Series 1956, No. 16

Issued February 1961

SOIL SURVEY

Shelby County Iowa

OUR SOIL ★ OUR STRENGTH

UNITED STATES DEPARTMENT OF AGRICULTURE
Soil Conservation Service
In cooperation with
IOWA AGRICULTURAL EXPERIMENT STATION

HOW TO USE THE SOIL SURVEY REPORT

THIS SOIL SURVEY of Shelby County will serve various groups of readers. It will help farmers in planning the kind of management that will protect their soils and provide good yields, and it will add to the knowledge of soil scientists.

In making this survey, soil scientists walked over the fields and woodlands. They dug holes and examined surface soils and subsoils; measured slopes with a hand level; noted differences in growth of crops, weeds, and brush; and, in fact, recorded all the things about the soils that they believed might affect their suitability for farming, trees, wildlife, and related uses.

The scientists plotted the boundaries of the soils on aerial photographs. Then, cartographers prepared from the photographs the detailed soil map in the back of this report. Fields, woods, roads, streams, and many other landmarks can be seen on the map.

Locating the soils

Use the index to map sheets to locate areas on the large map. The index is a small map of the county on which numbered rectangles have been drawn to show where each sheet of the large map is located. When the correct sheet of the large map is found, it will be seen that boundaries of the soils are outlined, and that there is a symbol for each kind of soil. All areas marked with the same symbol are the same kind of soil, wherever they appear on the map. Suppose, for example, an area located on the map has the symbol Me. The legend for the detailed map shows that this symbol identifies Minden silt loam. This soil, and all others mapped in the county, are described in the section, Descriptions of the Soils.

Finding information

Few readers will be interested in all of the soil survey report, for it has special sections for different groups, as well as some sections of value to all. The parts containing the discussions of climate, relief, drainage, water, and agricultural statistics will be of interest mainly to those not familiar with Shelby County.

Farmers and those who work with farmers will be interested mainly in the section, Descriptions of the Soils and in the section, Use and Management of Soils. Study of these sections will aid them in identifying soils on a farm, in learning ways the soils can be managed, and in judging what yields can be expected.

Farmers in Shelby County have organized the Shelby County Soil Conservation District. The district, through its district commissioners, arranges for farmers to receive technical help from the Soil Conservation Service in planning good use and conservation of the soils on their farms. The survey furnishes some of the facts needed for this technical help, but specific plans should be made for each farm.

Soil scientists will find information about how the soils were formed and how they were classified in the section, Genesis, Classification, and Morphology of Soils.

Students, teachers, and other users will find information about soils and their management in various parts of the report, depending upon their particular interest.

The soil survey map and report are also useful to engineers, assessors, bankers, credit agencies, and others who are concerned with the use and management of land.

The Guide to Mapping Units and Management Groups at the end of the report will simplify the use of the map and the report. This guide gives the map symbol for each soil, the name of the soil, the page on which the soil is described, the management group in which the soil has been placed, and the page where the management group is described.

* * *

The fieldwork for this survey was completed in 1956. Unless noted otherwise, all statements refer to conditions at the time of the survey. The employment of two persons to help in the survey was made possible through funds furnished by the Office of Assessor, Shelby County, Iowa.

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SOIL SURVEY OF SHELBY COUNTY, IOWA

Report by W. M. JURY, D. F. SLUSHER, and S. M. SMITH, Soil Conservation Service, United States Department of Agriculture

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United States Department of Agriculture in cooperation with Iowa Agricultural Experiment Station

SHELBY COUNTY, located in the west-central part of Iowa, has an area of approximately 587 square miles, or 375,680 acres. Distances by air from Harlan, the county seat, to principal cities are shown in the figure on the back of cover.

Shelby County is predominantly agricultural. The early settlers produced mostly for their own needs. As transportation improved, more livestock and crops were grown for market. Wheat probably was the main crop grown by the early settlers, but it was soon superseded by corn.

The cash-grain-livestock system of farming is dominant. The most common practice is to feed crops to livestock and market the livestock.

Corn is the principal grain crop in Shelby County. It is grown throughout the county except in steep, wooded, or wet areas.

Oats is the most important small grain; it is also grown as a companion crop for legumes and grasses. Much of the crop is fed on the farm, but some is marketed. The acreage of wheat and barley is small. Wheat is sown in fall and generally is grown on the finer textured bottom lands.

Hay ranks third in acreage. Red clover, timothy, alfalfa, and bromegrass are grown throughout the county. A combination of alfalfa and bromegrass is rapidly becoming the most important hay and pasture crop. Most of the hay is baled and fed on the farm to livestock.

Details about agriculture will be found in the section, Agricultural Statistics.

General Soil Map

A general soil map of Shelby County has been made by drawing lines around the different patterns of soils and slopes on a small map. Figure 1 shows six general soil areas in Shelby County. The areas are named according to the major soils in the area. Topography, the relative proportions of loess and till, and the tendency of the wind-deposited material to be slightly more clayey from northwest to southeast were some of the characteristics used in separating the general soil areas. This map is too general for farm planning, but it is useful to those who want only a general idea of the soils, who want to compare different parts of the county, or who want to make county-wide interpretations. The discussion of each general soil area follows.

1. Hilly and Steep Soils From Loess: Ida-Monona

This is a hilly and steep general soil area in the extreme northwestern corner of the county. It consists of moderately dark colored soils that have developed from wind-deposited, silty material called loess.

The major soils of the area are the Ida and Monona on the uplands and the Judson and Nodaway along drainageways. The Ida soils are silty and calcareous. These soils are usually severely eroded. They occur mainly on the points, shoulders, or other convex positions on the ridges. The Monona soils are also silty, but they are generally slightly darker than the Ida soils and generally leached of lime to depths of 20 to 40 inches or more. The Judson and Nodaway soils are silty and have developed from material that washed from the Ida and Monona soils. Judson soils are dark colored to several feet below the surface. The Nodaway soils are light to moderately dark colored.

2. Gently Rolling to Hilly Soils From Loess: Ida-Monona-Marshall

This is a gently rolling to hilly general soil area that occupies most of the county west of the West Nishnabotna River. The soils are dark to moderately dark, and they have developed mainly from loess. Some outcrops of Kansan glacial till occur on the slopes. Lime has been leached from these soils to a greater depth than from those in the Ida-Monona general soil area.

The main soils in the area are the Marshall on the upland divides and the Ida and Monona on side slopes. The Marshall soils have dark-colored surface soil and yellowish-brown subsoil. They are usually leached of

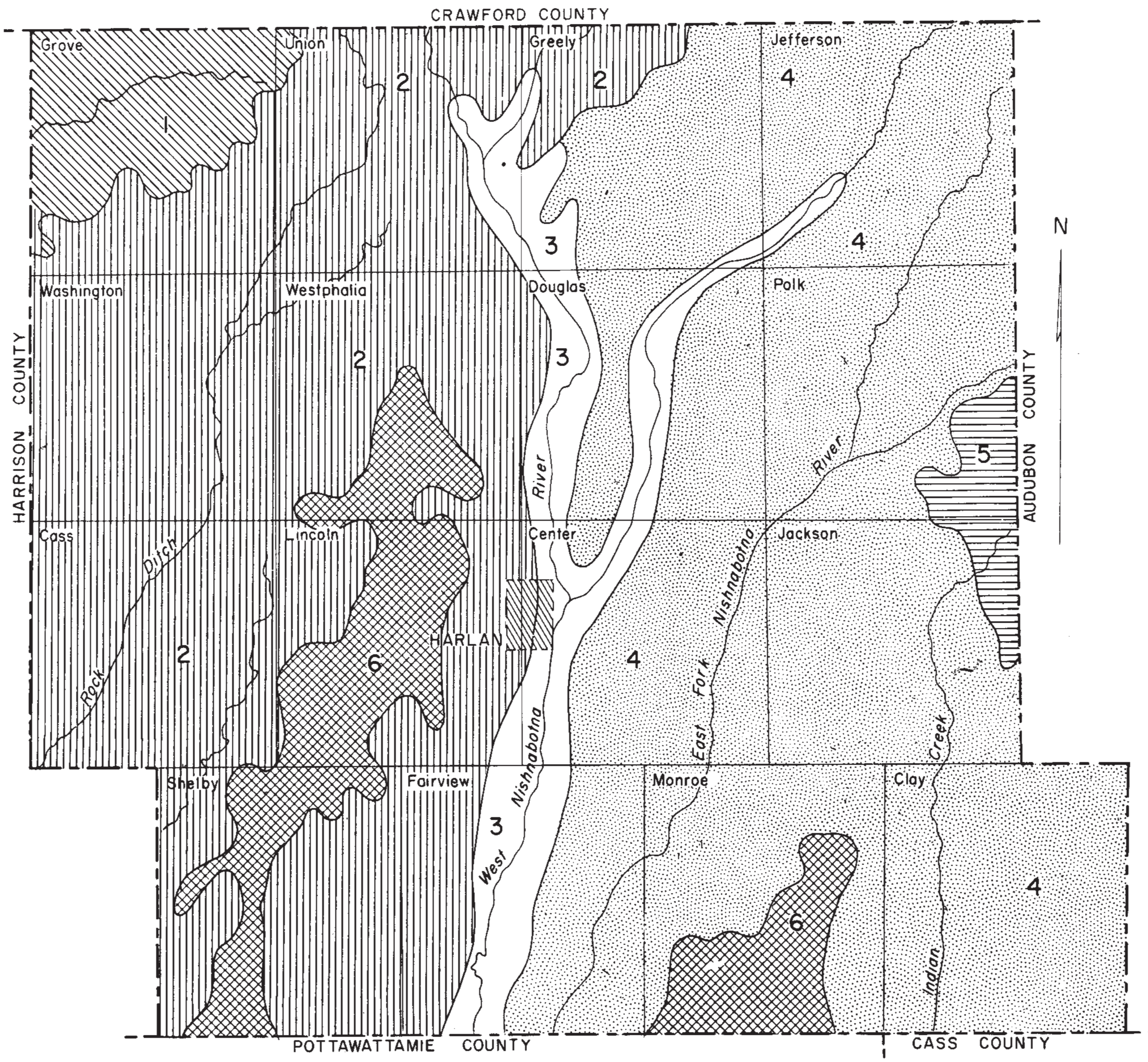

Figure 1.—**General soil map of Shelby County. 1. Hilly and steep soils from loess: Ida-Monona. 2. Gently rolling to hilly soils from loess: Ida-Monona-Marshall. 3. Nearly level soils of bottom land and in terrace positions: Kennebec-Zook. 4. Rolling to hilly soils from loess or till: Marshall-Shelby. 5. Hilly soils from till: Shelby. 6. Nearly level to strongly sloping soils from loess: Minden-Marshall.**

lime to depths of 6 to 10 feet or more, and they contain slightly more clay than the Monona soils. Shelby and Adair soils are minor in extent and have formed from Kansan till. The Shelby soils have a dark-colored surface soil and yellowish-brown clay loam subsoil. They are usually on the lower parts of slopes. The Adair subsoils normally contain more clay than the Shelby subsoils, and the subsoil is reddish in many places. They normally occur higher on the slope than the Shelby soils. Judson and Nodaway soils occur along waterways.

