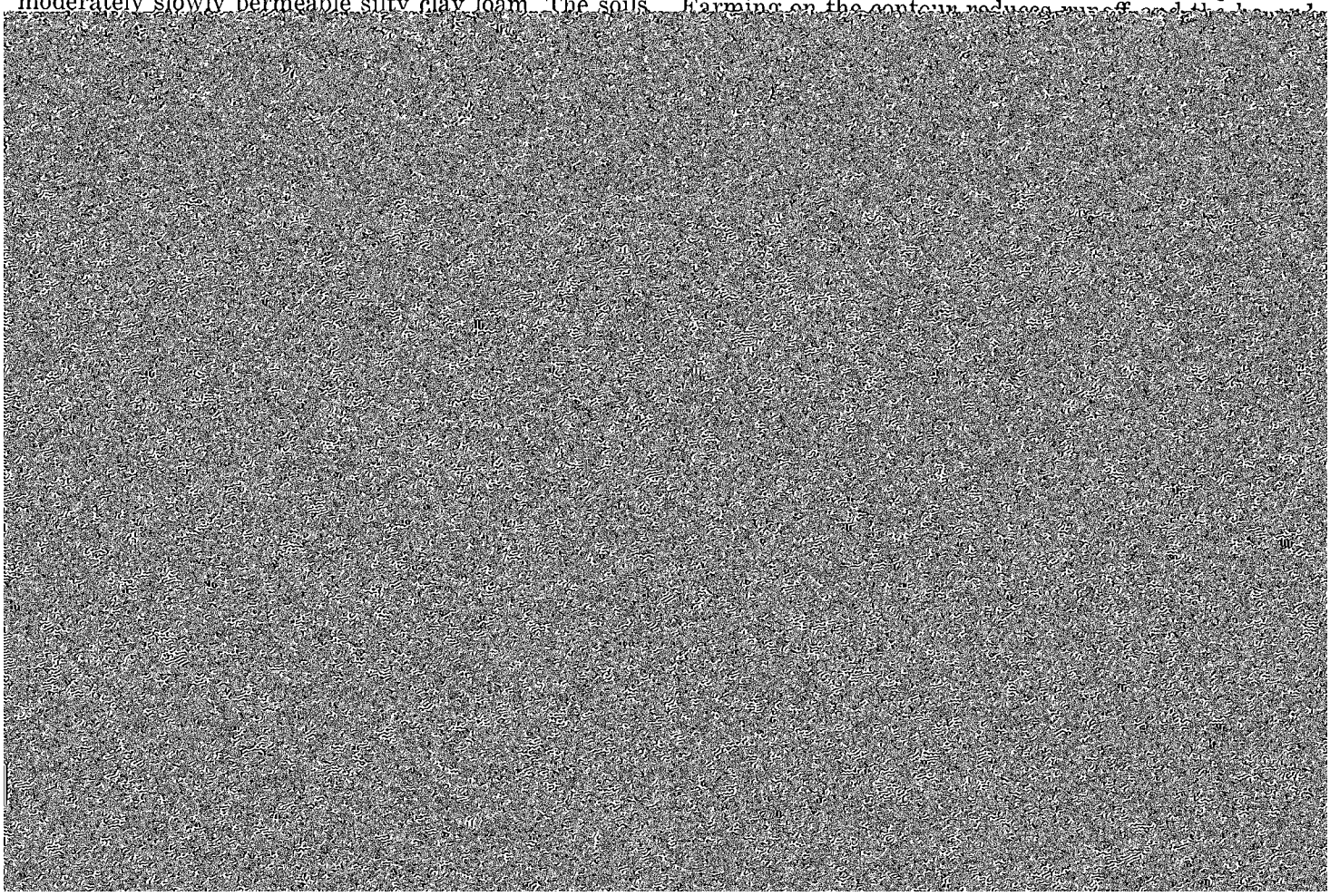
The organic-matter content is high. Unless limed, the surface layer ranges from medium to slightly acid. The subsoil is low in available phosphorus and medium to low in available potassium.

These soils are well suited to row crops and other crops commonly grown in the county. They warm up easily in spring and dry out quickly after a rain. Tilth is generally good.

Erosion is a slight problem. These soils receive some deposition from the steeper soils upslope. These deposits are less fertile and lower in organic matter than the original topsoil. A new seeding may occasionally be lost because of these deposits. Wetness is not a problem in most places because of the slope, but some small areas bordering poorly drained soils need tile.

Areas of these soils are generally small. When they are managed with the steeper, adjacent soils upslope they are used for hay or pasture. Other areas are intensively row cropped with more poorly drained alluvial soils downslope.

Diversion terraces are used to intercept runoff from steeper soils upslope and to reduce the deposition. Farming on the contour reduces runoff and the hazard of



lar slopes. A system of tile outlet terraces may be needed to protect this soil from erosion. Contour tillage and intensive use of row crops may be more practical.

[illegible] in fairly good tilth if crop residue is needed to provide proper aeration and a deep rooting zone for plants.

Organic-matter content is high. Unless limed, the surface layer is typically slightly acid. The subsoil is low to medium in available phosphorus and medium

cent uplands, or a high water table, or both. They dry out slowly in spring and must be worked later than the better drained associated bottom land soils. Some areas tend to be cloddy, especially if worked when wet. Available water capacity is high. Excessive wetness sometimes restricts plant growth and root development unless the soils are drained.

Organic-matter content is high. Unless limed, the surface layer is slightly acid. The subsoil is very low to medium in available phosphorus and medium to low in available potassium.

These soils are well suited to row crops but require artificial drainage or protection from overflow. Few areas are managed separately. Many are narrow and are generally not planted to crops. Corn and soybeans are the major crops in drained areas. The risk of crop loss is greater in undrained areas than in drained areas. Part of the acreage is in hay or pasture.

These soils sometimes receive runoff and damaging sediment from adjacent upland soils, and reseeding or replanting is necessary. Erosion is a major hazard, and active gullies or stream channels can form. Runoff from steeper soils upslope drains across these soils before entering a stream or river.

These soils are suited to row crops year after year if drained. An occasional meadow or green manure crop can be grown if tilth becomes poor or weeds or insects are problems.

Tile drains, which are commonly used, work well in these soils. Outlets are not difficult to locate. Grassed waterways are used in some areas to drain excess surface water. Excess water from runoff of adjacent slopes is controlled in some areas by diversion terraces at the base of upland slopes. Fall plowing is practical if wetness delays spring planting.

CAPABILITY UNIT IIIe-1

The one soil in this unit, Arispe silty clay loam, 5 to 9 percent slopes, is a moderately sloping, moderately well drained to somewhat poorly drained soil on uplands.

This soil has a friable silty clay loam surface layer and a friable to firm silty clay loam subsoil. It is moderately slowly permeable. It has a high available water capacity and medium to high runoff.

Fertility is average. The organic-matter content is moderate. Unless limed, the surface layer is slightly acid. The subsoil is very low to low in available phosphorus and low to medium in available potassium.

This soil is well suited to row crops. Areas are generally large enough to be managed separately but are sometimes farmed with less sloping soils or with steeper soils.

The major limitation is erosion. Row crops can be grown if erosion is controlled and grass waterways are maintained to prevent gully formation. If only contouring is used in erosion control, more meadow and fewer row crops should be grown. Many areas of this soil need additional lime. Row crops require additional fertilization.

CAPABILITY UNIT IIIe-2

This unit consists of moderately and strongly sloping, moderately well drained Nira, Ladoga, and Sharpsburg soils on uplands and high benches.

These soils have a friable light silty clay loam or silt loam surface layer and a friable or firm silty clay loam subsoil. Permeability is moderately slow in the subsoil.

These soils are moderately well drained and well aerated. Runoff is medium to rapid. Erosion ranges from slight to moderate, depending on past use and management. The available water capacity is high to medium. Properties are favorable for good, deep root development.

These soils have average fertility. The organic-matter content is moderate. The subsoil is very low to medium in available phosphorus and available potassium. Unless limed, the surface layer is slightly to medium acid in most soils. Tilth is good in most places but is poor in small, severely eroded areas where the subsoil is exposed. These eroded soils are hard and cloddy when dry.

These soils are well suited to crops. Most of the acreage is cropped to corn, soybeans, small grain, and hay. If managed with soils of lower capabilities, these soils are also well suited to pasture grasses, trees, or wildlife habitat.

These soils are subject to erosion unless protected by vegetation or soil conservation practices. Winter cover crops, manure, and crop residue increase the organic-matter content, improve tilth, and help control erosion. Row crops can be grown occasionally if terraces are used. If only contouring is used, more meadow and fewer row crops should be grown. Grassed waterways are needed in many places.

Spreading barnyard manure and returning crop residue to the soil are especially beneficial on eroded soils. Many areas need lime. Additional fertilization is needed if row crops are grown. Green manure crops can provide some of the needed nitrogen.

CAPABILITY UNIT IIIe-3

This unit consists of gently and moderately sloping, moderately well drained to somewhat poorly drained Pershing and Weller soils on uplands and high benches.

These soils have a friable silt loam surface layer and a light colored, platy subsurface layer. The subsoil is firm silty clay. Permeability is slow. The available water capacity is high.

Runoff is rapid. Erosion is slight to severe, depending on past use and management.

Fertility is below average. Organic-matter content is moderately low to moderate. The subsoil is high to medium in available phosphorus and very low in available potassium. Unless limed, the surface layer is medium to strongly acid. Tilth is poor in eroded areas, and the soils are somewhat cloddy when dry.

These soils are moderately well suited to row crops and well suited to small grain, alfalfa, pasture grasses, and woody vegetation. Areas are irregular in size and shape. Most are managed with adjacent soils. In some places these soils are wooded.

Erosion is a severe hazard in cultivated areas. Winter cover crops, manure, and crop residue on the soil increase the absorption rate and slow runoff, increase the organic-matter content, improve tilth, and help control erosion.

These soils are suited to row crops occasionally if erosion is controlled and grassed waterways are main-

tained to prevent gullying. If only contouring is used to control erosion, more meadow and fewer crops should be grown. Additional fertilization is needed if row crops are grown because of the low natural fertility.

CAPABILITY UNIT IIIe-4

This unit consists of moderately well drained and somewhat poorly drained, moderately sloping Mystic, Adair, Lamoni, and Armstrong soils on uplands.

The surface layer is friable silty clay loam, clay [illegible] The subsoil is clay loam and silty clay [illegible] Tilth is good in most areas but is poor in small, severely eroded areas where the subsoil is exposed. These eroded soils have poor tilth and are hard and cloddy when dry.

This unit is moderately well suited to most crops in the county. Yields range widely depending on the frequency, amount, and intensity of rainfall. Areas are small and are generally managed with other soils as cropland or pasture. Some of the acreage is wooded.

The major limitations are the hazard of erosion and poor tilth. In some areas the Lineville soil is wet because of the very slowly permeable subsoil.

and organic-matter content is high. Unless limed, the surface layer is slightly acid. The subsoil is low in available phosphorus and available potassium. Corn and soybeans are the main crops. Part of the acreage is in small grain, hay, and pasture. Undrained areas are best suited to hay and pasture.

This soil is generally managed with gently sloping and moderately sloping, adjacent soils. Interceptor tile placed just above the clayey substrata corrects the seepiness and wetness.

This soil is subject to moderate erosion because of the slope. It is suited to occasional row crops if tile and erosion control practices are used. Grassed waterways are needed in many places to control gullying.

CAPABILITY UNIT IIIw-2

This unit consists of very poorly drained to poorly drained Sperry and Belinda soils in nearly level to depressional areas on broad upland divides and terraces along the major streams.

These soils have a friable silt loam surface layer and a thick, distinct gray subsurface layer. The subsoil is firm silty clay that is very slowly permeable.

These soils dry out slowly. Water ponds and stands for long periods after a heavy rain. Good tilth is difficult to maintain. Available water capacity is high to moderately high, but the root zone is somewhat restricted by the firm subsoil and by wetness.

If the wetness is corrected, these soils are suited to row crops. They are moderately well suited to small grain and meadow. They are moderately fertile and are low to moderate in organic matter. The subsoil is very low to low in available phosphorus and very low in available potassium. Unless limed, the surface layer is slightly or medium acid.

Areas are mostly small and are managed as cropland with other better drained soils on the level ridgetops and level terraces. If drained, these soils are suited to row crops year after year. An occasional year of meadow or a green manure crop can be grown if tilth becomes poor or weeds or insects are problems.

Properly spaced drain tile may work in some areas of these soils, but others may need surface drains. Manure and crop residue improve tilth and maintain the supply of organic matter.

CAPABILITY UNIT IIIw-3

This unit consists of level, fine textured, very poorly drained to poorly drained Wabash and Humeston soils on bottom lands.

These soils have a silty clay loam surface layer that dries out very slowly and is normally cloddy and very hard when dry. Large cracks form during extended dry periods. The Humeston soil has a gray silt loam from slightly acid to medium acid. The subsoil is low to high in available phosphorus and very low to medium in available potassium.

Areas range widely in size and shape, but most are large. Many are managed separately. Others are managed with better drained adjacent soils. Most of the acreage is in crops.

Tile drainage does not work well on these soils. If good surface drainage is provided, these soils are suited to row crops year after year. Corn and soybeans are the principal crops. Yields depend on drainage and the frequency and amount of rainfall. Some areas are subject to overflow. Fall plowing and the return of crop residue improve the tilth.

CAPABILITY UNIT IVe-1

The one soil in this unit, Pershing silt loam, 9 to 14 percent slopes, is a moderately well drained to somewhat poorly drained, strongly sloping soil on uplands in the southeastern part of the county.

This soil has a silt loam surface layer and a light colored, platy, grayish subsurface layer. The subsoil is blocky, firm silty clay. Permeability is slow. The available water capacity is high. The root zone is deep. Runoff is rapid. Erosion is slight to severe, depending on past use and management.

This soil is moderate to moderately low in organic matter. The subsoil is high in available phosphorus and very low in available potassium. Unless limed, the surface layer is medium to slightly acid. In eroded areas, tilth is poor and the soil is somewhat cloddy when dry.

This soil is generally in crops or pasture. It is better suited to small grain, meadow, or permanent pasture than to row crops. Some of the acreage is best suited to trees or wildlife habitat, depending on the adjacent soils.

This soil is subject to erosion unless protected by vegetation or soil conserving practices. Winter cover crops, manure, and crop residue increase the organic-matter content, improve tilth, and help control erosion. Grassed waterways are needed in some areas.

CAPABILITY UNIT IVe-2

This unit consists of well drained to moderately well drained, strongly sloping and moderately steep Shelby soils on uplands. These soils have a clay loam surface layer and a firm clay loam subsoil that is moderately slowly permeable.

These soils are well drained to moderately well drained. Surface runoff is high to very high because of the strong and moderately steep slopes. They have properties favorable for good root development and a high available water capacity. They are subject to

These soils are subject to erosion and are highly susceptible if row crops are grown. They should be kept in hay or pasture most of the time. A corn crop can be grown on the contour when the stands of legumes and grasses need reseeding, generally after 4 years or more. Permanent pasture and woodland are alternate uses. Terrace construction is difficult in many places because of the irregular slopes. Even if the soils are terraced, row crops should be grown infrequently.

Most of the acreage that is used for crops is managed separately or with soils that are better suited. Areas used as permanent pasture, woodland, or wildlife habitat are generally managed with soils of lower capabilities.

CAPABILITY UNIT IVe-3

This unit consists of well drained to moderately well drained, strongly sloping Caleb and Gara soils on uplands and high benches.

The surface layer is loam. It is friable in most places. In some eroded areas where the subsoil has been mixed with the surface layer and is exposed by plowing, this layer is sticky when wet and hard when dry. The subsoil is clay loam to loam and sandy clay. It is friable to firm. Permeability is slow to moderately rapid.

Runoff is rapid in most places because of the slope. Properties are favorable for good root development. The available water capacity is high to moderate.

These soils are not well suited to row crops but are moderately well suited to pasture. Natural fertility is low, and tilth is poor in most areas. The organic-matter content is moderate to low. The subsoil is very low to low in available phosphorus and very low in available potassium. Unless limed, the surface layer is strongly acid. Erosion is a serious problem, and gullies form easily.

Most of the acreage is in crops, chiefly row crops, small grain, and grasses and legumes for hay and pasture. Contour tillage is a common practice, and grassed waterways are maintained to prevent gully formation. Terracing is practical in some areas. Even if erosion is controlled, these soils are suited to row crops only occasionally. They should be kept in hay or pasture most of the time. A year of row crops can be grown on the contour when stands of grasses and legumes need reseeding, usually after 4 years or more.

Some small areas managed with the better suited adjacent soils can be cropped more intensively. Others, with less suitable soils, should be managed as pasture or woodland.

CAPABILITY UNIT IVe-4

This unit consists of moderately well drained to very poorly drained, strongly sloping Mystic, Caleb, Lamoni, Adair, Shelby, Clarinda, and Armstrong soils on uplands and high benches.

The surface layer is silty clay loam, clay loam, or loam. It is friable in most places. In some eroded areas where the subsoil has been mixed with the surface layer and exposed by plowing, this layer is sticky when wet and hard when dry. The subsoil is heavy clay loam to clay. It is firm to very firm and is mod-

Saturation in the Lamoni and Clarinda soils causes narrow seepy areas upslope in the more permeable loess soils. Available water capacity is moderate to high. Root penetration is restricted in the subsoil in most of these soils.