3. Nearly Level Soils of Bottom Land and in Terrace Positions: Kennebec-Zook

This general soil area contains dark-colored soils that occur along the West Nishnabotna River and a major tributary. The soils on bottom land are occasionally flooded. The major soils are the Kennebec and Zook on bottom land and the Marshall and Minden in terrace positions. The Kennebec soils are silty and moderately well drained and are dark to a considerable depth. The

Zook soils are more clayey, less well drained, and generally have somewhat darker surface soil than the Kennebec soils. The Minden soils have a thicker surface soil, and they are not quite so well drained as the Marshall soils.

4. Rolling to Hilly Soils From Loess or Till: Marshall-Shelby

This area covers most of the county east of the West Nishnabotna River. The soils in this area are dark. Marshall soils occupy the upland divides and side slopes down to where the till outcrops. Adair soils generally occur in a band just below the Marshall soils. Shelby soils are below the Adair soils and often occupy steeper slopes. Judson and Kennebec soils are along drainageways, but the Colo and Zook soils occur along the larger streams. The Colo soils are similar to the Zook soils in color and drainage, but they are not so clayey.

5. Hilly Soils From Till: Shelby

This is a small general soil area on the eastern edge of the county in Polk and Jackson Townships. The soils are generally on steeper slopes than those in the Marshall-Shelby general soil area, and a higher percentage have developed from glacial till. The Shelby soils occupy most of the slopes, and the Marshall soils are on ridge crests.

6. Nearly Level to Strongly Sloping Soils From Loess: Minden-Marshall

This general soil area occurs in two separate places in the county. One narrow area is in Shelby and Lincoln Townships and in part of Westphalia Township. The other area is mainly in the southern part of Monroe Township. The Marshall and Minden are the major soils, and the Corley is a minor soil in the area. The Minden, Corley, and Marshall soils occur on upland divides, and the Marshall and Monona soils are on side slopes. The Corley soil has a fairly dark surface layer and an ashy-gray subsurface layer. It has a gray and yellowish-brown subsoil that is less porous and contains more clay than that of the Marshall or Minden soils.

The Soils of Shelby County

This section contains a discussion of soil survey methods and the detailed descriptions of all soils mapped in the county.

Soil Survey Methods

The soil scientist who makes the soil survey bores or digs many holes and examines highway and railroad cuts to see what the soils are like. He measures steepness of slope and notes the lay of the land and the kinds of crops and native plants growing on the soil. Each excavation exposes a series of individual soil layers, or horizons, collectively called the soil profile. In each layer the scientist notes the color, texture, structure, porosity, and consistence of the soil and the content of organic matter, gravel, and stone. In addition, simple tests are used to determine the reaction (degree of acidity) and the presence of free lime or salts. The internal and external drainage and the interrelations between soil and water are noted.

The dark color of the topmost soil layer is usually related to its content of organic matter. The darkest soils are highest in content of organic matter, which is decomposed or partly decomposed vegetation. Streaks and spots of gray in the lower layers generally mean that drainage and aeration are restricted. Uniform brown to yellowish-brown colors indicate good drainage and aeration.

Texture, or the content of sand, silt, and clay, is determined by the way the moist soil feels when rubbed between the fingers. It is also checked by laboratory analyses. Texture determines how well the soil retains moisture, plant nutrients, and fertilizer and the ease with which it can be cultivated.

Structure refers to the arrangement of the soil grains into lumps, granules, blocks, or other aggregates. It affects the permeability of the soil to air, water, and roots. Structure is determined by observing the soil in place or by noticing the particles that result from gently shaking or agitating a small quantity of soil.

Porosity is the degree to which the soil mass is permeated with pores or cavities. A soil is porous if a large percentage of its volume consists of pores.

Consistence is the combination of properties that determine the resistance of soil to crushing and its ability to be molded or changed in shape. It is an indication of how well a soil will stay open and porous under cultivation. Consistence is described as hard, friable, plastic, sticky, compact, tough, or cemented.

Stones are rocks over 4 inches in diameter; gravel is rock less than 4 inches in diameter. A soil referred to as stony or gravelly must contain stone or gravel in the surface layer that interferes with tillage.

On the basis of these characteristics, soils that are much alike in the kind, thickness, and arrangement of their layers belong to one soil series (*16*).[1] The soil type is a subdivision of the soil series based on the texture of the surface soil. Soil types may be subdivided into phases, mainly because of differences in slope or degree of erosion. Soil phases are also useful in prescribing management and practices for conservation of soil and moisture.

When very small areas of two or more kinds of soil are so intricately mixed that it is not feasible to map them separately, they are delineated together, and the resulting combination of soils is called a complex. For example, the Judson-Nodaway-Zook complex is a complex of Zook silty clay, Nodaway silt loam, and Judson silt loam.

Other terms used in the soil survey are defined in the Glossary at the end of this report.

Descriptions of the Soils

In this section the soils of Shelby County are described in detail and their suitability for agriculture is interpreted. The approximate acreage of the soils mapped

[1] Italic numbers in parentheses refer to Literature Cited, p. 58.

in this county is shown in table 1. The location and distribution of the soils are shown on the detailed soil map in the back of the report. All of the soils mapped in Shelby County, their map symbols, and their management grouping are given in the Guide to Mapping Units and Management Groups at the end of the report.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*

Soil	Area	Extent
	Acres	*Percent*
Adair clay loam, 5 to 11 percent slopes, moderately eroded	311	0. 1
Adair clay loam, 11 to 18 percent slopes, moderately eroded	311	. 1
Adair clay loam, 18 to 28 percent slopes, moderately eroded	164	(1)
Adair soils, 5 to 11 percent slopes, severely eroded	76	(1)
Adair soils, 11 to 18 percent slopes, severely eroded	722	. 2
Clarinda silty clay loam, 5 to 11 percent slopes, moderately eroded	56	(1)
Clarinda silty clay loam, 11 to 18 percent slopes, moderately eroded	96	(1)
Clarinda soils, 5 to 11 percent slopes, severely eroded	45	(1)
Clarinda soils, 11 to 18 percent slopes, severely eroded	310	. 1
Colo silty clay loam	8	(1)
Colo silty clay loam, overwashed	65	(1)
Colo silty clay loam, silty clay substratum	2, 243	. 6
Corley silt loam	88	(1)
Corley silt loam, bench position	62	(1)
Dow silt loam, 8 to 14 percent slopes, severely eroded	94	(1)
Dow silt loam, 14 to 18 percent slopes, severely eroded	18	(1)
Ida silt loam, 5 to 8 percent slopes, severely eroded	936	. 3
Ida silt loam, 8 to 11 percent slopes, severely eroded	1, 678	. 4
Ida silt loam, 11 to 14 percent slopes, severely eroded	5, 123	1. 4
Ida silt loam, 14 to 18 percent slopes, severely eroded	8, 712	2. 3
Ida silt loam, 18 to 23 percent slopes, severely eroded	2, 700	. 7
Ida silt loam, 23 to 28 percent slopes, severely eroded	363	. 1
Ida silt loam, 28 to 40 percent slopes, severely eroded	45	(1)
Judson silt loam, 0 to 2 percent slopes	380	. 1
Judson silt loam, 2 to 5 percent slopes	5, 353	1. 4
Judson silt loam, 5 to 8 percent slopes	2, 567	. 7
Judson-Nodaway-Colo complex, 2 to 5 percent slopes	38, 298	10. 2
Judson-Nodaway-Colo complex, 5 to 8 percent slopes	1, 445	. 4
Judson-Nodaway-Zook complex, 2 to 5 percent slopes	36, 374	9. 7
Judson-Nodaway-Zook complex, 5 to 8 percent slopes	71	(1)
Kennebec silt loam	3, 052	. 8
Kennebec silt loam, channeled	3, 592	1. 0
Marshall silt loam, 0 to 2 percent slopes	6, 640	1. 8
Marshall silt loam, 2 to 5 percent slopes	32, 828	8. 7
Marshall silt loam, 5 to 8 percent slopes, moderately eroded	11, 657	3. 1
Marshall silt loam, 8 to 11 percent slopes, moderately eroded	7, 365	2. 0
Marshall silt loam, 11 to 14 percent slopes, moderately eroded	5, 688	1. 5
Marshall silt loam, 14 to 18 percent slopes, moderately eroded	779	. 2
Marshall silt loam, 18 to 28 percent slopes, moderately eroded	253	. 1
Marshall silt loam, bench position, 0 to 2 percent slopes	1, 007	. 3
Marshall silt loam, bench position, 2 to 5 percent slopes	3, 830	1. 0
Marshall silt loam, bench position, 5 to 8 percent slopes, moderately eroded	2, 156	. 6
Marshall silt loam, bench position, 8 to 11 percent slopes, moderately eroded	235	. 1
Marshall soils, 5 to 8 percent slopes, severely eroded	3, 617	1. 0
Marshall soils, 8 to 11 percent slopes, severely eroded	8, 796	2. 3
Marshall soils, 11 to 14 percent slopes, severely eroded	40, 878	10. 9
Marshall soils, 14 to 18 percent slopes, severely eroded	13, 301	3. 5
Marshall soils, 18 to 23 percent slopes, severely eroded	1, 856	. 5
Marshall soils, 23 to 32 percent slopes, severely eroded	246	. 1
Marshall soils, bench position, 8 to 11 percent slopes, severely eroded	515	. 1
Marshall soils, bench position, 11 to 14 percent slopes, severely eroded	203	. 1
Minden silt loam	329	. 1
Minden silt loam, bench position	588	. 2
Monona silt loam, 2 to 5 percent slopes, moderately eroded	815	. 2
Monona silt loam, 5 to 8 percent slopes, moderately eroded	5, 869	1. 6
Monona silt loam, 5 to 8 percent slopes, severely eroded	2, 639	. 7
Monona silt loam, 8 to 11 percent slopes, moderately eroded	2, 556	. 7
Monona silt loam, 8 to 11 percent slopes, severely eroded	11, 574	3. 1
Monona silt loam, 11 to 14 percent slopes, moderately eroded	2, 622	. 7
Monona silt loam, 11 to 14 percent slopes, severely eroded	31, 560	8. 4
Monona silt loam, 14 to 18 percent slopes, moderately eroded	1, 568	. 4
Monona silt loam, 14 to 18 percent slopes, severely eroded	14, 844	4. 0
Monona silt loam, 18 to 23 percent slopes, moderately eroded	1, 047	. 3
Monona silt loam, 18 to 23 percent slopes, severely eroded	2, 585	. 7
Monona silt loam, 23 to 32 percent slopes, severely eroded	904	. 2
Monona silt loam, bench position, 2 to 5 percent slopes	93	(1)
Monona silt loam, bench position, 5 to 8 percent slopes, moderately eroded	338	. 1
Monona silt loam, bench position, 8 to 11 percent slopes, moderately eroded	114	(1)
Monona silt loam, bench position, 11 to 14 percent slopes, severely eroded	19	(1)
Nodaway silt loam	12, 092	3. 2
Nodaway silt loam, shallow to silty clay	4, 323	1. 2
Shelby loam, 8 to 11 percent slopes, moderately eroded	328	. 1
Shelby loam, 11 to 14 percent slopes, moderately eroded	1, 105	. 3
Shelby loam, 14 to 18 percent slopes, moderately eroded	540	. 1
Shelby loam, 18 to 23 percent slopes, moderately eroded	265	. 1
Shelby loam, 23 to 32 percent slopes, moderately eroded	175	(1)

See footnote on page 5.

TABLE 1.—*Approximate acreage and proportionate extent of the soils mapped*—Continued

Soil	Area	Extent	Soil	Area	Extent
	Acres	*Percent*		*Acres*	*Percent*
Shelby soils, 8 to 11 percent slopes, severely eroded	257	0. 1	Steinauer soils, 8 to 11 percent slopes, severely eroded	6	(1)
Shelby soils, 11 to 14 percent slopes, severely eroded	2, 430	. 6	Steinauer soils, 11 to 14 percent slopes, severely eroded	99	(1)
Shelby soils, 14 to 18 percent slopes, severely eroded	3, 278	. 9	Steinauer soils, 14 to 18 percent slopes, severely eroded	288	0. 1
Shelby soils, 18 to 23 percent slopes, severely eroded	847	. 2	Zook silty clay	3, 429	. 9
Steinauer loam, 8 to 11 percent slopes, moderately eroded	92	(1)	Zook silty clay, overwashed	2, 364	. 6
Steinauer loam, 11 to 14 percent slopes, moderately eroded	77	(1)	Zook silty clay loam	2, 643	. 7
Steinauer loam, 14 to 18 percent slopes, moderately eroded	114	(1)	Zook silty clay loam, overwashed	2, 365	. 6
Steinauer loam, 18 to 28 percent slopes, moderately eroded	240	. 1	Urban areas	1, 051	. 3
			Total	375, 680	100. 0

[1] Less than 0.1 percent.

Adair series

The Adair soils are medium acid, moderately well drained to imperfectly drained, and very slowly permeable. They have a reddish-brown clay or silty clay subsoil. They generally occur as narrow bands on moderately to very steep side slopes below the Marshall and Monona soils and above the Shelby soils.

The Adair soils were formed from Kansan glacial till, possibly under forest vegetation. They were subsequently buried under a mantle of loess and exposed again at the surface after centuries of geologic erosion. After that the native vegetation was prairie. The subsoil characteristics result mainly from weathering during the earlier geologic time. The surface layer is loesslike in some places.

Representative profile (Adair clay loam):

0 to 12 inches, dark-brown clay loam; texture ranges from silt loam to clay loam, depending on thickness of the loess and the amount it has eroded.

12 to 42 inches, reddish-brown to yellowish-brown, firm, gritty, heavy silty clay loam, silty clay, or clay; some mottles of yellowish brown and reddish brown.

42 to 60 inches, yellowish-brown, firm, gritty, light clay loam mottled with reddish brown and very dark grayish brown.

Although these soils are on slopes, they are wet and seepy in spring and in seasons of high rainfall. Seepage can be controlled by laying intercepting tile in the more permeable soils above the Adair soils.

Soils of the Adair series erode easily when cultivated. Slips and shallow gully erosion are common. Severely eroded spots are extremely difficult to cultivate because of clay in the subsoil. When the soil is used for cultivated crops, terraces and crop rows should be on a slight grade, instead of level, to help the drainage as well as to provide control of erosion.

The soils of this series are low in fertility; they do not respond well to fertilizer because of their unfavorable physical properties. They have only limited use for cultivated crops and can be worked only in a narrow range of moisture content without becoming cloddy. Their best use is for hay or pasture, but yields will be low.

Very small areas of Adair soils are shown by the conventional symbol as clay spots on the soil map.

Adair clay loam, 5 to 11 percent slopes, moderately eroded (AdD2).—The profile of this soil differs from the one described in that the surface layer is only 4 to 7 inches thick. This soil is suitable for only limited use for cultivated crops, but small areas are farmed the same as the surrounding soils. Management group 14 (IVe).

Adair clay loam, 11 to 18 percent slopes, moderately eroded (AdF2).—The profile of this soil differs from the one described in that the dark-colored surface layer is only 4 to 7 inches thick. The soil is subject to severe erosion and is most suitable for permanent pasture. Management group 15 (VIe).

Adair clay loam, 18 to 28 percent slopes, moderately eroded (AdH2).—The profile of this soil differs from the one described in that the surface layer is lighter colored. The soil is subject to severe erosion when cultivated but is more suitable for permanent pasture. Management group 16 (VIIe).

Adair soils, 5 to 11 percent slopes, severely eroded (AsD3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. Severe erosion has removed the rest. During tillage, the original surface soil has been mixed with the subsoil to form a plow layer of clay, silty clay, or heavy clay loam. Good vegetative cover is very difficult to establish and maintain. This soil is best suited to permanent pasture. Management group 14 (IVe).

Adair soils, 11 to 18 percent slopes, severely eroded (AsF3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer is left. The rest has been removed by erosion. During tillage, the remaining surface soil has been mixed with the subsoil. As a result, the texture of the plow layer is now a heavy clay loam, clay, or silty clay. Good vegetative cover is very difficult to establish and maintain. This soil is best suited to permanent pasture. Management group 16 (VIIe).

Clarinda series

The Clarinda series consists of medium acid, poorly drained, very slowly permeable soils. They occur as narrow bands or outcrops on side slopes and are usually

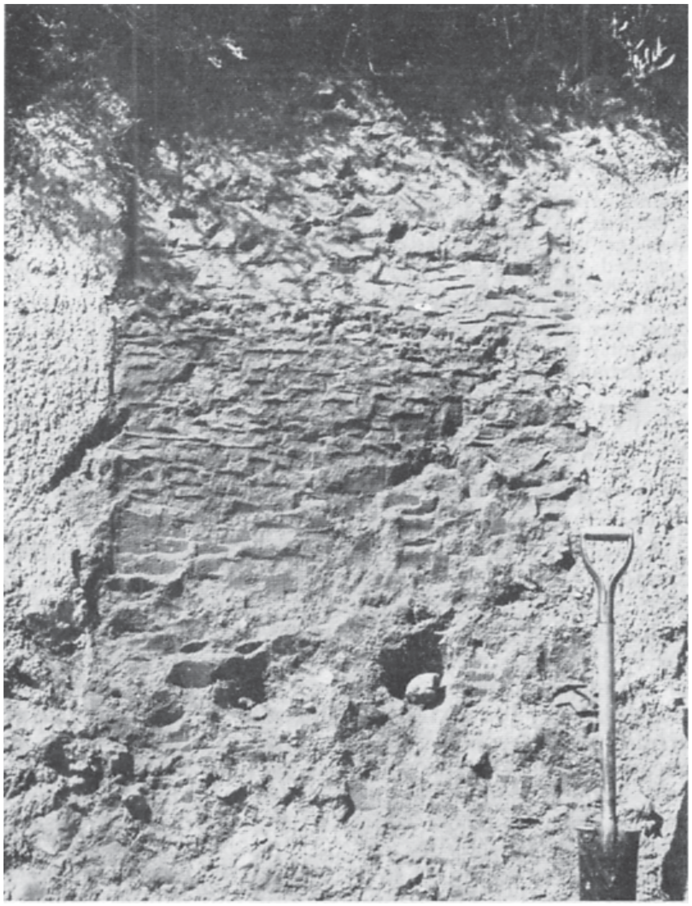

Figure 2.—**Roadbank showing loess that is underlain by a buried soil (Clarinda or Adair series) that developed from Kansan till.**

below the Marshall and Monona soils. Many areas are in coves at the heads of drainageways. Areas are usually small.

These soils were developed in a weathered Kansan glacial till (fig. 2) sometimes called gumbotil. The Kansan till weathered to form a heavy plastic clay (gumbotil) in an earlier geologic age and was later buried under a mantle of loess. After centuries of geologic erosion, the loess was removed. The Clarinda soils were formed where this once buried soil is exposed on the surface. The subsoil characteristics result mainly from weathering that occurred in the earlier geologic time. The native vegetation was grass. In places, a thin layer of loesslike material is found on the surface of Clarinda soils.

Representative profile (Clarinda silty clay loam, moderately eroded):

0 to 5 inches, dark-gray, friable to slightly firm silty clay loam.
5 to 42 inches, grayish-brown, very firm clay to silty clay mottled with olive yellow.
42 to 60 inches, strong-brown, very firm clay loam to silty clay.

Although these soils are on slopes, they are wet and seepy in spring and in seasons of high rainfall. Seepage can be controlled best by laying intercepting tile in the more permeable soils above the Clarinda soils.

These soils erode easily when cultivated. Severely eroded spots are extremely difficult to cultivate because of clay in the surface soil. If the soil is cultivated, terraces and crop rows should be on a slight grade, instead of level, to help drainage and to control erosion.

These soils are low in fertility, and they do not respond well to fertilizer because they are wet and have poor tilth. They are poorly suited to cultivated crops and can be worked only in a narrow range of moisture content without becoming cloddy. Their best use is for hay or pasture; yields will be low.

Very small areas of Clarinda soils are shown by the conventional symbol as clay spots on the soil map.

Clarinda silty clay loam, 5 to 11 percent slopes, moderately eroded (CdD2).—This soil has a profile that is similar to the one described. It is suitable for only limited use for cultivated crops. Management group 14 (IVe).

Clarinda silty clay loam, 11 to 18 percent slopes, moderately eroded (CdF2).—This soil has a profile that is similar to the one described. It is suitable for hay or pasture. Management group 15 (VIe).