These soils are not well suited to row crops but are moderately well suited to pasture. Natural fertility is low and tilth is poor in most areas. The organic-matter content is low to moderate. The subsoil is very low to low in available phosphorus and very low to medium in available potassium. Unless limed, the soils are medium to strongly acid. Erosion is a serious problem. Gullies form easily.

Most of the acreage is in crops, chiefly row crops, small grain, and grasses and legumes for hay and pasture. Contour tillage is a common practice. Grassed waterways are maintained to prevent gully formation. Terracing is practical in some areas. Because the subsoil is mostly clayey and dense, good management is needed to restore productivity in the terrace channels. Even if erosion is controlled, these soils are seldom suited to row crops. They should be kept in hay or pasture most of the time. A year of row crops can be grown on the contour when stands of grasses and legumes need reseeding, usually after 4 years or more.

Some small areas can be cropped more intensively with better suited adjacent soils. Others, with less suitable soils, should be managed as pasture or woodland.

CAPABILITY UNIT IVe-5

This unit consists of Gara-Armstrong loams, 9 to 14 percent slopes, moderately eroded. These soils are strongly sloping, moderately well drained to somewhat poorly drained soils on uplands.

The surface layer is thin, friable, and loamy. The subsoil is firm clay and clay loam that is slowly to moderately slowly permeable. Runoff is rapid. The available water capacity is high and moderately high.

These soils are very poorly suited to row crops and are poorly suited to small grain and meadow. They are moderately well suited to pasture or woodland. Organic-matter content is low to moderate. The subsoil is very low to low in available phosphorus and available potassium. Unless limed, the surface layer is strongly acid.

Areas are small, and most of the acreage is managed with steeper adjacent soils as permanent pasture or woodland. In some areas a row crop can be grown on the contour when stands of grasses and legumes need reseeding, usually after 4 years or more of pasture and hay. Some of the existing permanent pasture can be renovated and more productive pasture plants introduced.

Fencing out livestock and good woodland management help increase the productivity of many areas presently in woodland.

CAPABILITY UNIT IVe-6

The one soil in this unit, Dickinson fine sandy loam, 5 to 14 percent slopes, is a thin, moderately sloping and strongly sloping, well drained soil on ridges or side slopes of the uplands or high benches.

This soil has a friable fine sandy loam surface layer

The available water capacity is low to moderate. The root zone is favorable.

The organic-matter content is moderately low, and the supply of available plant nutrients is very low. Unless limed, the surface layer is medium acid to slightly acid.

This soil is droughty. It readily absorbs rainfall but holds little moisture available for plants. It warms up quickly in spring and can be worked soon after a rain. Tilth is generally good.

This soil is generally used for row crops because it occurs as small areas within larger areas of more suitable soils. It is susceptible to soil blowing and sheet erosion. Blowing sand sometimes damages new seedings on this soil or on adjacent soils. Good management is needed. Leaving crop residue on the surface helps control soil blowing.

CAPABILITY UNIT IVw-1

This unit consists of moderately sloping, very poorly drained Clarinda soils on uplands near the heads of drainageways.

The surface layer is silty clay loam. It is generally friable and absorbs water well. In eroded areas, however, the surface layer is somewhat firm, and runoff is more rapid. The subsoil is a very firm gray silty clay. It has a high available water capacity but is very slowly permeable, very poorly drained, and poorly aerated. These factors severely limit root growth.

These soils remain wet and saturated for long periods. Because of the very slow permeability, seepy areas occur where these soils are adjacent to the more permeable soils upslope. Seepage water moves downslope and increases the wetness of the Clarinda soils.

the major streams and tributaries are nearly level and have a larger number of meandering stream channels and surface drains.

On the narrow stream bottoms, the surface layer is lighter colored and coarse textured. Near the larger streams the major limitations are longer periods of flooding, streambank erosion, ponding in low areas, and deposition of sandy material.

Most of the acreage along small intermittent streams and small branching waterways is in pasture. A small part is managed as cropland with adjacent soils. Areas near the larger streams are in trees and brush.

This soil is not suited to crops because of flooding, gullying, or channels. Stream straightening, channel filling and shaping, tree and brush clearing, and drainage are used in some areas to convert this soil to cropland or improved pasture. Reclaimed areas are managed with adjacent soils better suited to cultivation.

CAPABILITY UNIT VIe-1

This unit consists of well drained to moderately well drained, moderately steep and steep Shelby and Caleb soils on uplands and high benches.

In most places the surface layer is loam to light clay loam. In severely eroded areas it is mixed with the lighter colored subsoil material, which has been exposed by plowing. The subsoil is light to heavy clay loam. It is moderately slowly permeable and slowly permeable and well aerated.

Runoff is rapid because of the steep slopes. Unless protected, these soils are subject to erosion. Gullies form easily in waterways.

These soils are not suited to row crops. They are moderately well suited to pasture and are well suited to wildlife habitat. The most serious limitation is erosion. In some areas wetness and seepage from more limited for pasture because of the steep slopes. They are suited to woodland and wildlife habitat.

Areas range from large to small. They are mainly pasture, wooded pasture, or woodland. In areas that

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1975. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-	Smooth	Kentucky

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
Pershing:						
131C, T131C	96	36	53	4.0	6.7	3.5
131C2	91	33	50	3.8	6.4	3.4
131D	85	33	46	3.6	6.0	3.4
T131B	101	38	56	4.2	7.0	3.8
Weller:						
132C	90	34	50	3.8	6.4	3.7
Colo:						
133	104	40	78	4.2	5.5	4.2
133B	102	39	76	4.0	5.3	4.2
Dickinson:						
175D	67	25	50	2.3	4.0	2.0
Gara:						
179D	78	30	43	3.3	4.7	2.7
179D2	75	28	41	3.1	4.5	2.5
179E	----	----	----	2.5	3.3	1.7
179E2	----	----	----	2.2	----	1.5
179F	----	----	----	1.5	----	1.3
Adair:						
192C	73	28	40	3.1	4.0	2.7
192C2	65	25	36	2.7	3.5	2.3
192D2	54	20	30	2.3	2.9	1.9
Kennebec:						
212	118	45	67	5.0	7.0	4.1
Nodaway:						
220	110	42	60	4.6	6.5	4.0
C220	----	----	----	3.0	5.5	4.0
Clarinda:						
222C	63	24	34	2.6	3.7	2.7
222C2	55	21	30	2.2	3.3	2.3
222D	54	20	30	2.1	3.1	2.1
222D2	46	17	25	1.8	2.9	1.7
Wabash:						
248	86	33	47	2.5	4.1	3.3
Humeston:						
269	88	33	48	3.7	5.0	3.3
Olmitz:						
273B	100	38	55	4.2	6.0	3.9
Haig:						
362	105	40	58	4.2	7.0	3.8
Grundy:						
364B	107	41	59	4.5	6.6	3.6

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Smooth bromegrass	Kentucky bluegrass
	Bu	*Bu*	*Bu*	*Ton*	*AUM* [1]	*AUM* [1]
Macksburg:						
368	121	46	67	5.1	8.4	4.5
368B	117	44	64	4.9	8.2	4.2
Winterset:						
369	117	44	64	4.9	8.2	4.3
Sharpsburg:						
370B	113	43	62	4.7	7.8	4.2
370C	108	41	59	4.5	7.3	4.1
370C2	108	40	58	4.4	7.0	4.0
370D	99	38	54	4.2	6.8	3.9
Nira:						
[2] 371C	110	42	61	4.6	7.6	4.1
[2] 371C2	107	40	59	4.5	7.4	4.0
Keswick:						
425C	61	23	33	2.6	3.7	2.1
Caleb:						
451C2	76	29	41	3.1	4.4	2.7
451D2	66	25	36	2.8	4.0	2.1
451E2	----------	----------	20	1.9	3.3	1.7
Lineville:						
452C	70	27	38	2.9	3.5	2.5
Mystic:						
592C2	60	23	33	2.5	3.0	2.1
592D2	51	19	28	2.0	2.3	1.9
Armstrong:						
792C	67	25	36	2.7	3.3	2.3
792C2	59	22	33	2.5	3.1	2.1
792D2	50	19	28	2.0	2.7	1.7
Lamoni:						
822C	76	29	42	3.2	4.5	3.0
822C2	71	27	39	3.0	4.3	2.7
822D	66	25	36	2.7	4.0	2.3
822D2	61	23	33	2.6	3.7	2.1
Gara:						
[2] 993D2	67	25	37	2.8	3.9	2.3
[2] 993E2	60	23	33	1.8	3.0	1.5

[1] Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

TABLE 3.—*Woodland management and productivity*

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Erosion hazard	Equipment limitation	Seedling mortality	Plant competition	Important trees	Site index	
Judson:								
8B	2o	Slight	Slight	Slight	Moderate	Black walnut	73	Black walnut, eastern cottonwood, green ash.
						White oak		
						Northern red oak		
Nodaway:								
[1] 13B:								
Nodaway part	2o	Slight	Slight	Slight	Moderate	White oak	65	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
Vesser part.								
Lindley:								
65E, 65F	4r	Moderate	Moderate	Slight	Slight	White oak	60	White oak, green ash, yellow-poplar, post oak, blackjack oak, black oak.
						Post oak		
						Blackjack oak		
						Black oak		
Ladoga:								
76B, 76C, 76C2, 76D, T76B, T76C	2o	Slight	Slight	Slight	Moderate	White oak	65	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, eastern red-cedar, sugar maple, white spruce.
						Northern red oak	65	
Mystic:								
[1] 94D2:								
Mystic part	3o	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
						Northern red oak	55	
Caleb part	3o	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
						Northern red oak	55	
Belinda:								
T130	5w	Slight	Moderate	Moderate	Severe	White oak	45	Eastern cottonwood, silver maple, laurel willow, American sycamore, green ash, northern white-cedar.

n white pine,
h pine, Norway
e, red pine, white
e.

n white pine,
h pine, Norway
e, white spruce,
ine, European
, black walnut,
r maple.

n white pine, red
jack pine.

n white pine, red
Norway spruce,
h pine.

valnut, bur oak,
berry, green ash,
rn cottonwood,
rican sycamore.

n white pine, red
Norway spruce,
h pine, white
e, European
, black walnut,
r maple.

, pecan, eastern
nwood.

n cottonwood,
ak.

valnut, hack-
, green ash.

valnut, hack-
, green ash.

TABLE 3.—*Woodland management and productivity*—Continued

Soil name and map symbol	Ordination symbol	Management concerns: Erosion hazard	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Plant competition	Potential productivity: Important trees	Potential productivity: Site index	Trees to plant
[1] 371C2:								
Nira part.								
Sharpsburg part	4o	Slight	Slight	Slight	Slight	Black oak	60	Black walnut, hackberry, green ash.
						Black walnut	60	
						White oak	--------	
						Hackberry	--------	
						Green ash	--------	
Keswick: 425C	3c	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, European larch, white spruce, sugar maple.
						Northern red oak	55	
Caleb: 451D2	3o	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
						Northern red oak	55	
451E2	3r	Moderate	Moderate	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
						Northern red oak	55	
Mystic: 592C2, 592D2	3o	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple.
						Northern red oak	55	
Armstrong: 792C, 792C2, 792D2	4c	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplars.
						Northern red oak	55	
Gara:								
[1] 993D2:								
Gara part	3o	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine.
						Northern red oak	55	
Armstrong part	4c	Slight	Slight	Slight	Slight	White oak	55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplars.
						Northern red oak	55	

[1] 993E2:								
Gara part	3r	Moderate	Moderate	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine.
Armstrong part	4c	Slight	Slight	Slight	Slight	White oak Northern red oak	55 55	Eastern white pine, red pine, Norway spruce, Scotch pine, white spruce, European larch, black walnut, sugar maple, poplars.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

owners or forest managers planning use of soils for wood crops. Map unit symbols for soils suitable for wood crops are listed, and the ordination (woodland suitability) symbol for each soil is given. All soils bearing the same ordination symbol require the same general kinds of woodland management and have [illegible] potential productivity.

The *potential productivity* of merchantable or *important trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Important trees are those that woodland managers generally

clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations, testing, and analysis by personnel having expertise in the specific use contemplated.

The information is presented mainly in tables. Table 4 shows, for each kind of soil, the degree and kind of limitations for building site development; table 5, for sanitary facilities; and table 7, for water management. Table 6 shows the suitability of each kind of soil as a source of construction materials.

The information in the tables, along with the soil map, the soil descriptions, and other data provided in this survey, can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

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

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 4. A *slight* limitation indicates that soil properties generally are favorable for the specified use; any limitation is minor and is easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are made for pipelines, sewerlines, communications and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table; the texture and consistence of soils; the tendency of soils to cave in or slough; and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is given, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 4 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence of the structure from settling or shear failure of the foundation does not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious hazard.

Local roads and *streets* referred to in table 4 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones affect stability and ease of excavation.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that affect ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 5 shows the degree and kind of limitations of each soil for such uses and for use of the soil as daily cover for landfills. It is important to observe local ordinances and regulations.

If the degree of soil limitation is expressed as *slight,* soils are generally favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil prop-

TABLE 4.—*Building site development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and	Shallow	Dwellings without	Dwellings with	Small commercial	Local roads

TABLE 4.—*Building site development*—Continued

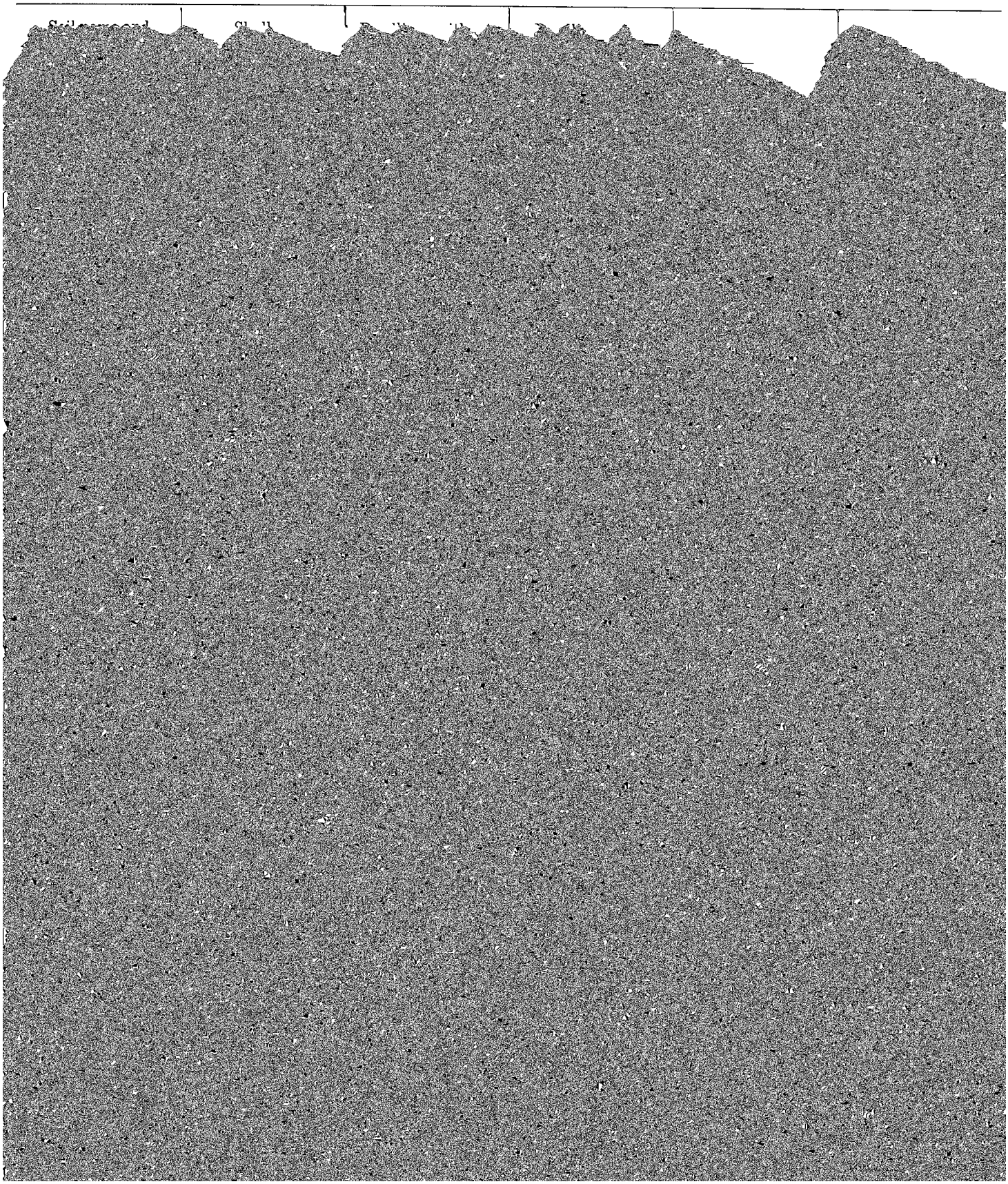


TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Gara: 179D, 179D2	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope	Severe: low strength.
179E, 179E2, 179F	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: low strength, slope.
Adair: 192C, 192C2, 192D2	Severe: wetness, too clayey.	Severe: shrink-swell.	Severe: shrink-swell, wetness.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Kennebec: 212	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action, low strength.
Nodaway: 220, C220	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action.
Clarinda: 222C, 222C2, 222D, 222D2	Severe: wetness, too clayey.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness shrink-swell, low strength.
Wabash: 248	Severe: wetness, floods, too clayey.	Severe: wetness, floods,	Severe: wetness, floods,	Severe: wetness, floods,	Severe: wetness floods,

TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Nira:					
[1] 371C:					
Nira part	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: frost action, low strength, shrink-swell.
Sharpsburg part.	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
[1] 371C2:					
Nira part	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: frost action, low strength, shrink-swell.
Sharpsburg part.	Slight	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Keswick:					
425C	Severe: wetness	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: low strength, shrink-swell, frost action.
Caleb:					
451C2	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness.	Moderate: slope, shrink-swell.	Severe: low strength.
451D2	Moderate: wetness.	Moderate: slope, shrink-swell.	Moderate: wetness, slope.	Severe: slope	Severe: low strength.
451E2	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: low strength, slope.
Lineville:					
452C	Severe: wetness	Severe: low strength, wetness.	Severe: shrink-swell, wetness, low strength.	Severe: wetness, low strength.	Severe: low strength, frost action.
Mystic:					
592C2	Moderate: wetness, too clayey.	Moderate: wetness, shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: wetness, shrink-swell, slope.	Severe: low strength, frost action.
592D2	Moderate: wetness, slope, too clayey.	Moderate: wetness, shrink-swell, slope.	Moderate: wetness, shrink-swell, slope.	Severe: slope	Severe: low strength, frost action.
Armstrong:					
792C, 792C2	Severe: wetness	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength, frost action.
792D2	Severe: wetness	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength, slope.	Severe: shrink-swell, low strength, frost action.
Lamoni:					
822C, 822C2, 822D, 822D2	Severe: wetness, too clayey.	Severe: shrink-swell,	Severe: shrink-swell,	Severe: shrink-swell,	Severe: shrink-swell,

TABLE 4.—*Building site development*—Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets
Gara:					
[1] 993D2:					
Gara part	Moderate: slope, too clayey.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope	Severe: low strength.
Armstrong part	Severe: wetness	Severe: shrink-swell, low strength.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength, slope.	Severe: shrink-swell, low strength, frost action.
[1] 993E2:					
Gara part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: low strength, slope.
Armstrong part	Severe: wetness, slope.	Severe: shrink-swell, low strength, slope.	Severe: shrink-swell, wetness, low strength.	Severe: shrink-swell, low strength, slope.	Severe: shrink-swell, low strength, frost action.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

erties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance is required. Soil suitability is rated by the terms *good, fair,* or *poor,* which, respectively, mean about the same as the terms *slight, moderate,* and *severe.*

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for

is required to minimize seepage and contamination of ground water. Soils that are very high in content of organic matter and those that have cobbles, stones, or boulders are not suitable. Unless the soil has very slow permeability, contamination of ground water is a hazard where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce the lagoon's capacity for liquid waste. Slope, depth to bedrock, and suscepti-

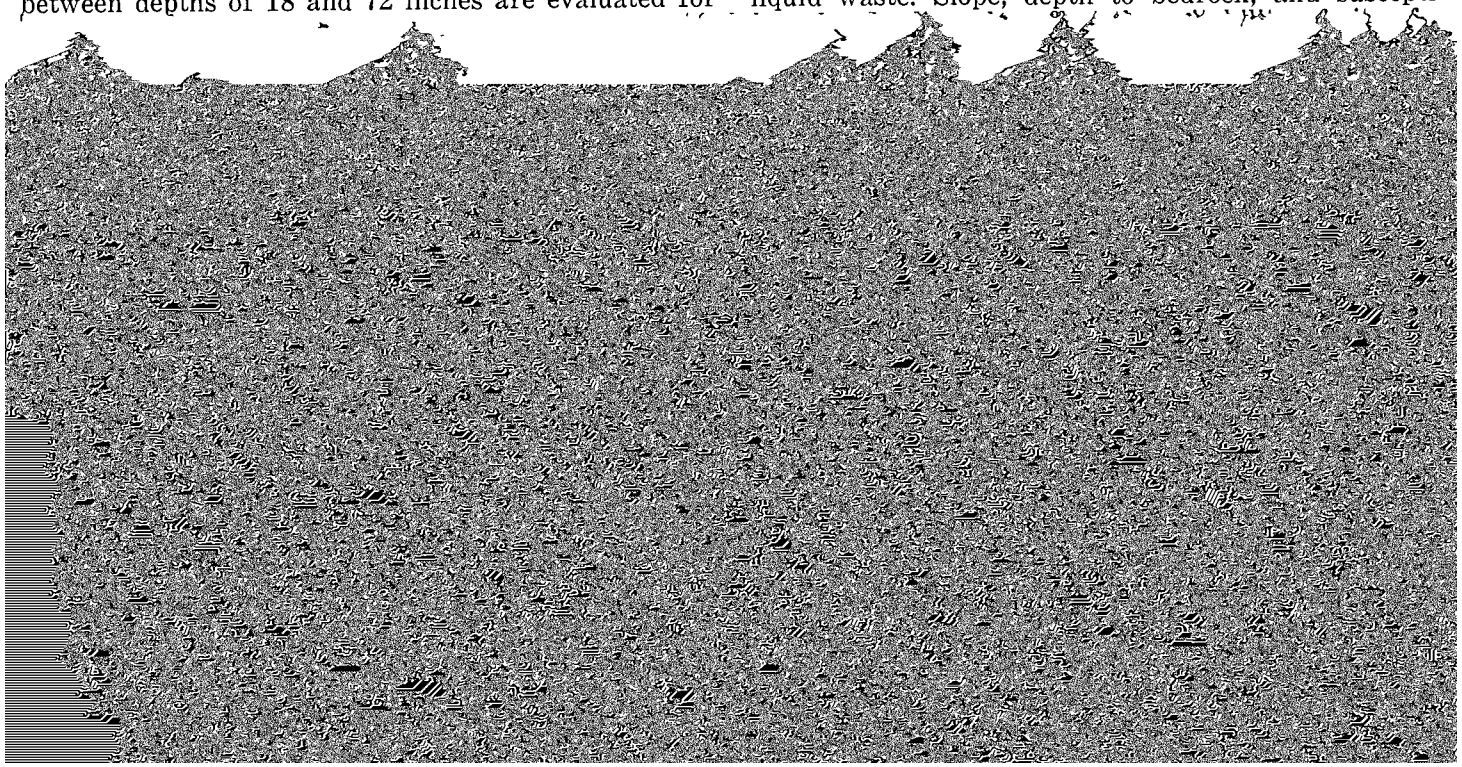


TABLE 5.—*Sanitary facilities*

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
[1] 93E2:					
Adair part	Severe: percs slowly, slope.	Severe: slope	Severe: wetness, too clayey.	Severe: slope	Poor: area reclaim.
Shelby part	Severe: percs slowly, slope.	Severe: slope	Moderate: too clayey, slope.	Severe: slope	Poor: slope.
Mystic:					
[1] 94D2:					
Mystic part	Severe: percs slowly, wetness.	Severe: slope, wetness, seepage.	Severe: seepage, wetness.	Moderate: wetness.	Fair: area reclaim.
Caleb part	Moderate: wetness, slope.	Severe: slope	Severe: wetness	Severe: wetness	Poor: area reclaim.
Sperry: 122	Severe: percs slowly, wetness.	Severe: wetness	Severe: wetness	Severe: wetness	Poor: wetness, area reclaim.
Belinda: T130	Severe: percs slowly, wetness.	Slight	Severe: wetness	Severe: wetness	Poor: wetness, too clayey.
Pershing: 131C, 131C2, T131C	Severe: percs slowly, wetness.	Severe: slope	Moderate: too clayey, wetness.	Moderate: wetness.	Fair: too clayey.
131D	Severe: percs slowly, wetness.	Severe: slope	Moderate: too clayey, wetness.	Moderate: wetness, slope.	Fair: too clayey, slope.
T131B	Severe: percs slowly, wetness.	Moderate: slope	Moderate: too clayey, wetness.	Moderate: wetness.	Fair: too clayey.
Weller: 132C	Severe: percs slowly.	Severe: slope	Severe: wetness	Moderate: wetness.	Fair: too clayey.
Colo: 133, 133B	Severe: percs slowly, wetness, floods.	Severe: excess humus, wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Dickinson: 175D	Moderate: slope	Severe: seepage, slope.	Severe: seepage	Severe: seepage	Fair: slope, thin layer.
Gara: 179D, 179D2	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: too clayey, slope.
179E, 179E2, 179F	Severe: percs slowly, slope.	Severe: slope	Moderate: too clayey, slope.	Severe: slope	Poor: slope, area reclaim.
Adair: 192C, 192C2	Severe: percs slowly.	Severe: slope	Severe: wetness, too clayey.	Slight	Poor: area reclaim.
192D2	Severe: percs slowly.	Severe: slope	Severe: wetness, too clayey.	Moderate: slope	Poor: area reclaim.
Kennebec: 212	Severe: floods, wetness.	Severe: floods	Severe: floods, wetness.	Severe: floods, wetness.	Good.
Nodaway:	[illegible]	[illegible]	Severe: floods	Severe: floods	Good.

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Wabash:					
248	Severe: percs slowly, floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
Humeston:					
269	Severe: wetness	Severe: floods, wetness.	Severe: wetness	Severe: wetness	Poor: wetness.
Olmitz:					

TABLE 5.—*Sanitary facilities*—Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
451E2	Severe: slope	Severe: slope	Severe: wetness	Severe: slope, wetness.	Poor: area reclaim, slope.
Lineville: 452C	Severe: percs slowly, wetness.	Severe: slope	Severe: wetness	Severe: wetness	Poor: area reclaim.
Mystic: 592C2, 592D2	Severe: percs slowly, wetness.	Severe: slope, wetness, seepage.	Severe: seepage, wetness.	Moderate: wetness.	Fair: area reclaim.
Armstrong: 792C, 792C2, 792D2	Severe: percs slowly.	Severe: slope	Severe: wetness	Severe: wetness	Poor: area reclaim.
Lamoni: 822C, 822C2, 822D, 822D2	Severe: percs slowly.	Severe: slope	Severe: wetness, too clayey.	Severe: wetness	Poor: area reclaim, too clayey.
Gara: [1] 993D2: Gara part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: too clayey, slope.
Armstrong part	Severe: percs slowly.	Severe: slope	Severe: wetness	Severe: wetness	Poor: area reclaim.
[1] 993E2: Gara part	Severe: percs slowly, slope.	Severe: slope	Moderate: too clayey, slope.	Severe: slope	Poor: slope, area reclaim.
Armstrong part	Severe: percs slowly, slope.	Severe: slope	Severe: wetness	Severe: wetness, slope.	Poor: area reclaim, slope.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior of the whole mapping unit.

6 feet. If the trench is deeper, a limitation of slight or moderate may not be valid. Site investigation is needed before a site is selected.

Daily cover for landfill should be soil that is easy to excavate and spread over the compacted fill in wet and dry periods. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

The soils selected for final cover of landfills should

Construction materials

The suitability of each soil as a source of roadfill, sand, gravel, and topsoil is indicated in table 6 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed, generally about 6 feet.

Roadfill is soil material used in embankments for roads. Soils are evaluated as a source of roadfill for

TABLE 6.—*Construction materials*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited"]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Judson:				
8B	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Colo:				
[1] 11B:				
Colo part	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness.
Ely part	Poor: frost action, low strength.	Unsuited	Unsuited	Good.
Nodaway:				
[1] 13B:				
Nodaway part	Poor: frost action	Unsuited	Unsuited	Good.
Vesser part	Poor: frost action	Unsuited	Unsuited	Poor: wetness.
Arispe:				
23C	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey.
Shelby:				
24C, 24C2	Poor: low strength	Unsuited	Unsuited	Fair: thin layer.
24D, 24D2, 24D3	Poor: low strength	Unsuited	Unsuited	Fair: thin layer, slope.
24E, 24E2, 24F2	Poor: low strength	Unsuited	Unsuited	Poor: slope.
Vesser:				
51	Poor: frost action	Unsuited	Unsuited	Poor: wetness.
Lindley:				
65E, 65F	Poor: low strength	Unsuited	Unsuited	Poor: slope.
Clearfield:				
69C	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
Ladoga:				
76B, 76C, 76C2, T76B, T76C	Poor: frost action	Unsuited	Unsuited	Fair: thin layer.
76D	Poor: frost action	Unsuited	Unsuited	Fair: thin layer, slope.
Adair:				
[1] 93D:				
Adair part	Poor: low strength, area reclaim.	Unsuited	Unsuited	Poor: area reclaim.
Shelby part	Poor: low strength	Unsuited	[illegible]	[illegible]

TABLE 6.—*Construction materials*—Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Sperry: 122	Poor: area reclaim, shrink-swell, wetness.	Unsuited	Unsuited	Poor: area reclaim, wetness.
Belinda: T130	Poor: shrink-swell, wetness.	Unsuited	Unsuited	Fair: area reclaim.
Pershing: 131C, 131C2, 131D, T131B, T131C	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: area reclaim, thin layer.
Weller: 132C	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: area reclaim, thin layer.
Colo: 133, 133B	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness.
Dickinson: 175D	Good	Fair: excess fines	Unsuited	Fair: slope.
Gara: 179D, 179D2	Poor: low strength	Unsuited	Unsuited	Fair: thin layer, slope.
179E, 179E2, 179F	Poor: low strength	Unsuited	Unsuited	Poor: slope.
Adair: 192C, 192C2, 192D2	Poor: low strength, area reclaim.	Unsuited	Unsuited	Poor: area reclaim.
Kennebec: 212	Poor: excess humus, frost action, low strength.	Unsuited	Unsuited	Good.
Nodaway: 220, C220	Poor: frost action	Unsuited	Unsuited	Good.
Clarinda: 222C, 222C2, 222D, 222D2	Poor: shrink-swell, wetness, low strength.	Unsuited	Unsuited	Poor: area reclaim, too clayey.
Wabash: 248	Poor: wetness, shrink-swell, low strength.	Unsuited	Unsuited	Poor: wetness, too clayey.
Humeston: 269	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: area reclaim.
Olmitz: 273B	Poor: low strength	Unsuited	Unsuited	Good.
Haig: 362	Poor: shrink-swell, wetness, low strength.	Unsuited	Unsuited	Poor: wetness.
Grundy: 364B	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Fair: thin layer.
Macksburg: 368, 368B	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Good.
Winterset: 369	Poor: shrink-swell, wetness, low strength.	Unsuited	Unsuited	Poor: wetness.

TABLE 6.—*Construction materials*—Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Sharpsburg:				
370B, 370C, 370C2	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: thin layer.
370D	Poor: shrink-swell,	Unsuited	Unsuited	Fair: slope, thin layer.

soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within their profile. The estimated engineering properties in table 6 provide specific information

high content of organic matter, a surface horizon is generally preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth

TABLE 7.—*Water management*

[Some terms that describe restrictive soil features are defined in the Glossary]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Judson:						
8B	Seepage	Compressible, low strength, shrink-swell.	Not needed	Favorable	Favorable	Favorable.
Colo:						
[1] 11B:						
Colo part	Favorable	Compressible, low strength, hard to pack.	Floods, wetness.	Floods, wetness.	Not needed	Wetness.
Ely part	Favorable	Low strength, compressible, shrink-swell.	Favorable	Favorable	Wetness	Favorable.
Nodaway:						
[1] 13B:						
Nodaway part	Seepage	Low strength	Floods	Floods	Not needed	Not needed.
Vesser part	Favorable	Low strength, shrink-swell.	Floods	Floods	Erodes easily, wetness.	Erodes easily, wetness.
Arispe:						
23C	Favorable	Compressible, shrink-swell.	Slope	Slope, slow intake.	Erodes easily	Erodes easily.
Shelby:						
24C, 24C2	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope, erodes easily.	Favorable	Erodes easily, slope.
24D, 24D2, 24D3, 24E, 24E2, 24F2	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope. erodes easily.	Erodes easily, slope.	Erodes easily, slope.
Vesser:						
51	Favorable	Low strength, shrink-swell.	Floods	Floods	Erodes easily, wetness.	Erodes easily, wetness.
Lindley:						
65E, 65F	Slope	Favorable	Not needed	Slope	Slope, percs slowly, erodes easily.	Erodes easily, percs slowly, slope.
Clearfield:						
69C	Favorable	Compressible, low strength, shrink-swell.	Favorable	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.
Ladoga:						
76B, 76C, 76C2, 76D, T76B, T76C	Favorable	Compressible, low strength, shrink-swell.	Not needed	Erodes easily	Favorable	Favorable.
Adair:						
[1] 93D:						
Adair part	Slope	Shrink-swell, erodes easily.	Percs slowly	Erodes easily, percs slowly, slow intake.	Complex slope.	Percs slowly.
Shelby part	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope, erodes easily.	Erodes easily, slope.	Erodes easily, slope.
[1] 93D2:						
Adair part	Slope	Shrink-swell, erodes easily.	Percs slowly	Erodes easily, percs slowly, slow intake.	Complex slope.	Percs slowly.