Clarinda soils, 5 to 11 percent slopes, severely eroded (CnD3).—The profile of the soils of this mapping unit differs from the profile described in that less than 3 inches of the original surface layer remains. Erosion has removed the rest. The surface soil has been mixed with subsoil during tillage. The surface layer is now a silty clay and is extremely difficult to work. Good vegetative cover is very difficult to establish and maintain. At best, this soil is suited to only limited use for cultivation. It is more suitable for hay or pasture. Management group 14 (IVe).

Clarinda soils, 11 to 18 percent slopes, severely eroded (CnF3).—The profile of the soils of this mapping unit differs from the one described in that less than 3 inches are left of the original surface layer. During tillage, the remaining surface soil has been mixed with the subsoil. The plow layer now has the texture of silty clay and is extremely difficult to work. Good vegetative cover is very difficult to establish and maintain. This soil is suitable for permanent pasture, but yields will be low. Management group 16 (VIIe).

Colo series

The Colo series consists of dark, poorly drained, neutral to slightly acid soils on nearly level bottom lands throughout the county. They are subject to various degrees of flooding. The native vegetation was grass. The Colo soils are high in organic matter and in available moisture-holding capacity. They tend to be low in available nitrogen and medium in available phosphorus.

Representative profile (Colo silty clay loam):

0 to 24 inches, very dark gray to black, friable silty clay loam.
24 to 42 inches, black to very dark gray, friable silty clay loam.
42 to 60 inches, dark-gray to gray, friable silty clay loam with mottles of strong brown.

In wet years, cultivation of Colo soils is delayed and crop yields are reduced unless drainage has been improved. Surface drainage works well on these soils. Tile drainage can be used in most Colo soils, but tile does not work very well in the silty clay substratum phase.

Diversion terraces constructed at the base of adjacent upland slopes help protect these soils from overflow. The Colo soils become cloddy if worked when too wet, but, when the moisture is right, the surface layer is easily worked.

Colo silty clay loam (Cm).—This soil has a profile that is similar to the one described for the Colo series. In some places there is a layer of silt loam overwash on the surface that is up to 8 inches thick.

If properly drained and protected from flooding, this soil is suitable for frequent row cropping. The permeability is moderately slow, but tile will work well if suitable outlets can be obtained. Management group 3 (IIw).

Colo silty clay loam, overwashed (Co).—The profile of this soil differs from the one described in that the surface layer is a silt loam overwash ranging from 8 to 20 inches in thickness. This soil can be worked more easily than the other Colo soils because it has a silty surface layer.

If drainage is provided and flooding is controlled, this soil is well suited to frequent row cropping. Permeability is moderately slow, but tile drainage will work well if suitable outlets can be obtained. Management group 3 (IIw).

Colo silty clay loam, silty clay substratum (Cr).—The profile of this soil differs from the one described in that it is a silty clay below 20 to 36 inches. This silty clay layer is heavier and more clayey than the silty clay loam described for the series, and it restricts the movement of air and water through the subsoil. The surface layer is silt loam or silty clay loam in places.

This soil is slowly permeable, and tile drainage will not work well because the subsoil is heavy. Drainage can be improved, however, with surface drains. Without artificial drainage, this soil is wetter than the other Colo soils. It is suitable for frequent row cropping. If drainage is improved and flooding is controlled, yields can be increased. Management group 3 (IIw).

Corley series

The Corley series consists of dark-colored, poorly drained, medium acid soils that have developed from thick loess. They are medium to low in available phosphorus, and they tend to be medium to high in nitrogen. They occur with Minden and Marshall soils in slight depressions on upland flats or on loess-covered benches. They are often ponded for short periods. The Corley soils are usually in small tracts and are of minor importance in Shelby County.

Representative profile (Corley silt loam):

0 to 16 inches, black, friable silt loam to silty clay loam.
16 to 34 inches, very dark gray, friable silt loam; some grayish–brown coatings on peds.
34 to 52 inches, dark grayish-brown to grayish-brown, slightly firm, heavy silty clay loam; peds coated with dark gray; mottles of dark brown.
52 to 60 inches, grayish-brown to light brownish-gray, friable, medium silty clay loam to silt loam; dark-brown mottles.

Erosion is not a problem. Cultivation is usually delayed in wet seasons unless these soils have been drained. They are generally farmed in the same manner as the surrounding soils, and, if drained, they are well suited to cultivated crops. Tile will improve the drainage of these soils to some extent but may not be economically feasible because of fairly long distances to an outlet. Surface drainage is suggested for most of these soils.

Corley silt loam (Cs).—This soil has a profile that is similar to the one described for the Corley series. The surface texture ranges from a silt loam to a light silty clay loam. This soil is on upland flats and is frequently ponded after heavy rains. Management group 3 (IIw).

Corley silt loam, bench position (Ct).—This soil has a profile similar to the one described. The surface texture ranges from a silt loam to a light silty clay loam. This soil is on loess-covered benches on second bottoms near streams. It is subject to some ponding following heavy rains. Management group 3 (IIw).

Dow series

The Dow series consists of neutral or calcareous, well-drained, upland soils that have developed in olive-gray or grayish-brown loess. They are low in available phosphorus and nitrogen. In many areas concretions of lime occur in all layers. These soils have moderately rapid permeability. The Dow soils occur as narrow bands on the sides and on the eroded points of strong to steep slopes. Many small areas of Dow soils have been included with the Ida soils. Because of their gray color, these Dow soils are conspicuous on the landscape. The native vegetation was grass.

Representative profile (Dow silt loam, severely eroded):

0 to 7 inches, dark-gray, very friable silt loam; calcareous.
7 to 16 inches, dark grayish-brown to grayish-brown, very friable silt loam; calcareous.
16 to 60 inches, olive-gray to grayish-brown, very friable silt loam; strong-brown and black mottles; calcareous.

These soils respond well to nitrogen and phosphate fertilizers but do not need lime. They can hold large amounts of water but may be somewhat droughty, as water is absorbed slowly and much runs off. The Dow soils are subject to severe sheet erosion when cultivated without erosion control practices. The lesser slopes are suitable for terraces.

Dow silt loam, 8 to 14 percent slopes, severely eroded (DoE3).—This soil has a profile similar to the one described. It is suitable for cultivated crops if terraced, cultivated on the contour, and heavily fertilized with nitrogen and phosphate. Since it occurs as small areas, this soil is usually cropped the same as the surrounding soils. Management group 7 (IIIe).

Dow silt loam, 14 to 18 percent slopes, severely eroded (DoF3).—This soil has a profile similar to the one described. Because of steep slopes and severe erosion, it has limited use for cultivated crops, even if terraced and improved in fertility. Crop rotations should consist mainly of hay and pasture, but this soil is generally cropped the same as surrounding soils because it occurs as small areas. Management group 12 (IVe).

Ida series

The Ida series consists of light-colored, well-drained soils high in lime (calcareous). They are low in organic matter and very low in nitrogen and are especially deficient in available phosphorus. They have moderately rapid permeability. Ida soils occupy moderate to very steep slopes, and they are generally severely eroded.

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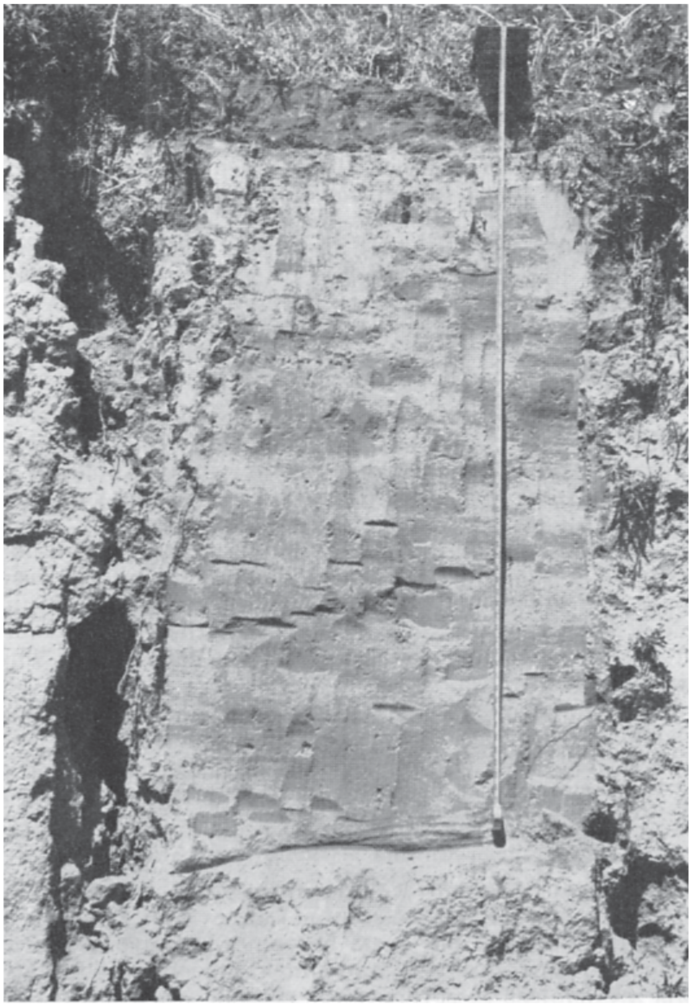

Figure 3.—**Ida silt loam. Dark layer on surface is within plow depth.**

Some of the acreage is not suitable for cultivation because deep gullies have formed. Little of the original surface layer is left. The soils have developed in thick, calcareous loess, and concretions of lime are normally scattered over the surface. Ida soils are more common and in larger areas in the western part of the county than in the eastern part (fig. 3).

Representative profile (Ida silt loam, severely eroded):

0 to 4 inches, dark grayish-brown, very friable, light silt loam; high content of lime (calcareous).
4 to 60 inches, yellowish-brown, very friable silt loam with mottles of brown and grayish brown; high content of lime (calcareous).

Ida soils respond well to nitrogen and phosphate fertilizers. Crop yields will be low unless these are applied. Lime is not needed. The soils can hold large amounts of water, but they may be somewhat droughty because water is slowly absorbed at the surface and much runs off.

These soils are silty; they are easily worked, though severely eroded. They erode easily if used for row crops, unless they are terraced and cultivated on the contour. Level terraces work well on slopes of less than 18 percent. Siltation in terrace channels may cause problems if the soils are used frequently for row crops.

Ida silt loam, 5 to 8 percent slopes, severely eroded (IdC3).—This soil has a profile similar to the one described for the Ida series. It is suitable for crops if terraced, cultivated on the contour, and fertilized with nitrogen and phosphate. Management group 7 (IIIe).

Ida silt loam, 8 to 11 percent slopes, severely eroded (IdD3).—This soil has a profile similar to the one described. It is suitable for cultivated crops if erosion is controlled and nitrogen and phosphate are added. Management group 7 (IIIe).