TABLE 7.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Shelby part	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope, erodes easily.	Erodes easily, slope.	Erodes easily, slope.
[1] 93E2:						
Adair part	Slope	Shrink-swell, erodes easily.	Percs slowly	Erodes easily, percs slowly, slow intake.	Complex slope.	Percs slowly.
Shelby part	Slope	Low strength, shrink-swell.	Not needed	Slow intake, slope, erodes easily.	Erodes easily. slope.	Erodes easily, slope.
Mystic:						
[1] 94D2:						
Mystic part	Slope, seepage.	Low strength	Percs slowly, slope.	Slow intake, slope.	Slope, complex slope, wetness.	Erodes easily, percs slowly.
Caleb part	Slope	Unstable fill	Not needed	Erodes easily, slope.	Erodes easily, slope.	Erodes easily, slope.
Sperry: 122	Favorable	Compressible, low strength, shrink-swell.	Percs slowly, poor outlets, wetness.	Percs slowly, slow intake, wetness.	Not needed	Not needed.
Belinda: T130	Not needed	Compressible, low strength, shrink-swell.	Percs slowly	Wetness, slow intake.	Not needed	Not needed.
Pershing: 131C, 131C2, 131D, T131B, T131C	Favorable	Compressible, low strength, shrink-swell.	Percs slowly, slope.	Wetness, slow intake.	Percs slowly	Favorable.
Weller: 132C	Favorable	Compressible, low strength, shrink-swell.	Not needed	Erodes easily, slow intake.	Percs slowly	Percs slowly, erodes easily.
Colo: 133, 133B	Favorable	Compressible, low strength, hard to pack.	Floods, wetness.	Floods, wetness.	Not needed	Wetness.
Dickinson: 175D	Seepage	Seepage, piping.	Not needed	Soil blowing, droughty, fast intake.	Too sandy, soil blowing, complex slope.	Droughty.
Gara: 179D, 179D2, 179E, 179E2, 179F	Slope	Low strength, shrink-swell.	Not needed	Erodes easily, slope.	Erodes easily, slope.	Erodes easily, slope.
Adair: 192C, 192C2, 192D2	Slope	Shrink-swell, erodes easily.	Percs slowly	Erodes easily, percs slowly, slow intake.	Complex slope.	Percs slowly.
Kennebec: 212	Seepage	Low strength, compressible, excess humus.	Floods, frost action.	Floods	Favorable	Favorable.
Nodaway: 220, C220	Seepage	Low strength	Floods	Floods	Not needed	Not needed.

TABLE 7.—*Water management*—Continued

Soil name and	Pond reservoir	Embankments, dikes, and	Drainage	Irrigation	Terraces	Grassed

TABLE 7.—*Water management*—Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Lineville: 452C	Favorable	Shrink-swell, low strength.	Percs slowly	Slow intake	Erodes easily	Erodes easily.
Mystic: 592C2, 592D2	Slope, seepage.	Low strength	Percs slowly, slope.	Slow intake, slope.	Slope, complex slope, wetness.	Erodes easily, percs slowly.
Armstrong: 792C, 792C2, 792D2	Slope	Shrink-swell, erodes easily.	Percs slowly	Erodes easily, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Lamoni: 822C, 822C2, 822D, 822D2	Slope	Shrink-swell, erodes easily, low strength.	Percs slowly, slope.	Erodes easily, slope.	Erodes easily, percs slowly.	Erodes easily, percs slowly.
Gara: [1] 993D2: Gara part	Slope	Low strength,	Not needed	Erodes easily,	Erodes easily,	Erodes easily,

TABLE 8.—*Recreational development*

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Judson:				
8B	Moderate: too clayey.	Moderate: too clayey.	Moderate: slope, too clayey.	Moderate: too clayey.
Colo:				
[1] 11B:				
Colo part	Severe: floods, wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness.
Ely part	Moderate: wetness, too clayey.	Moderate: wetness, too clayey.	Moderate: wetness, too clayey, slope.	Moderate: wetness, too clayey.

TABLE 8.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
[1] 93E2:				
Adair part	Severe: slope	Severe: slope	Severe: slope	Moderate: wetness.
Shelby part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Mystic:				
[1] 94D2:				
Mystic part	Moderate: percs slowly, wetness, slope.	Moderate: wetness, slope.	Severe: slope	Moderate: wetness.
Caleb part	Moderate: percs slowly, slope.	Moderate: slope	Severe: slope	Slight.
Sperry:				
122	Severe: percs slowly, wetness.	Severe: wetness	Severe: percs slowly, wetness.	Severe: wetness.
Belinda:				
T130	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Pershing:				
131C, 131C2, 131D, T131C	Moderate: percs slowly, wetness.	Moderate: wetness	Severe: slope	Moderate: wetness.
[illegible]	Moderate: percs [illegible]	Moderate: wetness	Moderate: wetness	Moderate: wetness.

TABLE 8.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails

TABLE 8.—*Recreational development*—Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lamoni:				
822C, 822C2	Severe: percs slowly	Moderate: wetness, too clayey.	Severe: percs slowly, slope.	Moderate: wetness, too clayey.
822D, 822D2	Severe: percs slowly	Moderate: slope, too clayey.	Severe: percs slowly, slope.	Moderate: wetness, too clayey.
Gara:				
993D2:				
Gara part	Moderate: percs slowly, slope.	Moderate: slope	Severe: slope	Slight.
Armstrong part	Moderate: percs slowly, wetness, slope.	Moderate: wetness, slope.	Severe: slope	Moderate: wetness.
[1] 993E2:				
Gara part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Armstrong part	Severe: slope	Severe: slope	Severe: slope	Moderate: wetness, slope.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

TABLE 9.—*Wildlife habitat potentials*

[See text for definitions of "good," "fair," "poor," and "very poor"]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Judson:										
8B	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Colo:										
[1] 11B:										
Colo part	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Ely part	Fair	Good	Good	Good	Good	Fair	Very poor.	Good	Good	Poor.
Nodaway:										
[1] 13B:										
Nodaway part	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
Vesser part	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Arispe:										
23C	Good	Good	Good	Good	Good	Very poor.	Poor	Good	Good	Very poor.
Shelby:										
24C, 24C2, 24D, 24D2, 24D3	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
24E, 24E2, 24F2	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
Vesser:										
51	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Lindley:										
65E, 65F	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Clearfield:										
69C	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Ladoga:										
76B, T76B	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
76C, 76C2, 76D, T76C	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
Adair:										
[1] 93D:										
Adair part	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
Shelby part	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
[1] 93D2:										
Adair part	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
Shelby part	Fair	Good	Fair	Good	Good	Poor	Poor	Fair	Good	Poor.
[1] 93E2:										
Adair part	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
Shelby part	Poor	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair	Poor.
Mystic:										
[1] 94D2:										
Mystic part	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Poor.
Caleb part	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Poor.
Sperry:										
122	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Belinda:										
T130	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Pershing:										
131C, 131C2, T131C, 131D.	Fair	Fair	Fair	Fair	Fair	Very poor.	Poor	Fair	Fair	Very poor.
T131B	Good	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.

TABLE 9.—*Wildlife habitat potentials*—Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Weller:										
132C	Fair	Fair	Fair	Fair	Fair	Very poor.	Poor	Fair	Fair	Very poor.
Colo:										
133	Good	Fair	Good	Fair	Poor	Good	Good	Fair	Fair	Good.
133B	Good	Fair	Good	Fair	Poor	Fair	Very poor.	Fair	Fair	Poor.
Dickinson:										
175D	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Gara:										
179D, 179D2	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Poor.
179E, 179E2, 179F	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Adair:										
192C, 192C2, 192D2	Fair	Good	Fair	Fair	Fair	Poor	Poor	Good	Fair	Poor.
Kennebec:										
212	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Nodaway:										
220, C220	Good	Good	Good	Good	Fair	Fair	Poor	Fair	Good	Fair.
Clarinda:										
222C, 222C2, 222D, 222D2	Poor	Fair	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor.
Wabash:										
248	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
Humeston:										
269	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Olmitz:										
273B	Good	Good	Fair	Good	Good	Poor	Poor	Good	Good	Poor.
Haig:										
362	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Grundy:										
364B	Fair	Good	Fair	Good	Good	Fair	Fair	Fair	Good	Fair.
Macksburg:										
368, 368B	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Winterset:										
369	Good	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
Sharpsburg:										
370B	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
370C, 370C2, 370D	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Nira:										
[1] 371C:										
Nira part	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
Sharpsburg part	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
[1] 371C2:										
Nira part	Fair	Good	Fair	Good	Good	Very poor.	Poor	Fair	Good	Very poor.
Sharpsburg part	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.

TABLE 9.—*Wildlife habitat potentials*—Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for—		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Keswick:										
425C	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Poor.
Caleb:										
451C2, 451D2	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Poor.
451E2	Poor	Good	Fair	Good	Fair	Very poor.	Very poor.	Poor	Good	Very poor.
Lineville:										
452C	Fair	Good	Fair	Good	Fair	Poor	Poor	Fair	Good	Poor.
Mystic:										

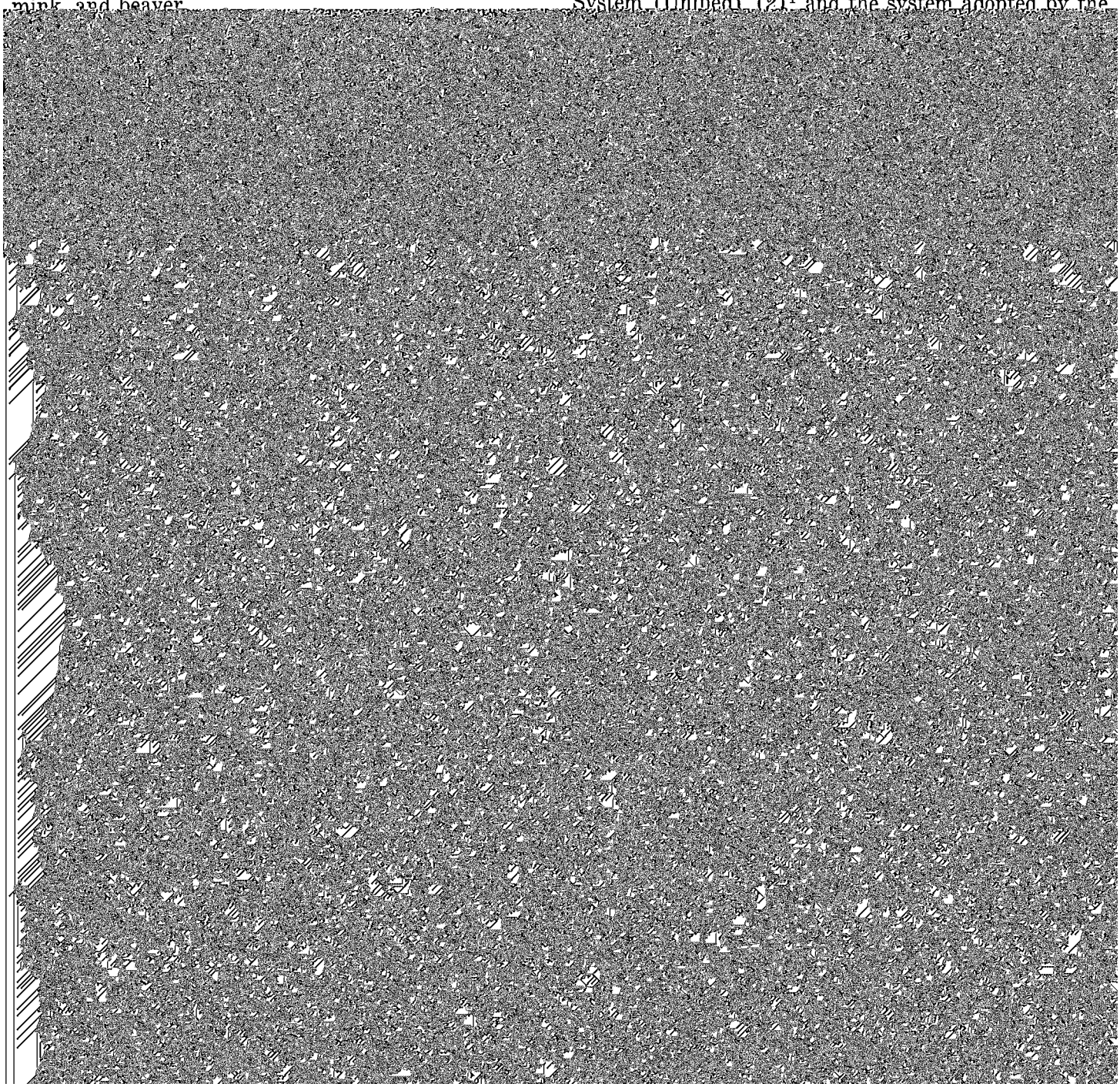
areas include bobwhite quail, pheasant, meadowlark, field sparrow, cottontail rabbit, and red fox.

Woodland habitat consists of areas of hardwoods or conifers, or a mixture of both, and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include wild turkey, ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, deer, and bear.

Wetland habitat consists of open, marshy or swampy, shallow water areas where water-tolerant plants grow. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

Texture is described in table 10 in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms are defined in the Glossary.

The two systems commonly used in classifying soils for engineering use are the Unified Soil Classification System (Unified) (*2*)[1] and the system adopted by the



mated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

In some surveys, the estimates are rounded to the nearest 5 percent. Thus, if the ranges of gradation and Atterburg limits extend a marginal amount across classification boundaries (1 or 2 percent), the classification in the marginal zone is omitted.

Physical and Chemical Properties

Table 11 shows estimated values for several soil characteristics and features that affect behavior of soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the typical pedon of each soil. The estimates are based on

steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rate of corrosion of concrete is based mainly on the sulfate content, texture, and acidity of the soil. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Uncoated steel intersecting soil boundaries or soil horizons is more susceptible to corrosion than an installation that is entirely within one kind of soil or within one soil horizon.

Erosion factors are used to predict the erodibility of a soil and its tolerance to erosion in relation to specific kinds of land use and treatment. The soil erodibility factor (K) is a measure of the susceptibil-

TABLE 10.—*Engineering properties*

[The symbol > means greater than. Absence

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Judson:				
8B	0–28	Silty clay loam	OL, CL, CL–ML, ML	A–6, A–7, A–4
	28–60	Silty clay loam, silt loam	CL, CL–ML, ML	A–6, A–7, A–4
Colo:				
[1] 11B:				
Colo part	0–41	Silty clay loam	CL, CH	A–7
	41–60	Silty clay loam	CL, CH	A–7
Ely part	0–32	Silty clay loam	CL, OL, CL–ML	A–7, A–6
	32–60	Silty clay loam	CL	A–7, A–6

and classifications

of an entry means data were not estimated]

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	100	95–100	25–50	5–25
0	100	100	100	95–100	25–50	5–25
0	100	100	90–100	90–100	41–60	15–30
0	100	100	90–100	90–100	41–55	15–30
0	100	100	95–100	95–100	30–55	5–25
0	100	100	95–100	95–100	35–50	11–25
0	100	95–100	95–100	90–100	25–35	5–15
0	100	100	98–100	95–100	30–40	11–20
0	100	100	98–100	95–100	30–40	11–20
0	100	100	98–100	95–100	35–55	15–25
0	100	100	100	95–100	41–55	20–30
0	100	100	100	95–100	45–60	25–35
0	100	100	100	95–100	41–50	20–30
0	90–100	85–98	75–90	55–70	30–40	11–20
0	90–100	85–98	75–90	55–70	35–45	15–25
0	90–100	85–98	75–90	55–70	35–45	15–25
0	100	100	98–100	95–100	30–40	11–20
0	100	100	98–100	95–100	30–40	11–20
0	100	100	98–100	95–100	35–55	15–25
0	95–100	90–100	85–95	50–65	15–30	5–15
0	95–100	90–100	85–95	55–75	30–45	15–25
0	100	100	100	95–100	45–55	20–30
0	100	100	100	95–100	50–60	25–35
0	100	100	95–100	80–90	55–70	35–45
0	100	100	100	95–100	25–40	5–15
0	100	100	100	95–100	41–55	25–35
0	95–100	80–95	75–90	60–80	30–40	11–20
0	95–100	80–95	70–90	55–80	45–55	20–30
0	95–100	80–95	70–90	55–80	35–45	15–25
0	90–100	85–98	75–90	55–70	30–40	11–20
0	90–100	85–98	75–90	55–70	35–45	15–25
0	90–100	85–98	75–90	55–70	35–45	15–25
0	95–100	80–95	75–90	60–80	30–40	11–20
0	95–100	80–95	70–90	55–80	45–55	20–30
0	95–100	80–95	70–90	55–80	35–45	15–25
0	90–100	85–98	75–90	55–70	30–40	11–20
0	90–100	85–98	75–90	55–70	35–45	15–25
0	90–100	85–98	75–90	55–70	35–45	15–25