Ida silt loam, 11 to 14 percent slopes, severely eroded (IdE3).—This soil has a profile that is similar to the one described. It is suitable for cultivated crops if terraced, cultivated on the contour, and fertilized with nitrogen and phosphate. Management group 7 (IIIe).

Ida silt loam, 14 to 18 percent slopes, severely eroded (IdF3).—This soil has a profile that is similar to the one described. It is suitable for only occasional use for cultivated crops, even if terraced and fertilized with nitrogen and phosphate. It is more suitable for permanent pasture than for cultivated crops. Management group 12 (IVe).

Ida silt loam, 18 to 23 percent slopes, severely eroded (IdG3).—This soil has a profile that is similar to the one described. It is suitable for permanent pasture. Management group 15 (VIe).

Ida silt loam, 23 to 28 percent slopes, severely eroded (IdH3).—This soil has a profile that is similar to the one described. It is suitable for permanent pasture. Management group 16 (VIIe).

Ida silt loam, 28 to 40 percent slopes, severely eroded (IdI3).—This soil has a profile that is similar to the one described. It should be used for permanent pasture, but production is low. Management group 16 (VIIe).

Judson series

The Judson series consists of deep, dark, moderately permeable, well drained to moderately well drained soils. They are slightly acid and high in organic matter. They are usually medium to high in available nitrogen but are only medium in available phosphorus. The moisture-holding capacity is high. Judson soils occur as small areas on alluvial fans at the end of small drainageways and in narrow bands at the base of slopes. They developed from silty material that has washed from higher slopes. The native vegetation was grass.

Representative profile (Judson silt loam):

0 to 24 inches, black, friable silt loam.
24 to 43 inches, very dark gray to dark grayish-brown, friable silt loam.
43 to 50 inches, dark-gray, friable silt loam.

Gully erosion can be a serious problem because the soils occur at the base of slopes and at the end of drainageways. Occasional deposits of fresh silt can be expected following heavy rains, and in some places the surface layer is dark gray, instead of black, as a result of recent deposits.

Judson soils are highly productive and easily worked, but they generally need protection from overflow. This can be obtained by constructing diversion terraces on higher slopes. These soils are generally cropped in the same manner as surrounding soils.

Judson silt loam, 0 to 2 percent slopes (JdA).—This soil has a profile like the one described. It may be slightly wet part of the time, but it can be used frequently for row crops. Since it occurs as small areas, it is normally farmed in the same manner as the surrounding soils. Management group 1 (I).

Judson silt loam, 2 to 5 percent slopes (JdB).—This soil has a profile like the one described. It is slightly wet at times, but it can be used frequently for row crops. Management group 2 (IIe).

Judson silt loam, 5 to 8 percent slopes (JdC).—The profile of this soil is similar to the one described. It is subject to both sheet and gully erosion. It can be used for frequent row cropping, but it should be terraced or cultivated on the contour. Management group 8 (IIIe).

Judson-Nodaway-Colo complex, 2 to 5 percent slopes (JnB).—These soils occur in upland drainageways in such an intricate pattern that they were not mapped separately. Each member of the complex is described separately in its series. The Colo and Nodaway soils are adjacent to the channel of the more nearly level drainageways. The Judson soils are in narrow bands at the bases of slopes that border narrow drainageways.

This complex of soils is subject to some flooding. Diversion terraces constructed on adjacent higher slopes will help control runoff and prevent some of the flooding. Tile drainage may be needed in the wetter parts of the Colo soils. Gullying may be a serious problem.

This complex is generally cropped in the same manner as surrounding soils. Management group 2 (IIe).

Judson-Nodaway-Colo complex, 5 to 8 percent slopes (JnC).—This mapping unit is similar to Judson-Nodaway-Colo complex, 2 to 5 percent slopes, but has a higher percentage of Judson soil. It occupies moderate slopes. Management group 8 (IIIe).

Judson-Nodaway-Zook complex, 2 to 5 percent slopes (JzB).—These soils generally occur in drainageways. They are associated in such an intricate pattern that it was not practical to map them separately. Each member of the complex is described separately in its series. Figure 4 shows how this complex occurs on the landscape.

The Judson soils occur at the base of the slope. The poorly drained Zook and the well drained to moderately well drained Nodaway are near the stream channel. The pattern of this complex is variable because of difference

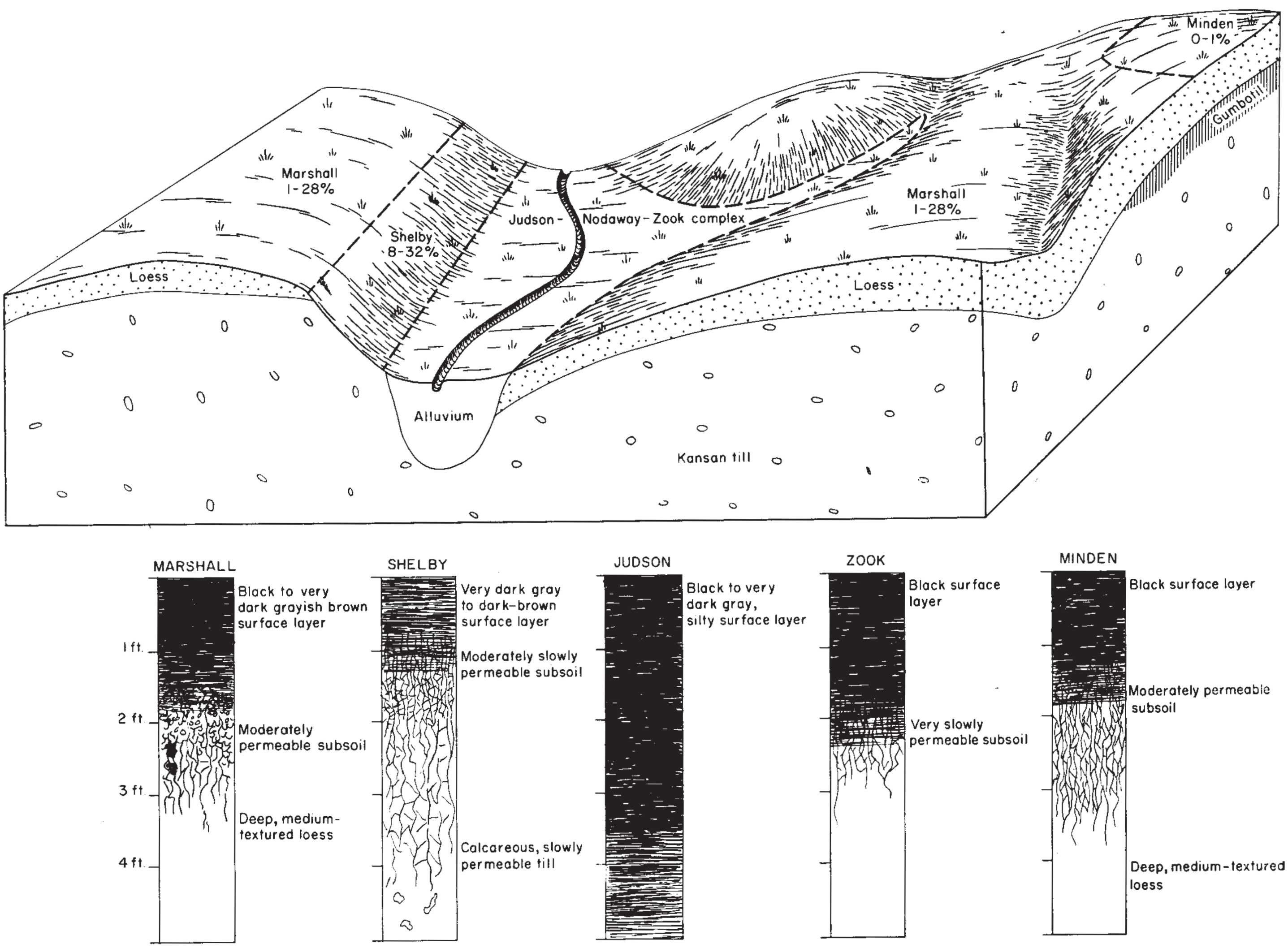

Figure 4.—The occurrence of some major upland soils in relation to parent material and slope.

in slope, texture, and color and because of material recently deposited.

Runoff water from adjacent hillsides tends to form gullies in these soils. The upper parts of many drainageways should be in grass to control runoff and prevent gully erosion. Diversion terraces are sometimes used at the base of adjacent hillsides to protect these soils from overflow. Tiling is not suitable for the Zook soils in this complex. Large areas of these soils are suitable for frequent row cropping. Smaller areas are cropped along with surrounding soils. Management group 3 (IIw).

Judson-Nodaway-Zook complex, 5 to 8 percent slopes (JzC).—This mapping unit consists of soils like those of Judson-Nodaway-Zook complex, 2 to 5 percent slopes. It has, however, a higher percentage of Judson soil. It occurs on moderate slopes. The stronger slopes erode easily when cultivated. Management group 8 (IIIe).

Kennebec series

The Kennebec series consists of dark-colored, moderately well drained soils on flood plains. They are low to medium in content of available phosphorus, medium to high in nitrogen, and high in organic matter. They are neutral to slightly acid and have a high capacity for holding moisture. The subsoil is moderately permeable to air and moisture. The native vegetation was grass and trees.

Representative profile (Kennebec silt loam):

0 to 16 inches, black, friable silt loam.
16 to 40 inches, very dark brown, friable silt loam to light silty clay loam.
40 to 60 inches, very dark gray, friable silt loam with occasional layers of dark brown.

Kennebec soils are generally subject to flooding, but straightening of channels partly eliminates this hazard.

Kennebec silt loam (Kb).—This soil has a profile like the one described for the series. It is well suited to frequent row cropping and is one of the most productive soils in the county. Management group 1 (I).

Kennebec silt loam, channeled (Kc).—This soil has a profile that is similar to the one described. One or more meandering oxbow channels are in the areas of this soil. These channels are wet part of the time and should be provided with outlets into the main stream. Oxbows frequently dissect the soil into small areas and make cultivation difficult. This soil is suitable for frequent row cropping, but the control of floods may be a problem. Management group 1 (I).

Marshall series

The Marshall series consists of well-drained, slightly acid to medium acid soils that have developed in thick loess. Most Marshall soils are on uplands; the rest are on benches. They are among the major soils in the county and occur in all parts except the extreme northwestern corner. Marshall soils are high in available potassium and low to medium in available phosphorus. Normally, they tend to be low in nitrogen. The subsoil is moderately permeable to air, moisture, and roots. The Marshall soils have a high capacity to hold available moisture.