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
[1] 93E2:				
Adair part	0–16	Clay loam	CL	A–6
	16–35	Silty clay, clay, clay loam	CL, CH	A–7
	35–60	Clay loam	CL	A–6, A–7
Shelby part	0–15	Clay loam	CL	A–6
	15–38	Clay loam	CL	A–6, A–7
	38–65	Clay loam	CL	A–6, A–7
Mystic:				
[1] 94D2:				
Mystic part	0–12	Silt loam	CL, CL–ML, ML	A–4, A–6
	12–54	Clay loam, clay, silty clay	CL	A–6, A–7
	54–62	Sandy clay loam	SC, CL, SM–SC, CL–ML	A–6, A–4
Caleb part	0–14	Loam	CL	A–6
	14–32	Clay loam, loam, sandy clay loam	CL, CH	A–6, A–7
	32–72	Sandy clay loam, sandy loam	SC, CL, SM–SC, CL–ML	A–4, A–6
Sperry:				
122	0–20	Silt loam	ML, CL	A–6
	20–51	Silty clay loam, silty clay	CH	A–7–6
	51–72	Silty clay loam	CL	A–7–6
Belinda:				
T130	0–7	Silt loam	CL, CL–ML	A–4, A–6
	7–18	Silt loam	CL–ML, CL	A–4
	18–43	Silty clay	CH	A–7
	43–80	Silty clay loam	CH	A–7
Pershing:				
131C, 131C2, 131D, T131B, T131C	0–10	Silt loam	CL	A–6
	10–34	Silty clay loam, silty clay	CH	A–7
	34–61	Silty clay loam	CH, CL	A–7
Weller:				
132C	0–12	Silt loam	ML, CL	A–6, A–4
	12–41	Silty clay loam, silty clay	CH	A–7
	41–63	Silty clay loam	CH, CL	A–7
Colo:				
133, 133B	0–41	Silty clay loam	CL, CH	A–7
	41–60	Silty clay loam	CL, CH	A–7
Dickinson:				
175D	0–23	Fine sandy loam	SM, SC	A–4, A–2
	23–60	Loamy sand	SM, SP	A–2
	50–60	Sand	SP, SM	A–3, A–2
Gara:				
179D, 179D2, 179E, 179E2, 179F	0–12	Loam	CL, CL–ML	A–4, A–6
	12–40	Clay loam	CL	A–6
	40–60	Loam, clay loam	CL	A–6
Adair:				
192C, 192C2, 192D2	0–16	Clay loam	CL	A–6
	16–35	Silty clay, clay, clay loam	CL, CH	A–7
	35–60	Clay loam	CL	A–6, A–7

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	95–100	80–95	75–90	60–80	30–40	11–20
0	95–100	80–95	70–90	55–80	45–55	20–30
0	95–100	80–95	70–90	55–80	35–45	15–25
0	90–100	85–98	75–90	55–70	30–40	11–20
0	90–100	85–98	75–90	55–70	35–45	15–25
0	90–100	85–98	75–90	55–70	35–45	15–25
0	100	95–100	95–100	65–90	30–40	5–20
0	100	95–100	95–100	65–80	35–45	20–30
0	100	95–100	90–95	40–65	25–35	5–20
0	90–100	80–100	70–90	60–80	30–40	10–20
0	85–100	80–100	60–80	50–75	35–55	15–30
0	85–100	80–100	50–75	35–60	20–35	5–15
0	100	100	100	95–100	30–40	11–20
0	100	100	100	95–100	50–60	20–30
0	100	100	100	95–100	41–55	15–25
0	100	100	100	95–100	30–40	5–15
0	100	100	100	95–100	25–35	5–10
0	100	100	100	95–100	55–70	30–40
0	100	100	100	95–100	50–65	25–35
0	100	100	100	95–100	30–40	11–20
0	100	100	100	95–100	50–65	30–40
0	100	100	100	95–100	45–55	25–35
0	100	100	100	95–100	30–40	5–15
0	100	100	100	95–100	50–65	30–40
0	100	100	100	95–100	45–55	20–30
0	100	100	90–100	90–100	41–60	15–30
0	100	100	90–100	90–100	41–55	15–30
0	100	100	85–95	35–50	15–30	NP–10
0	100	100	80–95	5–20	10–30	NP–5
0	100	100	70–90	5–20	----------	NP
0	85–95	80–90	70–80	55–70	20–30	5–15
0	85–95	80–90	70–85	55–75	30–40	15–25
0	85–95	80–90	70–85	55–75	35–45	15–25
0	95–100	80–95	75–90	60–80	30–40	11–20
0	95–100	80–95	70–90	55–80	45–55	20–30
0	95–100	80–95	70–90	55–80	35–45	15–25
0	100	100	95–100	90–100	30–50	5–25
0	100	100	95–100	90–100	30–50	5–20
0	100	95–100	95–100	90–100	25–35	5–15

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Clarinda:				
222C, 222C2, 222D, 222D2	0–7	Silty clay loam	CL	A–7
	7–33	Silty clay, clay	CH	A–7
	33–65	Clay	CH	A–7
Wabash:				
248	0–17	Silty clay loam	CL, CH	A–6, A–7
	17–72	Silty clay, clay	CH	A–7
Humeston:				
269	0–13	Silty clay loam	CL, CL–ML	A–6, A–4
	13–26	Silt loam	CL, CL–ML	A–7, A–6, A–4
	26–63	Silty clay loam, silty clay	CH, CL	A–7
Olmitz:				
273B	0–33	Loam	CL	A–6
	33–63	Clay loam	CL	A–6, A–7
Haig:				
362	0–7	Silty clay loam	CL, OL	A–6, A–7
	7–24	Silty clay loam, silty clay	CL, CH	A–7
	24–44	Silty clay	CH	A–7
	44–65	Silty clay loam	CL, CH	A–7, A–6
Grundy:				
364B	0–11	Silty clay loam	CL, ML	A–6, A–7, A–4
	11–24	Silty clay loam, silty clay	CH, CL	A–7
	24–37	Silty clay, silty clay loam	CH	A–7
	37–60	Silty clay loam	CH, CL	A–7
Macksburg:				
368, 368B	0–22	Silty clay loam	ML, OL, CL	A–7
	22–43	Silty clay loam, silty clay	CH	A–7
	43–67	Silty clay loam	CL	A–7
Winterset:				
369	0–18	Silty clay loam	CL, OL	A–7
	18–42	Silty clay, silty clay loam	CH	A–7
	42–75	Silty clay loam	CL, CH	A–7
Sharpsburg:				
370B, 370C, 370C2, 370D	0–13	Silty clay loam	OL, CL, CH, OH	A–7, A–6
	13–40	Silty clay loam, silty clay	CH, CL	A–7, A–6
	40–62	Silty clay loam	CL	A–7, A–6
Nira:				
[1] 371C:				
Nira part	0–13	Silty clay loam	CL, OL	A–7
	13–30	Silty clay loam	CL	A–7
	30–60	Silty clay loam	CL	A–6, A–7
Sharpsburg part	0–13	Silty clay loam	OL, CL, CH, OH	A–7, A–6
	13–40	Silty clay loam, silty clay	CH, CL	A–7, A–6
	40–62	Silty clay loam	CL	A–7, A–6
[1] 371C2:				
Nira part	0–13	Silty clay loam	CL, OL	A–7
	13–30	Silty clay loam	CL	A–7
	30–60	Silty clay loam	CL	A–6, A–7
Sharpsburg part	0–13	Silty clay loam	OL, CL, CH, OH	A–7, A–6
	13–40	Silty clay loam, silty clay	CH, CL	A–7, A–6
	40–62	Silty clay loam	CL	A–7, A–6
Keswick:				
425C	0–11	Loam	CL, CL–ML	A–6, A–4
	11–35	Clay loam, clay	CH, MH	A–7
	35–64	Clay loam, sandy clay loam	CL, SC	A–6

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	95–100	90–100	85–100	40–50	20–30
0	100	95–100	85–100	80–100	55–70	30–40
0	95–100	95–100	80–95	75–90	50–60	25–35
0	100	100	100	95–100	30–55	12–35
0	100	100	100	95–100	52–78	30–55
0	100	100	95–100	95–100	25–40	5–20
0	100	100	95–100	95–100	25–45	5–20
0	100	100	95–100	95–100	45–55	25–35
0	100	90–100	85–95	60–80	30–40	11–20
0	100	90–100	85–95	60–80	35–45	15–25
0	100	100	95–100	90–100	35–45	10–20
0	100	100	95–100	90–100	40–55	20–30
0	100	100	95–100	90–100	50–65	30–40
0	100	100	95–100	90–100	35–60	20–30
0	100	100	95–100	90–100	30–45	5–25
0	100	100	95–100	95–100	45–55	30–40
0	100	100	95–100	95–100	50–70	30–45
0	100	100	95–100	95–100	45–55	30–40
0	100	100	100	95–100	41–50	15–25
0	100	100	100	95–100	50–60	25–35
0	100	100	100	95–100	41–50	20–30
0	100	100	100	95–100	40–50	20–30
0	100	100	100	95–100	50–70	30–40
0	100	100	100	95–100	45–55	25–35
0	100	100	100	95–100	35–55	20–30
0	100	100	100	95–100	35–60	20–35
0	100	100	100	95–100	35–50	20–30
0	100	100	100	95–100	41–50	15–25
0	100	100	100	95–100	41–50	20–30
0	100	100	100	95–100	35–45	15–25
0	100	100	100	95–100	35–55	20–30
0	100	100	100	95–100	35–60	20–35
0	100	100	100	95–100	35–50	20–30
0	100	100	100	95–100	41–50	15–25
0	100	100	100	95–100	41–50	20–30
0	100	100	100	95–100	35–45	15–25
0	100	100	100	95–100	35–55	20–30
0	100	100	100	95–100	35–60	20–35
0	100	100	100	95–100	35–50	20–30
0	95–100	80–100	75–90	60–80	20–30	5–15
0	95–100	80–100	70–90	55–80	50–60	20–30
0	95–100	80–100	65–85	40–70	35–40	15–25

TABLE 10.—*Engineering properties*

Soil name and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Caleb:				
451C2, 451D2, 451E2	0–14	Loam	CL	A–6
	14–32	Clay loam, loam, sandy clay loam	CL, CH	A–6, A–7
	32–72	Sandy clay loam, sandy loam	SC, CL, SM–SC, CL–ML	A–4, A–6
Lineville:				
452C	0–11	Silt loam	ML, CL	A–6, A–7
	11–28	Silty clay loam	CL, CH	A–7
	23–58	Clay loam, loam	CL	A–6, A–7
	58–72	Clay loam, clay	CH	A–7
Mystic:				
592C2, 592D2	0–12	Silt loam	CL, CL–ML, ML	A–4, A–6
	12–54	Clay loam, clay, silty clay	CL	A–6, A–7
	54–62	Sandy clay loam	SC, CL, SM–SC,	A–6, A–4

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	90–100	80–100	70–90	60–80	30–40	10–20
0	85–100	80–100	60–80	50–75	35–55	15–30
0	85–100	80–100	50–75	35–60	20–35	5–15
0	100	100	95–100	95–100	35–45	11–15
0	100	100	95–100	95–100	45–55	25–35
0	95–100	80–100	75–95	65–90	35–50	20–35
0	95–100	80–100	70–90	55–80	55–60	20–35
0	100	95–100	95–100	65–90	30–40	5–20
0	100	95–100	95–100	65–80	35–45	20–30
0	100	95–100	90–95	40–65	25–35	5–20
0	95–100	80–95	75–90	55–80	20–40	5–20
0	95–100	80–95	70–90	55–80	45–60	20–30
0	95–100	80–95	70–90	55–80	35–40	15–25
0	95–100	95–100	80–95	70–95	35–45	15–25
0	95–100	95–100	90–100	85–100	50–60	25–35
0	95–100	95–100	70–90	55–85	35–50	15–30
0	85–95	80–90	70–80	55–70	20–30	5–15
0	85–95	80–90	70–85	55–75	30–40	15–25
0	85–95	80–90	70–85	55–75	35–45	15–25
0	95–100	80–95	75–90	55–80	20–40	5–20
0	95–100	80–95	70–90	55–80	45–60	20–30
0	95–100	80–95	70–90	55–80	35–40	15–25
0	85–95	80–90	70–80	55–70	20–30	5–15
0	85–95	80–90	70–85	55–75	30–40	15–25
0	85–95	80–90	70–85	55–75	35–45	15–25
0	95–100	80–95	75–90	55–80	20–40	5–20
0	95–100	80–95	70–90	55–80	45–60	20–30
0	95–100	80–95	70–90	55–80	35–40	15–25

behavior of the whole mapping unit.

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

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

Flooding is the temporary covering of soil with water from overflowing streams, with runoff from adjacent slopes, and by tides. Water standing for short periods after rains or after snow melts is not considered flooding, nor is water in swamps and marshes. Flooding is rated in general terms that describe the frequency and duration of flooding and the time of year when flooding is most likely. The ratings are based on evidence in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with in-

TABLE 11.—*Physical and chemical*

[Dashes indicate data were not available. The symbol < means less than. The erosion tolerance

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Judson:				
8B	0–28	0.6–2.0	0.21–0.23	6.1–7.3
	28–60	0.6–2.0	0.21–0.23	6.1–7.8
Colo:				
[1] 11B:				
Colo part	0–41	0.2–0.6	0.21–0.23	5.6–6.5
	41–60	0.2–0.6	0.18–0.20	6.1–7.3
Ely part	0–32	0.6–2.0	0.21–0.23	5.6–6.5
	32–60	0.6–2.0	0.18–0.20	6.1–7.3
Nodaway:				
[1] 13B:				
Nodaway part	0–80	0.6–2.0	0.20–0.23	6.1–7.3
Vesser part	0–10	0.6–2.0	0.20–0.24	5.6–6.5
	10–25	0.6–2.0	0.18–0.22	5.1–6.0
	25–70	0.2–2.0	0.17–0.21	5.6–6.5
Arispe:				
23C	0–7	0.6–2.0	0.21–0.23	5.6–6.0
	7–40	0.2–0.6	0.18–0.20	5.6–7.3
	40–60	0.2–0.6	0.18–0.20	6.6–7.3
Shelby:				
24C, 24C2, 24D, 24D2, 24D3, 24E, 24E2, 24F2	0–15	0.6–2.0	0.20–0.22	5.6–6.0
	15–38	0.2–0.6	0.16–0.18	5.6–6.0
	38–65	0.2–0.6	0.16–0.18	6.6–7.8
Vesser:				
51	0–10	0.6–2.0	0.20–0.24	5.6–6.5
	10–25	0.6–2.0	0.18–0.22	5.1–6.0
	25–70	0.2–2.0	0.17–0.21	5.6–6.5
Lindley:				
65E, 65F	0–10	0.6–2.0	0.16–0.18	4.5–6.0
	10–60	0.2–0.6	0.14–0.18	4.5–6.5
Clearfield:				
69C	0–13	0.2–0.6	0.21–0.23	5.6–7.3
	13–48	0.2–0.6	0.18–0.20	5.6–7.3
	48–60	<0.06	0.10–0.12	5.6–7.3
Ladoga:				
76B, 76C, 76C2, 76D, T76B, T76C	0–11	0.6–2.0	0.22–0.24	6.1–6.5
	11–65	0.2–0.6	0.18–0.20	5.1–6.0
Adair:				
[1] 93D:				
Adair part	0–16	0.2–0.6	0.17–0.19	5.6–6.5
	16–35	0.06–0.2	0.13–0.16	5.1–6.5
	35–60	0.2–0.6	0.14–0.16	5.6–6.5
Shelby part	0–15	0.6–2.0	0.20–0.22	5.6–6.0
	15–38	0.2–0.6	0.16–0.18	5.6–6.0
	38–65	0.2–0.6	0.16–0.18	6.6–7.8
[1] 93D2:				
Adair part	0–16	0.2–0.6	0.17–0.19	5.6–6.5
	16–35	0.06–0.2	0.13–0.16	5.1–6.5
	35–60	0.2–0.6	0.14–0.16	5.6–6.5
Shelby part	0–15	0.6–2.0	0.20–0.22	5.6–6.0
	15–38	0.2–0.6	0.16–0.18	5.6–6.0
	38–65	0.2–0.6	0.16–0.18	6.6–7.8

properties of soils

factor (T) is for the entire profile. Absence of an entry means data were not estimated]

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	Moderate	Low	0.28	5	7
Moderate	Moderate	Low	0.43		
High	High	Moderate			7
High	High	Moderate			
Moderate	High	Moderate	0.32	5	7
Moderate	High	Low	0.43		
Moderate	Moderate	Low			7
Moderate	High	Moderate	0.32	5	7