Representative profile (Marshall silt loam):

0 to 11 inches, very dark brown to very dark grayish-brown, friable silt loam to light silty clay loam.

Figure 5.—A profile of Marshall silt loam. The dark-colored top layer is about 11 inches thick. The second layer is transitional to the subsoil, which is the third layer. Below the yardstick is parent material.

11 to 29 inches, dark-brown to dark yellowish-brown, friable silty clay loam.
29 to 60 inches, dark-brown to dark yellowish-brown, friable silt loam with mottles of grayish brown.

If not eroded, the Marshall soils are high in organic matter. They are easily worked and respond well to nitrogen and phosphate fertilizers. On gentle slopes they are among the most productive soils in the county (fig. 5). The stronger slopes are easily eroded and should be terraced if they are to be cropped frequently. Level terraces can be used because the subsoil is moderately permeable.

The Marshall soils differ from the Monona soils in that they are slightly more acid and have slightly more clay in the subsoil.

Marshall silt loam, 0 to 2 percent slopes (MaA).—The profile of this soil differs from the one described in that it has a thicker dark surface layer. This soil ordinarily is in small areas on nearly level, upland divides. Small areas of Minden and Corley soils were included with this soil.

Erosion is not a problem on this soil. It is well suited to row crops but is usually farmed the same as the surrounding soils. Management group 1 (I).

Marshall silt loam, 2 to 5 percent slopes (MaB).—This soil has a profile that is similar to the one described.

The soil is gently sloping and well suited to cultivated crops. Erosion is a slight problem. Management group 2 (IIe).

Marshall silt loam, 5 to 8 percent slopes, moderately eroded (MaC2).—The profile of this soil differs from the one described in that the dark surface layer is only 3 to 7 inches thick. The soil is well suited to cultivated crops, but erosion is a problem. Management group 4 (IIIe).

Marshall silt loam, 8 to 11 percent slopes, moderately eroded (MaD2).—The profile of this soil differs from the one described in that the dark surface layer is only 3 to 7 inches thick. Erosion is a serious problem, but the soil is suitable for cultivated crops if properly managed. Management group 5 (IIIe).

Marshall silt loam, 11 to 14 percent slopes, moderately eroded (MaE2).—The profile of this soil differs from the one described in that the dark surface layer is only 3 to 7 inches thick. Erosion is a serious problem, but the soil is suitable for cultivated crops if properly managed. Management group 6 (IIIe).

Marshall silt loam, 14 to 18 percent slopes, moderately eroded (MaF2).—The profile of this soil differs from the one described in that the dark surface layer is only 3 to 7 inches thick and is lighter colored. The soil is easily eroded when cultivated. Because of its strong slopes, this soil has limited use for cultivated crops. It should be used for meadow at least 2 years out of 4, even if terraced. Management group 11 (IVe).

Marshall silt loam, 18 to 28 percent slopes, moderately eroded (MaH2).—The profile of this soil differs from the one described in having a lighter colored surface layer that is only 3 to 7 inches thick. Because of its steep slopes, this soil is most suitable for permanent pasture. Management group 15 (VIe).

Marshall silt loam, bench position, 0 to 2 percent slopes (MbA).—The profile of this soil differs from the one described in that it has a thicker dark surface layer. Small areas of the Minden and the Corley soils are associated with this soil and have been mapped with it. Erosion is not a problem. This soil is well suited to row crops. Management group 1 (I).

Marshall silt loam, bench position, 2 to 5 percent slopes (MbB).—This soil has a profile similar to the one described. Erosion is a slight problem, but the soil is well suited to cultivated crops. Management group 2 (IIe).

Marshall silt loam, bench position, 5 to 8 percent slopes, moderately eroded (MbC2).—The profile of this soil differs from the one described in that the dark surface layer is only 3 to 7 inches thick. Erosion is a problem, but this soil is well suited to cultivated crops. Management group 4 (IIIe).

Marshall silt loam, bench position, 8 to 11 percent slopes, moderately eroded (MbD2).—This soil has a profile similar to the one described, but the dark surface layer is only 3 to 7 inches thick. Erosion is a serious problem, but, properly managed, the soil is suitable for cultivated crops. Management group 5 (IIIe).

Marshall soils, 5 to 8 percent slopes, severely eroded (McC3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. During tillage, the plow layer has been mixed with the subsoil and now is a silty clay loam. Erosion is serious, but, if properly managed, the soils are well suited to cultivated crops. Management group 4 (IIIe).

Marshall soils, 8 to 11 percent slopes, severely eroded (McD3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. Because of tillage, the surface layer has been mixed with the subsoil and now is a silty clay loam. Erosion is a serious problem. Nevertheless, if properly managed, these soils are suitable for cultivated crops. Management group 5 (IIIe).

Marshall soils, 11 to 14 percent slopes, severely eroded (McE3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. During tillage, the surface layer has been mixed with the subsoil and now is a silty clay loam. Erosion is serious, but, if properly managed, these soils are suitable for cultivation. Management group 6 (IIIe).

Marshall soils, 14 to 18 percent slopes, severely eroded (McF3).—The profile of the soils in this mapping unit is similar to the one described, but less than 3 inches of the original surface layer remains. The surface layer has been mixed with the subsoil and now is a silty clay loam. These soils erode easily. Because of the steep slopes and severe erosion on these soils, use for cultivated crops is limited. The soils should be in grass at least 2 years out of 4, even if they have been terraced. Management group 11 (IVe).

Marshall soils, 18 to 23 percent slopes, severely eroded (McG3).—The soils of this mapping unit have less than 3 inches of the original surface layer. The plow layer is now a silty clay loam. Otherwise, the profile is similar to the one described. Because of steep slopes, these soils are most suitable for permanent pasture. Management group 15 (VIe).

Marshall soils, 23 to 32 percent slopes, severely eroded (McI3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. The texture of the surface layer is now a silt loam to silty clay loam. Because of the steep slopes, these soils are suitable only for permanent pasture. Management group 16 (VIIe).

Marshall soils, bench position, 8 to 11 percent slopes, severely eroded (MdD3).—Less than 3 inches of the original surface layer remains because of severe erosion. Otherwise, the soils in this mapping unit have a profile like the one described for the Marshall series. The surface layer has been mixed with subsoil and now is a silty clay loam. Erosion is serious, but these soils are suitable for cultivated crops if properly managed. Management group 5 (IIIe).

Marshall soils, bench position, 11 to 14 percent slopes, severely eroded (MdE3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. The surface soil has been mixed with the subsoil and is now a silty clay loam. Erosion control is a serious problem, but these soils are suitable for cultivated crops if properly managed. Management group 6 (IIIe).

Minden series

The Minden series consists of dark-colored, imperfectly drained soils that have developed from thick loess. They are high in organic matter and in their capacity to hold available moisture. They are neutral to slightly acid, medium to low in available phosphorus, and generally medium in available nitrogen. The Minden soils are nearly level and are on uplands and benches in association with the Marshall and the Corley soils. The native vegetation was grass.

Representative profile (Minden silt loam):

0 to 22 inches, black to very dark gray, friable silt loam.
22 to 51 inches, gray to olive-gray, friable silty clay loam; brown mottles.
51 to 60 inches, gray, friable silt loam; brown mottles.

The Minden soils respond well to nitrogen and phosphate fertilizers. They may be slightly wet part of the time, though the subsoil is moderately permeable. Erosion is not a problem.

Minden silt loam (Me).—This soil is on uplands and has a profile similar to the one described. Figure 4 shows the position of this soil on the landscape and its relation to associated soils. Small areas (generally less than 1 acre) of Corley soils are included. Minden silt loam is suitable for frequent row cropping and is one of the most productive soils in the county. Management group 1 (I).

Minden silt loam, bench position (Mn).—This soil has a profile that is similar to the one described. It occurs in bench positions near streams. A few areas may receive runoff from the uplands and deposits of silt during heavy rains. In spring the water table may be within 20 inches of the surface. The soil is suitable for frequent row cropping. Management group 1 (I).

Monona series

The Monona series consists of well-drained, moderately dark soils that have developed from thick loess. They are neutral to slightly acid, low in available nitrogen, high in available potassium, and low to medium in available phosphorus. The subsoil is moderately permeable. The capacity of the soils to hold available moisture is high.

Monona soils most commonly occur on upland side slopes in the western half of the county, but they are also on upland divides in Grove Township. Occasionally, the Monona soils have bench positions. Slopes range from gentle to very steep. The native vegetation was grass.

Representative profile (Monona silt loam, moderately eroded):

0 to 6 inches, very dark brown to very dark grayish-brown, friable silt loam to light silty clay loam.
6 to 35 inches, dark-brown to dark yellowish-brown, friable silt loam to light silty clay loam.
35 to 60 inches, yellowish-brown, friable silt loam; dark-brown and grayish-brown mottles.

These soils respond well to nitrogen and phosphate fertilizers. Lime is not needed. On the more gentle slopes, the soils are very productive. The stronger slopes erode easily and should be terraced if used frequently for row crops. Movement of water through the subsoil is good, and level terraces are suitable. Monona soils are easily worked, even when eroded.

The Monona soils differ from the Marshall soils in having a more silty subsoil and in being slightly less acid.

Monona silt loam, 2 to 5 percent slopes, moderately eroded (MoB2).—This soil has a profile similar to the one described. It occurs on gentle upland slopes. Erosion is a slight problem. The soil can be used for cultivated crops, but erosion should be controlled. Some of the nearly level areas included with this soil may need lime. Management group 2 (IIe).

Monona silt loam, 5 to 8 percent slopes, moderately eroded (MoC2).—The profile of this soil is similar to the one described. Erosion is a problem, but the soil can be used for cultivated crops if erosion is controlled. Management group 4 (IIIe).

Monona silt loam, 5 to 8 percent slopes, severely eroded (MoC3).—The profile of this soil differs from the one described in that less than 3 inches of the original surface layer remains. During tillage, the remaining surface layer has been mixed with the subsoil. This soil can be used for cultivated crops if fertilizer is applied and erosion is controlled. Management group 4 (IIIe).

Monona silt loam, 8 to 11 percent slopes, moderately eroded (MoD2).—This soil has a profile similar to the one described. Erosion is a problem, but the soil can be used for cultivated crops if it is terraced or cultivated along the contour whenever row crops are grown. Management group 5 (IIIe).

Monona silt loam, 8 to 11 percent slopes, severely eroded (MoD3).—The profile of this soil differs from the one described in that less than 3 inches of the original surface layer remains. The soil is severely eroded, and the remaining surface layer has been mixed with the subsoil during tillage. This soil can be used for cultivated crops if it is fertilized, terraced, and tilled on the contour. Management group 5 (IIIe).