TABLE 11.—*Physical and chemical*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
[1] 93E2:				
Adair part	0–16	0.2–0.6	0.17–0.19	5.6–6.5
	16–35	0.06–0.2	0.13–0.16	5.1–6.5
	35–60	0.2–0.6	0.14–0.16	5.6–6.5
Shelby part	0–15	0.6–2.0	0.20–0.22	5.6–6.0
	15–38	0.2–0.6	0.16–0.18	5.6–6.0
	38–65	0.2–0.6	0.16–0.18	6.6–7.8
Mystic:				
[1] 94D2:				
Mystic part	0–12	0.6–2.0	0.22–0.24	4.5–6.0
	12–54	0.06–0.2	0.15–0.19	4.5–6.5
	54–62	0.6–2.0	0.16–0.18	6.1–6.5
Caleb part	0–14	0.6–2.0	0.14–0.18	4.5–6.0
	14–32	0.2–0.6	0.14–0.18	4.5–6.0
	32–72	0.6–2.0	0.12–0.16	6.1–6.5
Sperry:				
122	0–20	0.6–2.0	0.22–0.24	5.6–6.5
	20–51	<0.2	0.14–0.16	5.6–6.5
	51–72	0.6–2.0	0.19–0.21	6.1–6.5
Belinda:				
T130	0–7	0.6–2.0	0.22–0.24	5.6–6.5
	7–18	0.6–2.0	0.20–0.22	4.5–6.0
	18–43	<0.06	0.12–0.14	4.5–5.5
	43–80	0.06–0.6	0.18–0.20	5.1–6.0
Pershing:				
131C, 131C2, 131D, T131B, T131C	0–10	0.6–2.0	0.22–0.24	4.5–6.5
	10–34	0.06–0.2	0.18–0.20	5.1–6.0
	34–61	0.2–0.6	0.18–0.20	5.1–6.0
Weller:				
132C	0–12	0.6–2.0	0.22–0.24	4.5–6.0
	12–41	0.06–0.2	0.12–0.18	4.5–6.0
	41–63	0.2–0.6	0.18–0.20	5.1–6.0
Colo:				
133, 133B	0–41	0.2–0.6	0.21–0.23	5.6–6.5
	41–60	0.2–0.6	0.18–0.20	6.1–7.3
Dickinson:				
175D	0–23	2.0–6.0	0.12–0.15	5.6–6.5
	23–50	6.0–20	0.08–0.10	5.6–6.5
	50–60	6.0–20	0.02–0.04	5.6–6.5
Gara:				
179D, 179D2, 179E, 179E2, 179F	0–12	0.6–2.0	0.20–0.22	5.6–6.0
	12–40	0.2–0.6	0.16–0.18	5.1–6.5
	40–60	0.2–0.6	0.16–0.18	6.6–7.8
Adair:				
192C, 192C2, 192D2	0–16	0.2–0.6	0.17–0.19	5.6–6.5
	16–35	0.06–0.2	0.13–0.16	5.1–6.5
	35–60	0.2–0.6	0.14–0.16	5.6–6.5
Kennebec:				
212	0–30	0.6–2.0	0.22–0.24	5.6–6.5
	30–60	0.6–2.0	0.20–0.22	6.1–7.3

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	High	Moderate	0.32	3	6
High	High	Moderate	0.32		
Moderate	High	Moderate	0.32		
Moderate	Moderate	Moderate	0.28	5	6
Moderate	Moderate	Moderate	0.28		
Moderate	Moderate	Moderate	0.37		
Low	Moderate	Moderate	0.37	3	6
Moderate	Moderate	Moderate	0.37		

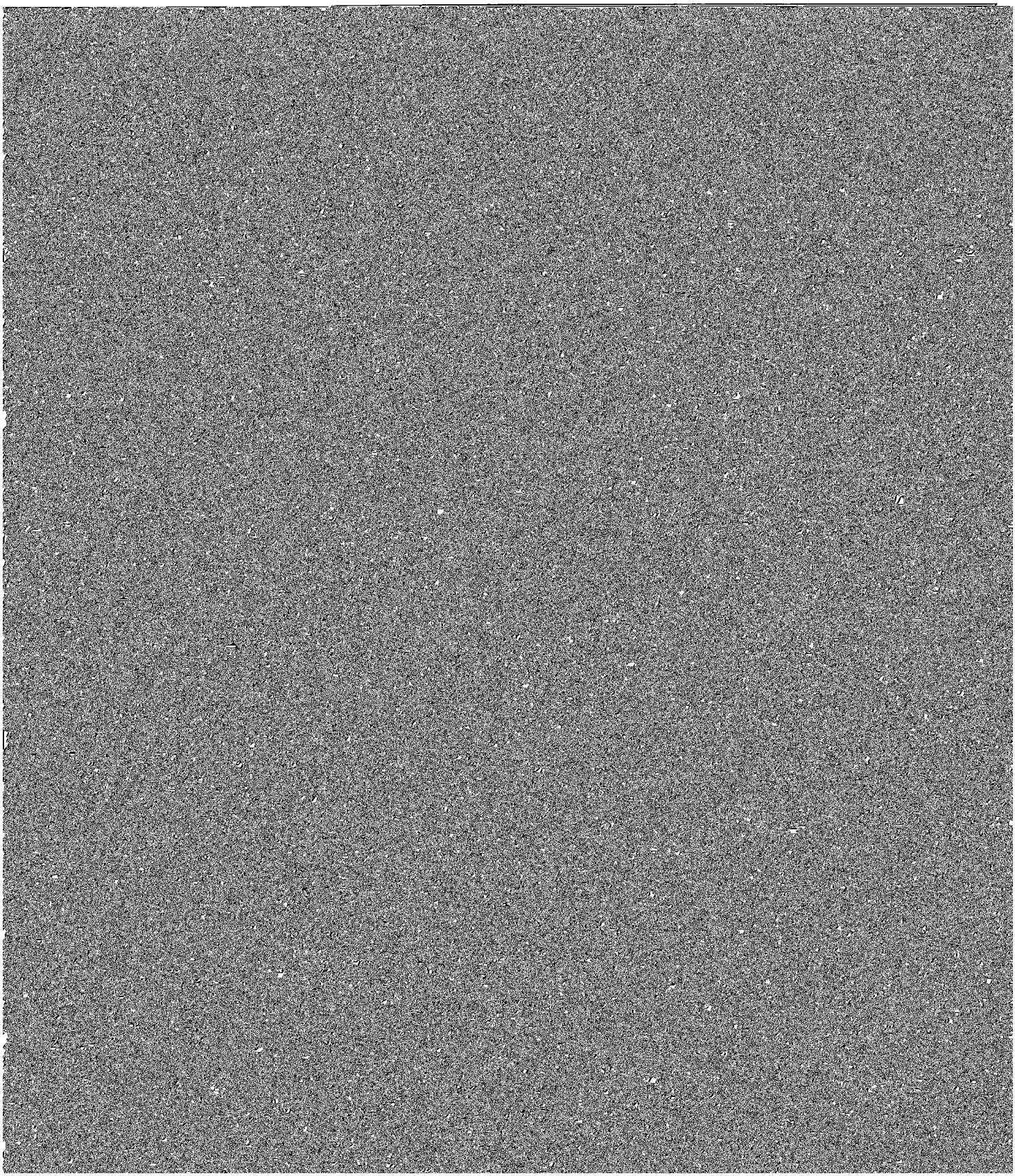
TABLE 11.—*Physical and chemical*

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Clarinda:				
222C, 222C2, 222D, 222D2	0–7	0.2–0.6	0.17–0.19	5.1–6.5
	7–33	<0.06	0.14–0.16	5.1–6.5
	33–65	<0.06	0.14–0.16	5.6–7.3
Wabash:				
248	0–17	0.06–0.2	0.21–0.24	5.6–7.3
	17–72	<0.06	0.08–0.12	5.6–7.8
Humeston:				
269	0–13	0.2–2.0	0.21–0.23	5.1–6.0
	13–26	0.2–2.0	0.20–0.22	4.5–6.0
	26–63	<0.06	0.13–0.15	4.5–6.5
Olmitz:				
273B	0–33	0.6–2.0	0.19–0.21	5.6–6.5
	33–63	0.6–2.0	0.15–0.17	5.1–6.5
Haig:				
362	0–7	0.6–2.0	0.22–0.24	5.6–6.5
	7–24	0.6–2.0	0.21–0.23	5.1–6.0
	24–44	<0.2	0.12–0.14	5.1–6.0
	44–65	0.2–0.6	0.18–0.20	6.1–7.3
Grundy:				
364B	0–11	0.6–2.0	0.22–0.24	5.6–7.3
	11–24	0.2–0.6	0.18–0.20	5.6–6.0
	24–37	0.06–0.2	0.11–0.13	5.1–6.5
	37–60	0.06–0.2	0.18–0.20	5.6–7.3
Macksburg:				
368, 368B	0–22	0.6–2.0	0.21–0.23	5.1–6.5
	22–43	0.2–0.6	0.18–0.20	5.1–6.0
	43–67	0.2–0.6	0.18–0.20	5.6–6.5
Winterset:				
369	0–18	0.2–0.6	0.21–0.23	5.6–7.3
	18–42	0.06–0.6	0.14–0.18	5.6–6.5
	42–75	0.2–0.6	0.18–0.20	6.1–7.3
Sharpsburg:				
370B, 370C, 370C2, 370D	0–13	0.6–2.0	0.21–0.23	5.1–6.5
	13–40	0.2–0.6	0.18–0.20	5.1–6.0
	40–62	0.2–0.6	0.18–0.20	6.1–6.5
Nira:				
[1] 371C:				
Nira part	0–13	0.6–2.0	0.21–0.23	5.6–6.5
	13–30	0.2–0.6	0.18–0.20	5.6–6.0
	30–60	0.6–2.0	0.18–0.20	5.6–6.5
Sharpsburg part	0–13	0.6–2.0	0.21–0.23	5.1–6.5
	13–40	0.2–0.6	0.18–0.20	5.1–6.0
	40–62	0.2–0.6	0.18–0.20	6.1–6.5
[1] 371C2:				
Nira part	0–13	0.6–2.0	0.21–0.23	5.6–6.5
	13–30	0.2–0.6	0.18–0.20	5.6–6.0
	30–60	0.6–2.0	0.18–0.20	5.6–6.5
Sharpsburg part	0–13	0.6–2.0	0.21–0.23	5.1–6.5
	13–40	0.2–0.6	0.18–0.20	5.1–6.0
	40–62	0.2–0.6	0.18–0.20	6.1–6.5
Keswick:				
425C	0–11	0.6–2.0	0.14–0.18	4.5–6.0
	11–35	0.06–2.0	0.11–0.15	4.5–6.0
	35–64	0.2–0.6	0.12–0.16	4.5–6.0

properties of soils—Continued

Shrink-swell potential	Risk of corrosion		Erosion factors		Wind erodibility group
	Uncoated steel	Concrete	K	T	
Moderate	High	Moderate	0.37	3	7
High	High	Moderate	0.37		
High	High	Moderate	0.37		
High	High	Moderate			4
Very high	High	Moderate			
Moderate	High	Moderate	0.32	4	7
Moderate	High	Moderate	0.32		
High	High	Moderate	0.32		
Moderate	Moderate	Moderate	0.28	5	6
Moderate	Moderate	Moderate	0.28		
Moderate	High	Moderate			6
High	High	Moderate			
High	High	Moderate			
High	High	Low			
Moderate	High	Low	0.37	3	6
High	High	Low	0.37		
High	High	Moderate	0.37		
High	High	Low	0.37		
Moderate	High	Moderate	0.32	5	6
High	High	Moderate	0.43		
High	High	Moderate	0.43		
Moderate	High	Moderate			7
High	High	Moderate			
High	High	Low			
Moderate	Moderate	Moderate	0.32	5	7
High	Moderate	Moderate	0.43		
Moderate	Moderate	Low	0.43		
Moderate	Moderate	Moderate	0.32	5	7
High	Moderate	Moderate	0.43		
Moderate	Moderate	Moderate	0.43		
Moderate	Moderate	Moderate	0.32	5	7
High	Moderate	Moderate	0.43		
Moderate	Moderate	Low	0.43		
Moderate	Moderate	Moderate	0.32	5	7

TABLE 11.—*Physical and chemical*



properties of soils—Continued

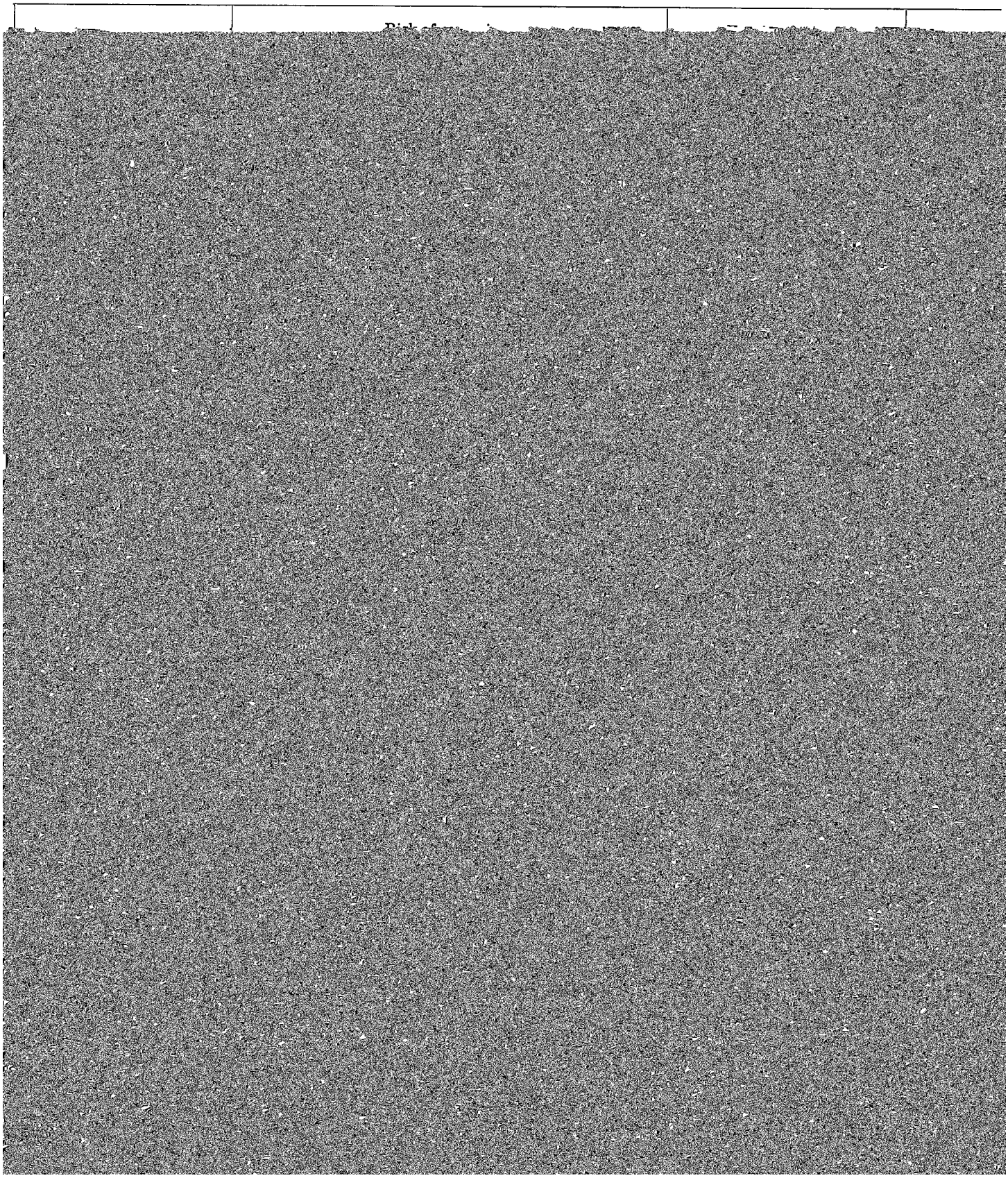


TABLE 12.—*Soil and*

[Absence of an entry indicates the feature is not a concern. See text for descriptions of

Soil name and map symbol	Hydrologic groups	Flooding		
		Frequency	Duration	Months
Judson:				
8B	B	None		
Colo:				
[1] 11B:				
Colo part	B/D	Common	Brief	Mar-Jun
Ely part	B	None		
Nodaway:				
[1] 13B:				
Nodaway part	B	Common	Brief	Feb-Nov

water features

symbols and such terms as "rare," "brief," and "perched." The symbol > means greater than]

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	

TABLE 12.—*Soil and*

Soil name and map symbol	Hydrologic groups	Flooding		
		Frequency	Duration	Months
Dickinson: 175D	B	None		
Gara: 179D, 179D2, 179E, 179E2, 179F	C	None		
Adair: 192C, 192C2, 192D2	D	None		
Kennebec: 212	B	Common	Brief	Feb-Nov
Nodaway: 220, C220	B	Common	Brief	Feb-Nov
Clarinda:				

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
1.0–3.0	Perched	Nov-Mar	>60	----------	High.
2.0–5.0	Apparent	Nov-May	>60	----------	High.
>6.0	----------	----------	>60	----------	High.
1.0–3.0	Perched	Nov-May	>60	----------	Moderate.
0–1.0	Perched	Nov-May	>60	----------	Moderate.
1.0–3.0	Apparent	Nov-Apr	>60	----------	High.
>6.0	----------	----------	>60	----------	Moderate.
0–3.0	Perched	Apr-Jul	>60	----------	High.
1.0–3.0	Perched	Mar-May	>60	----------	Moderate.
2.0–4.0	Perched	Apr-Jul	>60	----------	High.
0–3.0	Perched	Apr-Jul	>60	----------	High.
>6.0	----------	----------	>60	----------	High.
>6.0	----------	----------	>60	----------	High.
>6.0	----------	----------	>60	----------	High.
>6.0	----------	----------	>60	----------	High.
>6.0	----------	----------	>60	----------	High.
1.0–3.0	Perched	Nov-Mar	>60		High.

TABLE 12.—*Soil and*

Soil name and map symbol	Hydrologic groups	Flooding		
		Frequency	Duration	Months
Lamoni:				
822C, 822C2, 822D, 822D2	D	None		
Gara:				
[1] 993D2:				
Gara part	C	None		
Armstrong part	D	None		
[1] 993E2:				
Gara part	C	None		
Armstrong part	D	None		

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

County. It also explains the system of soil classification. Detailed descriptions of profiles considered representative of the series are in the section "Descriptions of the Soils." This information is useful to scientists, teachers, students, and others interested in the formation and classification of 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.

Climate and vegetation are active factors of soil

the major soils and their parent material are shown in figures 3, 4, and 5. The deposition of the various deposits in Union County and the subsequent geologic erosion have resulted in the formation of a landscape characterized by broad stable ridgetops occupied by soils that formed in glacial till and loess, and numerous large and small stream valleys where soils formed in alluvium. Union County has a similar landscape to that of Adair County, which adjoins the county on the north. In Adair County, a detailed study has been made of the landscape evolution and soil formation by R.V. Ruhe, R.B. Daniels, and J.G. Cady (*21*). This study will be referred to in several places on subsequent pages.

Loess.—Loess is a silty, wind-deposited material that consists largely of silt particles. It has smaller amounts of clay and sand. It is the most extensive parent material in Union County. Loess was deposited during the Wisconsin glacial period from about 24,500 to 14,000 years ago (*16, 21*). The loess is believed to have

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
1.0–3.0	Perched	Nov-May	>60		Moderate.
>6.0			>60		Moderate.
1.0–3.0	Perched	Nov-Mar	>60		High.
>6.0			>60		Moderate.
1.0–3.0	Perched	Nov-Mar	>60		High.

behavior of the whole mapping unit.

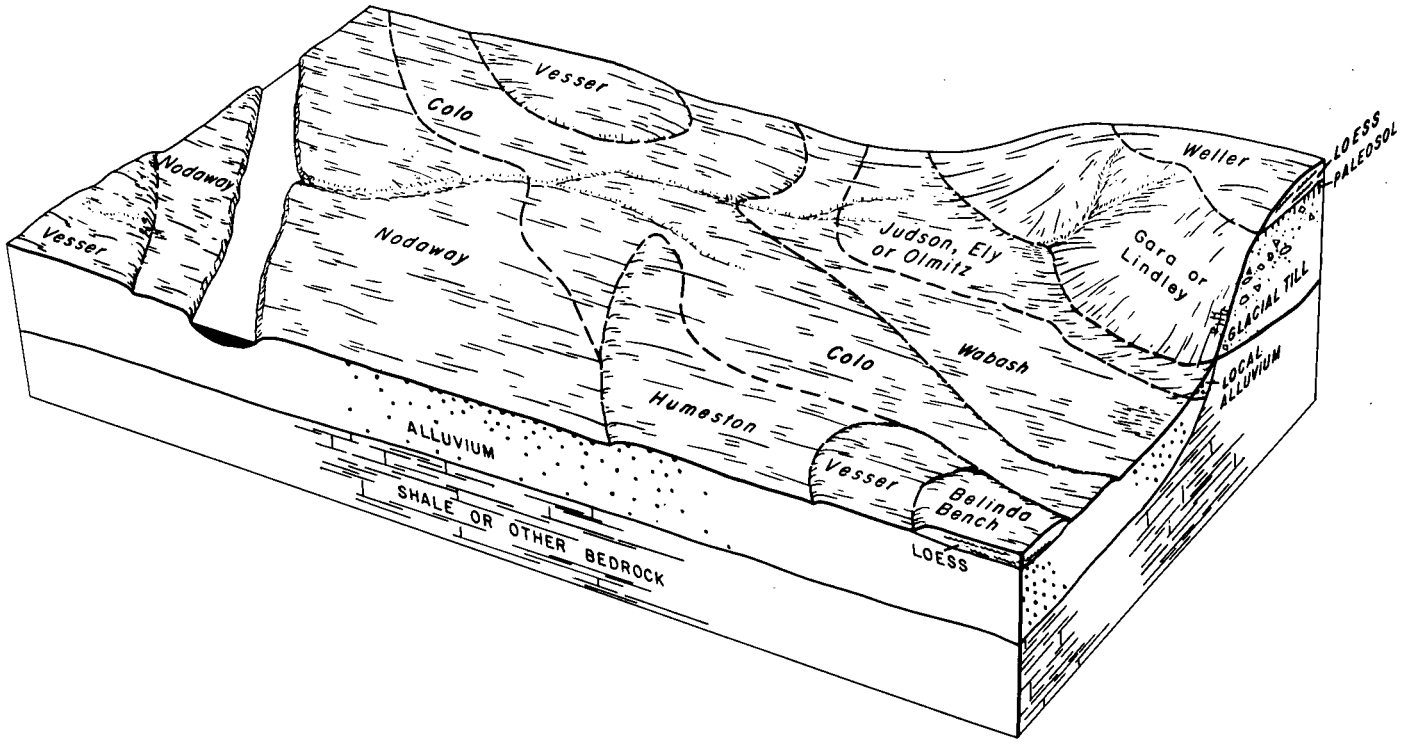


***Figure 3.*—Typical pattern of soil and parent material in Nodaway-Colo-Wabash soil association.**

studied physical and chemical changes accompanying soil profile formation in soils formed in loess in southwest Iowa. Among the soils he studied was Winterset. Other chemical and physical data on Winterset, Macksburg, and Sharpsburg soils have been reported (*22, 30*).

Glacial till.—Two glaciers deposited material in Union County, the Nebraskan, and later the Kansan. The Nebraskan till can be identified on the landscape. It occurs in a few places in the eastern part. The Kansan till is exposed in all parts of the county and, on steep slopes, forms an extensive part of the landscape. The unweathered till is a firm calcareous clay loam. It contains pebbles, boulders, and sand, as well as silt and clay. The till is a heterogeneous mixture and shows little evidence of sorting or stratification. The mineral composition of its components is also heterogeneous (*11*) and is similar to that of particles in unweathered loess.

Observations made during the survey show that the glacial deposits in Union County range to a depth of 100 feet or more. The thickness, hardness, or absence of the underlying sediments or rock has apparently had a direct effect on the thickness of the glacial till.

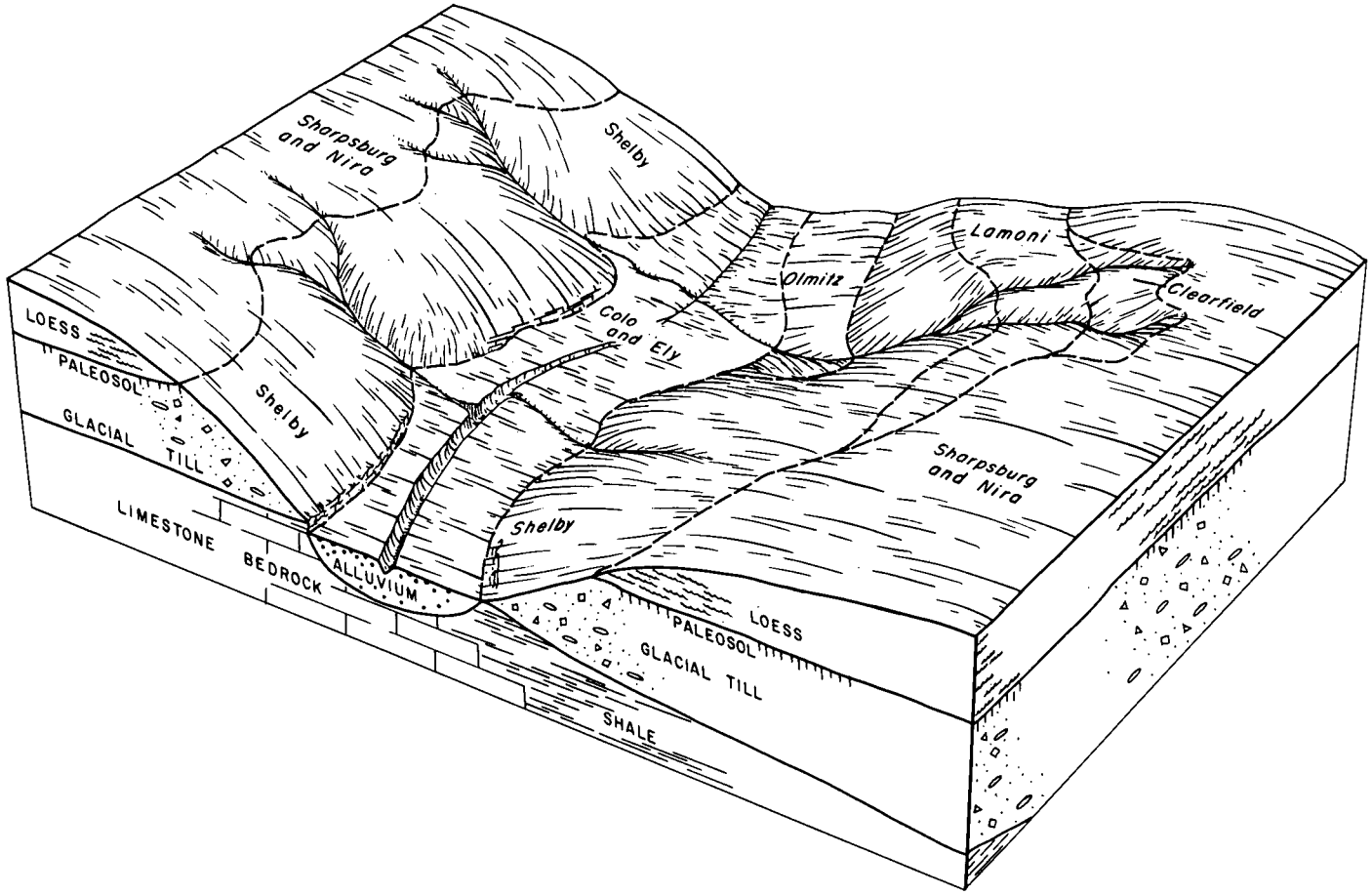


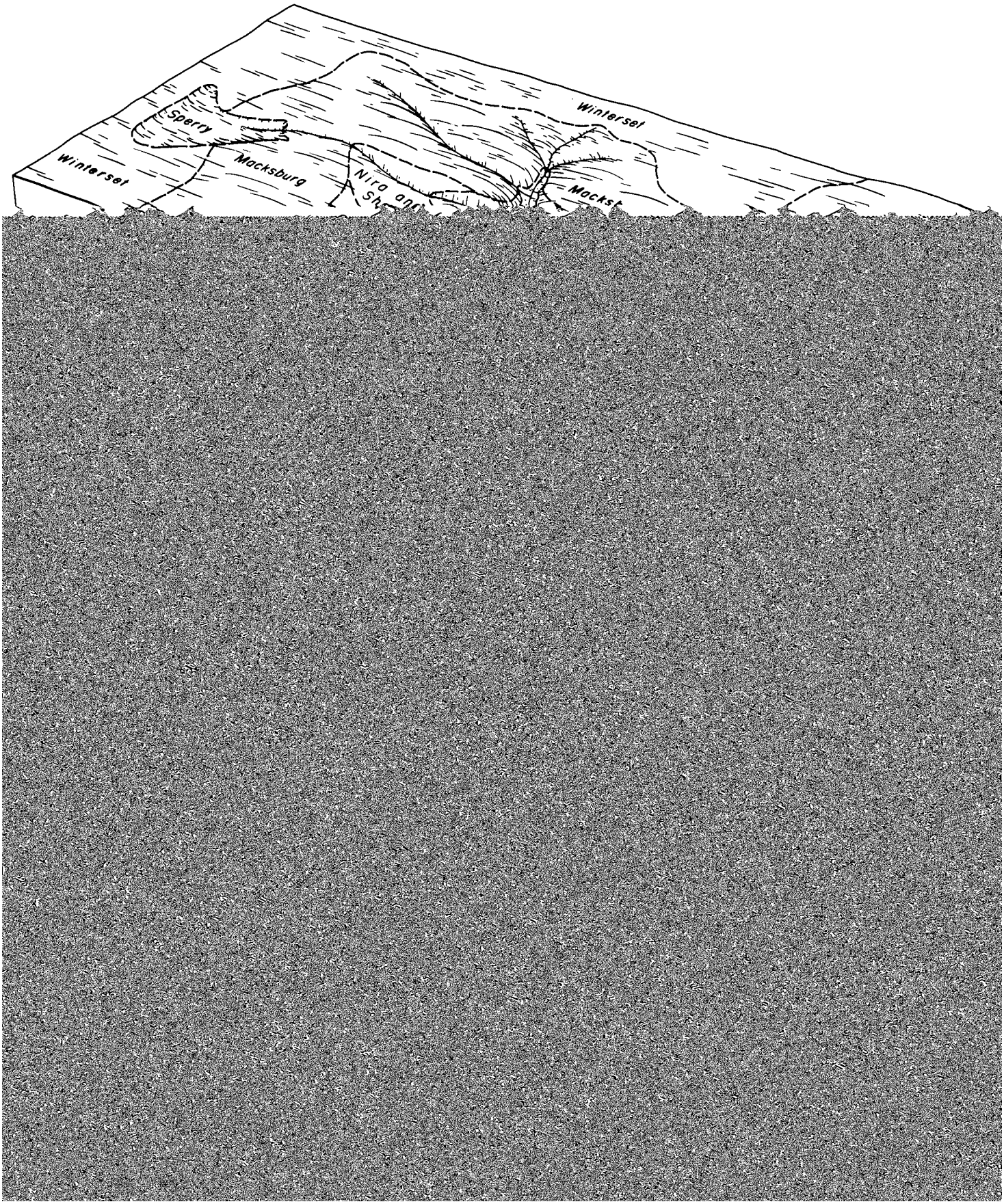
***Figure 4.*—Typical pattern of soil and parent material in Sharpsburg-Shelby-Nira soil association.**

Soils developed on the Kansan till plain during the Yarmouth and Sangamon interglacial periods before the loess was deposited (*20*). In nearly level areas, the soils were strongly weathered and had a gray plastic subsoil called "gumbotil" (*9, 10, 17, 20*). This gumbotil is several feet thick and very slowly permeable. A widespread erosion surface has cut below the Yarmouth-Sangamon paleosol into Kansan till and older deposits. The surface is characterized generally by a stone line or subadjacent sediment and is surmounted by pedisediment (*17, 18, 19*). Paleosols formed in the pedisediment stone line and the subadjacent till (fig. 6). This surface is of Late Sangamon age. The paleosols were more reddish and were not so strongly weathered and not so thick as those on the nearly level areas.

The soils that formed on the Kansan till during Yarmouth and Sangamon time were covered by loess. Geologic erosion has removed the loess from many slopes and has exposed these paleosols. In some places the paleosols have been beveled or truncated so that only the lower part of the strongly weathered paleosol remains. This erosion took place before the loess deposition, or more than 25,000 years ago (*20*). In other places, erosion has removed all of the paleosol and has exposed till that is only slightly weathered at the surface. This erosion mostly took place in post-glacial times (*20*).

The Clarinda soils formed in the strongly weathered, Yarmouth-Sangamon gray clay paleosol. Lamoni soils formed in the truncated Yarmouth-Sangamon paleosol. Their clay layer is not so thick as Clarinda soils. The Adair and Keswick soils formed where the less strongly weathered, reddish paleosol crops out. The Shelby, Gara and Lindley soils formed in slightly weathered glacial till.