Monona silt loam, 11 to 14 percent slopes, moderately eroded (MoE2).—The profile is like the one described for the Monona series. Erosion is a problem. The soil is suitable for cultivated crops, but, if row crops are grown, fields should be terraced and tilled on the contour. Management group 6 (IIIe).

Monona silt loam, 11 to 14 percent slopes, severely eroded (MoE3).—The profile of this soil differs from the one described in that less than 3 inches of the original surface layer remains. The soil is severely eroded, and the surface layer has been mixed with the subsoil. This soil is suitable for cultivated crops if it is fertilized, terraced, and farmed on the contour. Management group 6 (IIIe).

Monona silt loam, 14 to 18 percent slopes, moderately eroded (MoF2).—This soil has a profile like the one described. It erodes easily when cultivated but is suitable for occasional use for row crops. If it is cultivated, it ought to be in meadow at least 2 years out of 4. This soil should be terraced. Management group 11 (IVe).

Monona silt loam, 14 to 18 percent slopes, severely eroded (MoF3).—The profile of this soil differs from the one described in that less than 3 inches of the original surface layer remains. The soil is severely eroded. The surface soil has been mixed with subsoil during tillage. This soil is suitable for occasional use for row crops but should be in meadow at least 2 years out of 4. It should be terraced and tilled on the contour. Management group 11 (IVe).

Monona silt loam, 18 to 23 percent slopes, moderately eroded (MoG2).—This soil is similar to the one described. It erodes easily and, because of its steep slopes, is poorly suited to cultivated crops. It is more suitable for permanent pasture. Management group 15 (VIe).

Monona silt loam, 18 to 23 percent slopes, severely eroded (MoG3).—The profile of this soil differs from the one described in that less than 3 inches of the original surface layer is left. The soil has been cultivated in the past and is severely eroded. Because it is steep and severely eroded, it is poorly suited to cultivated crops. Permanent pasture is a more suitable use. Management group 15 (VIe).

Monona silt loam, 23 to 32 percent slopes, severely eroded (MoI3).—The profile of this soil differs from the one described in that less than 3 inches of the original surface layer remains. The soil is on very steep slopes, and it is suitable for permanent pasture. Management group 16 (VIIe).

Monona silt loam, bench position, 2 to 5 percent slopes (MtB).—The profile of this soil differs from the one described in that the surface layer is 7 to 14 inches thick. Erosion is a slight problem, but the soil can be used for frequent row cropping if erosion is controlled. Management group 2 (IIe).

Monona silt loam, bench position, 5 to 8 percent slopes, moderately eroded (MtC2).—This soil has a profile similar to the one described. The soil can be used for cultivated crops if erosion is controlled. Management group 4 (IIIe).

Monona silt loam, bench position, 8 to 11 percent slopes, moderately eroded (MtD2).—This soil has a profile similar to the one described. It is suitable for cultivated crops, but, if row crops are grown, fields should be terraced and tilled on the contour. Erosion is a problem. Management group 5 (IIIe).

Monona silt loam, bench position, 11 to 14 percent slopes, severely eroded (MtE3).—This soil differs from the one described in that less than 3 inches of the original surface layer remains. It is severely eroded. During tillage, the surface layer has been mixed with subsoil. This soil is suitable for cultivated crops if it is fertilized, terraced, and farmed on the contour. Management group 6 (IIIe).

Nodaway series

In the Nodaway series are light colored to moderately dark colored, nearly level soils that are subject to flooding. However, in areas where stream channels have been straightened, these soils are not frequently flooded. They are neutral to slightly acid, low to medium in available phosphorus, and ordinarily low to medium in available nitrogen. Their capacity for holding available moisture is high.

Representative profile (Nodaway silt loam):

0 to 20 inches, very dark grayish-brown, friable silt loam.
20 to 35 inches, very dark gray to very dark brown, friable silt loam; some reddish-brown mottles.
35 to 50 inches, black to very dark brown, friable silt loam or silty clay loam; this is a darker colored soil that has been buried by the more recent deposits.

The Nodaway soils respond well to nitrogen and phosphate fertilizers, and they are easy to work.

Nodaway silt loam (No).—This soil has a profile similar to the one described. The dark-colored, buried soil is at depths ranging from 20 to 42 inches or more. The subsoil is moderately permeable and circulation of air and water is good. This soil is well drained to moderately well drained. It is suitable for frequent row cropping and is one of the most productive soils in the county. Management group 1 (I).

Nodaway silt loam, shallow to silty clay (Ns).—The profile of this soil differs from the one described in having a silty clay subsoil at depths ranging from 20 to 36 inches. Clay in the subsoil restricts the movement of air and water and makes the soil imperfectly drained. The use of V- or W-type ditches will improve the drainage. Tile drains probably will not work well. This soil is suitable for frequent row cropping and yields will be increased if drainage can be improved. Management group 3 (IIw).

Shelby series

The Shelby series consists of dark-colored, well drained to moderately well drained upland soils that have developed from glacial till. They are generally medium acid, low to medium in available phosphorus, and usually low in available nitrogen. Medium to heavy clay loam in the subsoil tends to restrict the movement of air and water and to make the soils moderately slowly permeable. Shelby soils are on the points of eroded slopes or in bands on side slopes, usually below the Marshall, Monona, Adair, or Clarinda soils. Slopes range from moderate to very steep. The native vegetation was grass. Figure 4, page 9, shows the position of Shelby soils in relation to some of the associated soils.

Representative profile (Shelby loam, moderately eroded):

0 to 6 inches, very dark gray, friable loam.
6 to 30 inches, very dark grayish-brown to dark-brown, friable to firm, medium to heavy clay loam with mottles of brown and yellowish brown.
30 to 48 inches, dark yellowish-brown to yellowish brown, firm clay loam with mottles of yellowish brown, grayish brown, brown, and gray; generally calcareous (high in lime) below 48 inches.

Some small areas of the associated Adair soils were mapped with the Shelby soils because boundaries were not always distinct. Some of the included soils have a heavier and a more reddish-brown subsoil than that described for the Shelby series.

The Shelby soils respond fairly well to nitrogen and phosphate fertilizers. They erode easily, but the lesser slopes are suitable for cultivation if erosion is controlled. Terraces and contour tillage can be used to help control erosion. The terraces should be graded to allow for the safe disposal of excess water and to reduce wetness in the terrace channel. Shelby soils do not dry after rains quite so quickly as the associated Monona and Marshall soils.

Shelby loam, 8 to 11 percent slopes, moderately eroded (ShD2).—This soil has a profile similar to the one described. It is suitable for cultivated crops, but fields should be terraced or tilled on the contour if row crops are grown. Management group 9 (IIIe).

Shelby loam, 11 to 14 percent slopes, moderately eroded (ShE2).—This soil has a profile similar to the one described. It is suitable for cultivated crops, but should be in meadow at least 2 years out of 5, even when it is terraced. A few small sandy or gravelly areas are included and are shown by gravel symbols. Management group 9 (IIIe).

Shelby loam, 14 to 18 percent slopes, moderately eroded (ShF2).—This soil has a profile similar to the one described. It is poorly suited to cultivated crops and should be in permanent hay or pasture, or cultivated only occasionally. Management group 13 (IVe).

Shelby loam, 18 to 23 percent slopes, moderately eroded (ShG2).—This soil has a profile similar to the one described. It is best for permanent pasture. Management group 15 (VIe).

Shelby loam, 23 to 32 percent slopes, moderately eroded (ShH2).—This soil has a profile similar to the one described. It is suitable only for permanent pasture. Management group 16 (VIIe).

Shelby soils, 8 to 11 percent slopes, severely eroded (SoD3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. The rest was removed by severe erosion. The original surface layer has been mixed with the subsoil to form a lighter colored surface than that described as typical for Shelby soils. In addition, the texture of the surface layer is clay loam in most places.

The soils in this mapping unit are low in organic matter, difficult to work, and hard to keep in good tilth. They are poorly suited to cultivated crops. Keep them in permanent hay or pasture, or cultivate only occasionally. A very few small sandy and gravelly areas are included and are shown by gravel symbols. Management group 13 (IVe).

Shelby soils, 11 to 14 percent slopes, severely eroded (SoE3).—The profile of the soils in this mapping unit differs from the one described in that less than 3 inches of the original surface layer remains. The plow layer has been mixed with the subsoil during tillage. It is lighter colored than the plow layer described for the series and in most places now has the texture of clay loam.

The soils of this mapping unit are low in organic matter; they are more difficult to work and to keep in good tilth than the moderately eroded Shelby loam described as typical of the series. They are poorly suited to cultivated crops and should be in permanent hay or pasture, or cultivated only occasionally. A very few small sandy or gravelly areas are included and are shown by gravel symbols. Management group 13 (IVe).

Shelby soils, 14 to 18 percent slopes, severely eroded (SoF3).—The profile of these soils differs from the one described in that less than 3 inches of the original surface layer remains. The surface soil has been mixed with the subsoil. It is now lighter in color than the surface layer in the profile described as typical and in most places has the texture of clay loam. A very few small sandy and gravelly areas are included and are shown by gravel symbols.

The soils of this mapping unit are low in organic matter and more difficult to work and to keep in good tilth than the moderately eroded Shelby loam described as typical of the series.

These soils are not suitable for cultivated crops and should be kept in permanent hay or pasture. Management group 15 (VIe).

Shelby soils, 18 to 23 percent slopes, severely eroded (SoG3).—The profile of these soils differs from the one described in that less than 3 inches of the original surface layer remains. The surface layer in most places is now a clay loam. Because of steep slopes and severe erosion, this soil is suitable only for permanent pasture. A very few small sandy and gravelly areas are included and are shown by gravel symbols. Management group 16 (VIIe).

Steinauer series

In the Steinauer series are dark-colored, well-drained, upland soils that have developed from glacial till. They are high in lime, low in available phosphorus, and usually low in available nitrogen. Clay loam in the subsoil tends to restrict the movement of air and water and to make the soils moderately slowly permeable. The Steinauer soils occur on strong to steep slopes and as outcrops or narrow bands on side slopes. Areas are usually small but occur throughout the county. The native vegetation was grass.

Representative profile (Steinauer loam):

0 to 12 inches, very dark gray, friable loam; calcareous.
12 to 60 inches, dark-brown to yellowish-brown, slightly firm clay loam with mottles of brown and grayish brown; high in lime; many pebbles.