The Caleb and Mystic soils formed in pre-Sangamon erosional sediment of varied texture and glacial origin. This material appears to have been angularly truncated in many places. In many places it occurs as an irregular mixture of material of contrasting textures. Caleb and Mystic soils are on extended, stepped interfluves above the present drainage system. They owe their landscape configuration partly to valley fill, but their surfaces blend with the present erosional uplands. These areas are distinctly higher in elevation than the northern flood plain, but they are lower than the late Wisconsin, recent dissection slopes on which the Gara, Shelby, and Lindley soils formed. The Mystic soils are on the most stable parts of interfluves and have inherited many of their characteristics from the Late-Sangamon paleosol. Caleb soils are downslope on


Sperry
Macksburg
Winterset
Winterset

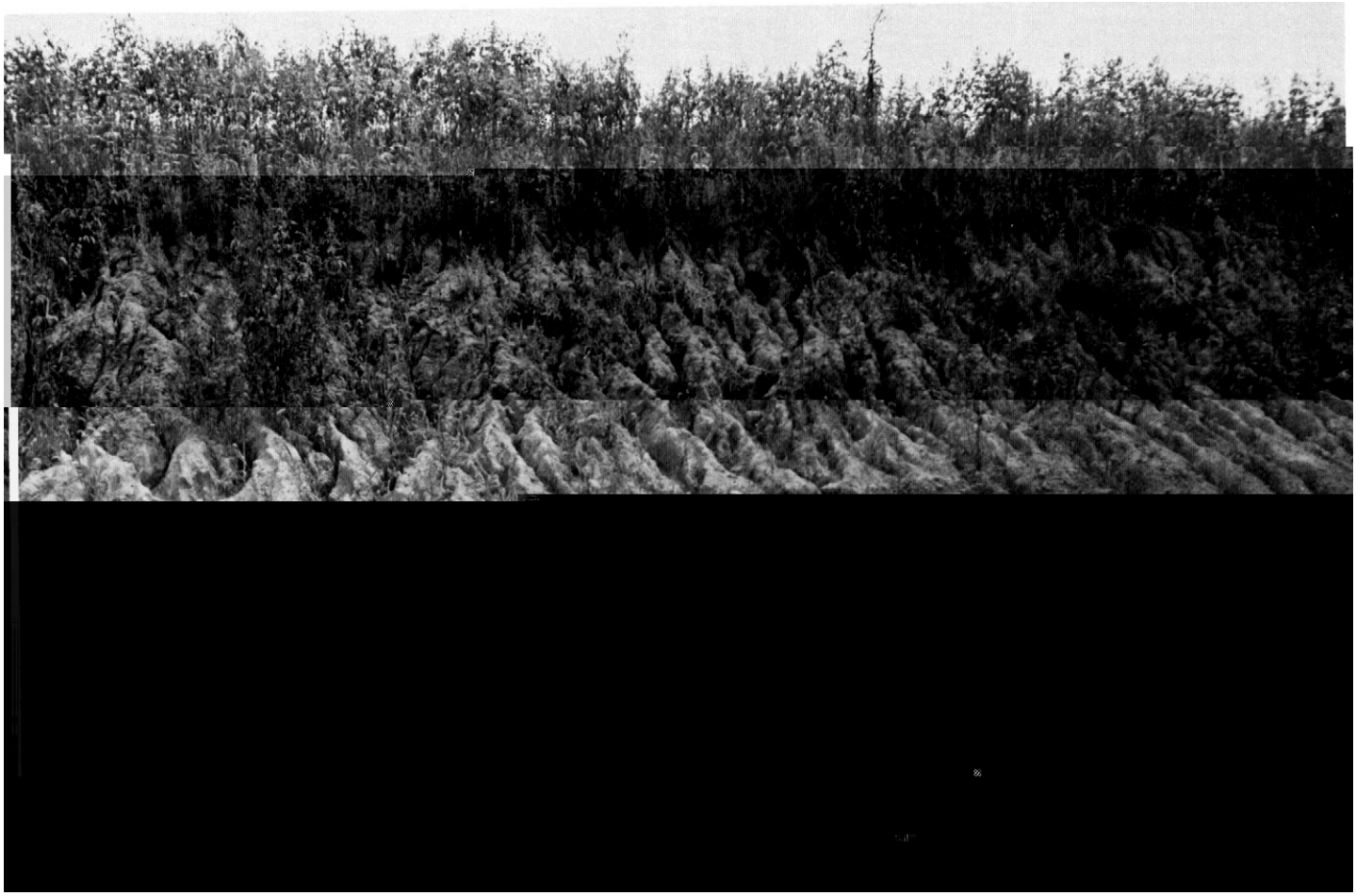


***Figure 6.*—Stone line in reddish paleosol buried under about 8 feet of light-colored loess.**

Climate

Union County soils, according to recent evidence, have been developing under variable climatic conditions. Walker (*31*) in his recent studies concluded that in the Post Cary glaciation period, about 13,000 to 10,500 years ago, the climate was cool and the vegetation was dominated by conifers. Between 10,500 to 8,000 years ago, there was a warming trend and the vegetation changed from conifers to mixed forest. Hardwoods were prominent (*4*). Beginning about 8,000 years ago, the climate became warmer and drier. Herbaceous prairie fauna became dominant and are still dominant. McComb and Loomis (*12*) concluded from

drained bottoms are wetter and colder than most areas around them.

The general climate has had an important overall influence on the characteristics of the soils but has not caused major differences among them. The local differences in climate do account for some differences.

Weathering of the parent material by water and air is activated by changes in temperature. As a result of weathering, changes caused by both physical and chemical actions take place. Rainfall has influenced the formation of the soils through its effect on the amount of leaching in soil and on the kinds of plants that grow.

of vegetation commonly cause the most marked differences among soils (*13*).

The soils of Union County appear to have been influenced in recent times by two main types of vegetation: prairie grasses and trees. The main prairie grasses were big and little bluestem. The trees were mainly oak, hickory, ash, elm, and other deciduous trees.

Studies of the effects of vegetation on soils similar to those in Union County have been made by Cardoso.[2]

orates. The water that percolates through soils removes clay from the A horizon, and much of this clay accumulates in the B horizon. The Sperry soils in depressions have accumulated more clay in the B horizon than the sloping Sharpsburg soils, because more water percolates through the profile. The content of clay in the B horizon is generally greater in gently sloping or level soils than in steep soils. This clay content is progressively greater from Sharpsburg soils to Macks-

TABLE 13.—*Classification of the soils*

Soil name	Family or higher taxonomic class
Adair	Fine, montmorillonitic, mesic Aquic Argiudolls
Arispe	Fine, montmorillonitic, mesic Aquic Argiudolls
Armstrong	Fine, montmorillonitic, mesic Aquollic Hapludalfs
Belinda	Fine, montmorillonitic, mesic Mollic Albaqualfs
Caleb	Fine-loamy, mixed, mesic Mollic Hapludalfs
Clarinda	Fine, montmorillonitic, mesic, sloping Typic Argiaquolls
Clearfield	Fine, montmorillonitic, mesic, sloping Typic Haplaquolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Ely	Fine-silty, mixed, mesic Cumulic Hapludolls
Gara	Fine-loamy, mixed, mesic Mollic Hapludalfs
Grundy	Fine, montmorillonitic, mesic Aquic Argiudolls
Haig	Fine, montmorillonitic, mesic Typic Argiaquolls
Humeston	Fine, montmorillonitic, mesic Argiaquic Argialbolls
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty. mixed, mesic Cumulic Hapludolls
Keswick	Fine, montmorillonitic, mesic Aquic Hapludalfs
Ladoga	Fine, montmorillonitic, mesic Mollic Hapludalfs
Lamoni	Fine, montmorillonitic, mesic Aquic Argiudolls
Lindley	Fine-loamy, mixed, mesic Typic Hapludalfs
Lineville	Fine-loamy, mixed, mesic Aquollic Hapludalfs

used to separate suborders are mainly those that reflect either the presence or absence of waterlogging or soil differences resulting from the climate or vegetation.

GREAT GROUP. Each suborder is divided into great groups on basis of uniformity in the kinds and sequence 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 contain a pan that interferes with the growth of roots or movement of water. The features used are the self-mulching properties of clay, the temperature, the major differences in chemical composition (mainly calcium, magnesium, sodium, and potassium) and the like. The great group is not shown separately in table 13 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 intergrade outside of the range of any other great group, suborder, or order. Each subgroup is identified by the name of the great group preceded by one or more adjectives.

FAMILY. Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or on the behavior of soils

upland plain, has been greatly modified by natural erosion and the trenching of streams. The trenching and landscape-shaping action of the larger streams and tributaries were greatly influenced by the geologic materials exposed below the original loess-mantled plain. The remnants of this plain now occupy a series of stable, loess-mantled divides throughout the county. These divides are less stable and more narrow in the eastern part of the county.

The highest elevation in the county is on the county line in the northwestern part of the county. The lowest is near the stream channel of the Grand River at the southeast corner.

The larger streams have formed valleys 100 to 250 feet below the upland plain. In many places, the south and west slopes are typically abrupt and steep. The valley north- and east-facing slopes are longer and less steep.

In the eastern part of the county, the topography is characterized by narrow, unstable divides, steep valley slopes, and nearly level bottom land and benches.

Most of the county, except along major streams, has topography typical of southern Iowa. The side slopes are rounded and uniform but range from gently sloping to steep. The long tributary streams that cut into thick deposits of glacial till extend far into the uplands.

Drainage

Two major streams and their tributaries provide the natural drainage of Union County. They are the Platte River in the west and the Grand River in the east. Runoff in the extreme northeast corner of the county flows into the South River, then into the Des Moines River, and eventually into the Mississippi. The northwestern part of the county is drained by tributaries of the Nodaway River.

Most of the natural drainage in the county flows into the Missouri River through the Grand and Platte River systems.

In 1971, approximately 115,000 acres was pasture. Much of this acreage is improved pasture that is seeded to mixtures of grasses and legumes. Some pastures are in bluegrass. Most of the woodland is also grazed.

Livestock.—Raising and feeding beef cattle and hogs is the major enterprise in Union County. Approximately 8,331 grain-fed cattle and 80,553 hogs were marketed in 1971. There were 21,477 beef cattle, 731 dairy cows, and 12,447 sows farrowed. There were 2,465 lambs born and 1,814 grain-fed sheep and lambs marketed. Laying hens numbered 13,545.

The number of beef cattle has increased since 1961. The number of grain-fed cattle has decreased slightly along with the number of sows farrowed. The number of laying hens has decreased from 77,034 in 1961 to 13,545 in 1971. Dairy cows have also decreased from 3,612 to 731 during the same period.

Climate[4]

Union County is in the western part of south central Iowa. The records at Creston are representative of the rest of the county. Data on temperature and precipitation are listed in tables 14 and 15.

Annual precipitation ranges from about 30.4 inches in the west to 31.5 inches in the east. The greatest part of this difference occurs during the warm season. Average monthly values and the extreme values to be expected for a month, 1 year in 10, are given in table 14. June is the wettest month, and August is the second wettest. From 1951 to 1960, Creston averaged 20 days per year with half an inch or more of rainfall and 55 days with 0.10 or more.

About 75 percent of the warm-season rainfall occurs as showers that vary widely across the county and are sometimes heavy enough to cause erosion problems. Cool-season precipitation seldom falls as showers. The probability of receiving an inch or more of rainfall in a 1-week period is about 4 years out of 10 in June, and decreases to between 2 and 3 years out of 10 in July and August. Well developed crops use over an inch of

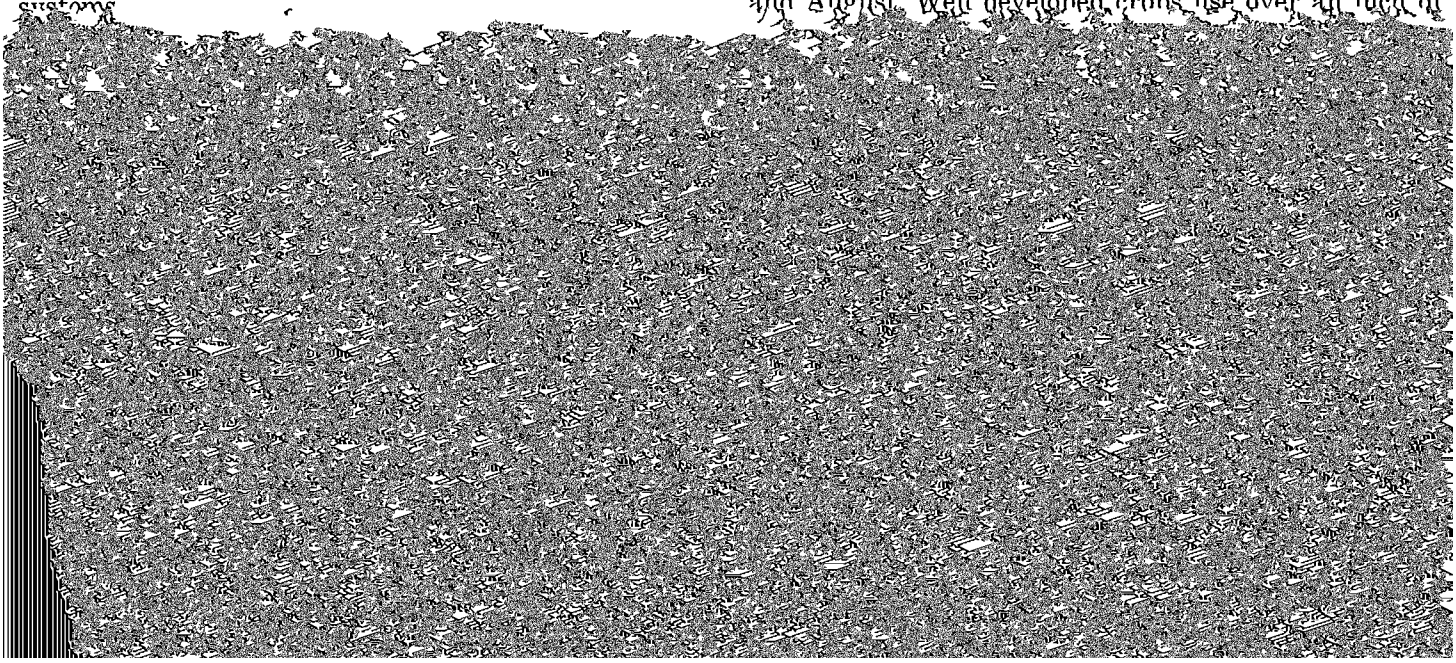


TABLE 14.—*Temperature and precipitation*

Month	Temperature				Precipitation			
						1 year in 10 will have—	Number	Average

(14) Ruhe, Robert V. and W. H. Scholtes. 1955. Radiocarbon dates in central Iowa. J. Geol., vol. 63: 82–92, illus.
(15) Ruhe, Robert V. 1954. Relations of the properties of Wisconsin loess to topography in western Iowa. Am. J. Sci. 252: 663–672.
(16) Ruhe, Robert V. 1956. Ages and development of soil landscapes in relation to climatic and vegetational changes in Iowa. Soil Sci. Soc. Am. Proc. 20: 264–273, illus.
(17) Ruhe, Robert V. 1956. Geomorphic surfaces and the nature of soils. Soil Sci. 82: 441–445, illus.
(18) Ruhe, Robert V. 1959. Stone lines in soils. Soil Sci. 87: 223–231, illus.
(19) Ruhe, Robert V. 1965. Quaternary paleopedology. Quaternary of the U.S., Princeton Univ. Press, INQUSA Rev. 1: 755–764.
(20) Ruhe, Robert V. 1968. Identification of paleosols in loess deposits in the United States. Proc. VII Congr. Int. Assoc. Quaternary Res. 12: 49–65.
(21) Ruhe, R. V., R. B. Daniels, and J. G. Cady. 1967. Landscape evolution and soil formation in southwestern Iowa. U.S. Dep. Agric. Tech. Bull. 1349: 242 pp., illus.
(22) Runge, E. C. A. and F. F. Riecken. 1966. Influence of natural drainage on the distribution and forms of phosphorus in some Iowa prairie soils. Soil Sci. Soc. Am. Proc. 30: 624–630, illus.
(23) Simonson, Roy W. 1959. Outline of a generalized theory of soil genesis. Soil Sci. Soc. Am Proc. 23: 152–156, illus.
(24) Simonson, Roy W. 1962. Soil classification in the United States. Sci. 137: 1027–1034.
(25) Smith, Guy D., W. H. Allaway, and F. F. Riecken. 1950. Prairie soils of the Upper Mississippi Valley. Adv. Agron. 2: 157–205.
(26) Tilton, J. L. and H. F. Bain. 1896. The geology of Madison County, Iowa. Geol. Surv. Annu. Rep. 7: 489–539.
(27) Ullrich, R. 1950. Some physical changes accompanying prairie, weisenboden, and planosol soil profile development of Peorian loess in Southwestern Iowa. Soil Sci. Soc. Amer. Proc. 14: 287–295.
(28) Ulrich, Rudolph. 1950. Some chemical changes accompanying profile formation of the nearly level soils developed from Peorian loess in southwestern Iowa. Soil Sci. Soc. Am. Proc. 15: 324–329, illus.
(29) United States Department of Agriculture. 1960. Soil classification, a comprehensive system, 7th approximation. Soil Conserv. Serv., 265 pp., illus. [Supplements issued March 1967, September 1968, April 1969.]
(30) United States Department of Agriculture. 1966. Soil laboratory data and descriptions for some soils of Iowa. Soil Conserv. Serv. in coop. Iowa Agric. Exp. Stn. Soil Surv. Invest. Rep. 3, 181 pp.
(31) Walker, P. H. 1966. Post-glacial erosion and environment changes in central Iowa. Soil and Water Conserv. 21: 21–23.
(32) White, E. M., and Riecken, F. F. 1955. Brunizem-gray brown podzolic soil biosequences. Soil Sci. Soc. Amer. Proc. 19: 504–509.

Glossary

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

Alluvium, local. Soil material that has been moved a short distance and deposited at the base of slopes and along small drainageways. It includes the poorly sorted material near the base of slopes that has been moved by gravity, frost action, soil creep, and local wash.

Area reclaim. An area difficult to reclaim after the removal of soil or construction and other uses. Revegetation and erosion control are extremely difficult.

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

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

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

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

Bottoms, first. The normal flood plain of a stream; land along the stream subject to overflow.

Bottoms, second. An old alluvial plain, generally flat or smooth, that borders a stream but is seldom flooded.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

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.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures is difficult.

Compressible. Excessive decrease in volume of soft soil under load.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.

Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly

pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is

or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock com-

the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

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

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

Substratum. The part of the soil below the solum.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

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 can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea. A stream terrace is frequently called a second bottom, in contrast with a flood plain, and is seldom subject to overflow. A marine terrace, generally wide, was deposited by the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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