The Steinauer soils are similar to the Shelby soils but are high in lime. The Shelby soils are acid. Steinauer soils respond fairly well to nitrogen and phosphate but do not need lime. Runoff is rapid, and, unless the fields are terraced and tilled on the contour, the soils erode easily when cultivated. The lesser slopes are suitable for cultivated crops if erosion is controlled. Steinauer soils in smaller areas are frequently farmed in the same way as surrounding soils.

A few small areas of Shelby and Adair soils are included with some areas of these soils.

Steinauer loam, 8 to 11 percent slopes, moderately eroded (SrD2).—The profile of this soil differs from the one described in that the surface layer is only 3 to 7 inches thick. The soil should be terraced or tilled on the contour if row crops are grown. Management group 9 (IIIe).

Steinauer loam, 11 to 14 percent slopes, moderately eroded (SrE2).—The profile of this soil differs from the one described in that the surface layer is 3 to 7 inches thick. The soil erodes easily when cultivated; it should be terraced and tilled on the contour if row crops are grown. Management group 9 (IIIe).

Steinauer loam, 14 to 18 percent slopes, moderately eroded (SrF2).—The profile of this soil differs from the one described in that the surface layer is only 3 to 7 inches thick. It is poorly suited to cultivated crops. Unless it is terraced, it erodes easily when in row crops. It is best suited to permanent hay or pasture. Management group 13 (IVe).

Steinauer loam, 18 to 28 percent slopes, moderately eroded (SrG2).—The profile of this soil differs from the one described in that the surface layer is only 3 to 7 inches thick. The soil is best suited to permanent pasture. Management group 16 (VIIe).

Steinauer soils, 8 to 11 percent slopes, severely eroded (SsD3).—The profile of these soils differs from the one described in that erosion has reduced the original surface layer to a thickness of less than 3 inches. During tillage, the surface layer has been mixed with the subsoil and now has the texture of clay loam. These soils are low in organic matter and difficult to work and to keep in good tilth. They are suitable only for occasional use for cultivated crops. Their best use is for permanent hay or pasture. Management group 13 (IVe).

Steinauer soils, 11 to 14 percent slopes, severely eroded (SsE3).—The profile of the soils of this mapping unit differs from the one described in that erosion has reduced the original surface layer to a thickness of less than 3 inches. The surface soil has been mixed with subsoil during tillage; it now has the texture of clay loam. These soils are low in organic matter and difficult to work and to keep in good tilth. They are suitable for only occasional cultivation, or for hay or pasture. Management group 13 (IVe).

Steinauer soils, 14 to 18 percent slopes, severely eroded (SsF3).—The profile of the soils in this mapping unit differs from the one described in that erosion has reduced the original surface soil to a thickness of less than 3 inches. The remaining surface soil has been mixed with the subsoil, and the plow layer is now a clay loam. These soils are low in organic matter and difficult to work and to keep in good tilth. They are suitable for permanent hay or pasture. Management group 15 (VIe).

Zook series

The Zook series consists of dark, poorly drained soils on bottom lands. They are wet and flooded part of the time and are difficult to manage. The clayey subsoil is slowly to very slowly permeable; it restricts the movement of air and moisture. Zook soils are fairly high in fertility, but wetness reduces yields. The native vegetation was grass and trees.

Representative profile (Zook silty clay):

0 to 20 inches, black, very firm silty clay.
20 to 40 inches, black to very dark gray, very firm silty clay.
40 to 60 inches, very dark gray to dark gray, very firm silty clay mottled with shades of olive.

Zook soils, among the most extensive bottom-land soils, are suitable for cultivation if adequately drained and protected from flooding. Tile drains do not work well, but V- or W-type ditches and bedding can be used to improve drainage. Diversion terraces constructed at the base of adjacent slopes help protect Zook soils from overflow.

Wheat and soybeans are suited to the Zook soils; corn can be grown if drainage is provided. Alfalfa is not well suited.

Zook silty clay (Zc).—The profile of this soil is similar to the one described. The surface layer is clayey and very slowly permeable. It is heavier than that in the other Zook soils and more difficult to work. If worked when too wet or too dry, it becomes fairly cloddy.

Zook silty clay is suitable for cultivated crops but should be protected from flooding and drained adequately. Tile drainage is not suitable. Management group 10 (IIIw).

Zook silty clay, overwashed (Zo).—The profile of this soil differs from the one described in that the surface layer is from 8 to 20 inches thick and consists of an overwash of very dark grayish-brown silt loam. This soil is easier to work than Zook silty clay. The subsoil, however, is a very slowly permeable silty clay. The effectiveness of tile drainage is doubtful.

The soil is suited to cultivated crops but should be drained and protected from flooding. Management group 10 (IIIw).

Zook silty clay loam (Zs).—The profile of this soil differs from the one described in that it has a dark-colored, silty clay loam surface layer that is from 15 to 20 inches thick. This soil is easier to work than the soil described as typical of the series, but it becomes cloddy if worked when too wet. Zook silty clay loam is slowly permeable, so the use of tile drainage is of questionable value. It is suitable for frequent row cropping but should be protected from flooding and drained adequately. Management group 3 (IIw).

Zook silty clay loam, overwashed (Zy).—The profile of this soil differs from the one described in that the surface layer is a very dark grayish-brown silt loam overwash, 8 to 20 inches thick. In addition, the next layer is black silty clay loam, 15 to 20 inches thick. Below this is silty clay that is similar to the surface layer in the profile described as typical for the series.

This soil is easier to work than the soil described for the series, and the upper layers are fairly permeable. The lower layers are clayey and slowly permeable; therefore, the use of tile drainage is of questionable value. This soil is suitable for frequent row cropping but should be drained and protected from flooding. Management group 3 (IIw).

Use and Management of Soils

In this section cropping systems, erosion control, tillage, and other management practices are discussed. In addition, the soils of Shelby County are placed in capability classes and management groups, and the use and management of each group are discussed. Finally, the estimated yields of crops, the principal management problems, and the cropping systems suggested for each mapping unit are given (table 7). A summary of the major characteristics of the soils (table 2) has been placed at the beginning of this section on management. It points out those properties of the soils that are most significant in planning use and management.

Management Practices

The most important soil management practices are discussed in this subsection. These practices—rotation of crops, control of erosion, tillage at the right time, drainage, and use of fertilizer—are essentials to be considered in management of any farm.

Cropping systems

The cropping systems in Shelby County generally consist of row crops, small grains, and meadow. The principal row crops grown are corn and soybeans, and the principal small grain is oats. The legumes and grasses are mainly alfalfa, red clover, bromegrass, and timothy. On most soils legumes and grasses are grown regularly in rotation with other crops to supply organic matter

TABLE 2.—*Major characteristics of the soils of Shelby County*

Soil	Parent material	Topographic position	Content of organic matter in plow layer	Subsoil: Permeability	Subsoil: Consistence when moist	Subsoil: Texture	Usual kind of erosion	Wetness hazard [1]
Adair clay loam, 5 to 11 percent slopes, moderately eroded.	Weathered glacial till.	Upland	Medium	Very slow	Firm	Silty clay	Sheet	Slight to severe.
Adair clay loam, 11 to 18 percent slopes, moderately eroded.	Weathered glacial till.	Upland	Low	Very slow	Firm	Silty clay	Sheet	Slight to severe.
Adair clay loam, 18 to 28 percent slopes, moderately eroded.	Weathered glacial till.	Upland	Low	Very slow	Firm	Silty clay	Sheet	Slight to severe.
Adair soils, 5 to 11 percent slopes, severely eroded.	Weathered glacial till.	Upland	Low	Very slow	Firm	Silty clay	Sheet	Slight to severe.
Adair soils, 11 to 18 percent slopes, severely eroded.	Weathered glacial till.	Upland	Low	Very slow	Firm	Silty clay	Sheet	Slight to severe.
Clarinda silty clay loam, 5 to 11 percent slopes, moderately eroded.	Weathered glacial till (gumbotil).	Upland	Low	Very slow	Very firm	Silty clay to clay.	Sheet	Slight to severe.
Clarinda silty clay loam, 11 to 18 percent slopes, moderately eroded.	Weathered glacial till (gumbotil).	Upland	Low	Very slow	Very firm	Silty clay to clay.	Sheet	Slight to severe.
Clarinda soils, 5 to 11 percent slopes, severely eroded.	Weathered glacial till (gumbotil).	Upland	Low	Very slow	Very firm	Silty clay to clay.	Sheet	Slight to severe.
Clarinda soils, 11 to 18 percent slopes, severely eroded.	Weathered glacial till (gumbotil).	Upland	Low	Very slow	Very firm	Silty clay to clay.	Sheet	Slight to severe.
Colo silty clay loam	Alluvium	Bottom land	High	Moderately slow.	Friable	Silty clay loam.	None	Slight to moderate.
Colo silty clay loam, overwashed.	Alluvium	Bottom land	High	Moderately slow.	Friable	Silty clay loam.	None	Slight to moderate.
Colo silty clay loam, silty clay substratum.	Alluvium	Bottom land	High	Slow	Firm	Silty clay	None	Wetter than other Colo soils.
Corley silt loam	Loess	Upland	High	Slow	Slightly firm	Silty clay loam.	None	Severe.
Corley silt loam, bench position.	Loess	Bench	High	Moderately slow.	Slightly firm	Silty clay loam.	None	Severe.
Dow silt loam, 8 to 14 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Dow silt loam, 14 to 18 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Ida silt loam, 5 to 8 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet	None.
Ida silt loam, 8 to 11 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Ida silt loam, 11 to 14 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Ida silt loam, 14 to 18 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Ida silt loam, 18 to 23 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Ida silt loam, 23 to 28 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Ida silt loam, 28 to 40 percent slopes, severely eroded.	Loess	Upland	Low	Moderately rapid.	Very friable	Silt loam	Sheet and gully.	None.
Judson silt loam, 0 to 2 percent slopes.	Local alluvium	Alluvial fan	Very high	Moderate	Friable	Silt loam	Gully	None to slight.

Judson silt loam, 2 to 5 percent slopes.	Local alluvium	Foot slope or alluvial fan.	Very high	Moderate	Friable	Silt loam	Gully	None.
Judson silt loam, 5 to 8 percent slopes.	Local alluvium	Foot slope	Very high	Moderate	Friable	Silt loam	Gully	None.
Judson-Nodaway-Colo complex, 2 to 5 percent slopes.	Alluvium	Narrow drainageways.	High	Moderate to moderately slow.	Friable to slightly firm.	Silt loam to silty clay loam.	Gully	Slight to moderate.
Judson-Nodaway-Colo complex, 5 to 8 percent slopes.	Alluvium	Narrow drainageways.	High	Moderate to moderately slow.	Friable to slightly firm.	Silt loam to silty clay loam.	Gully	None to slight.
Judson-Nodaway-Zook complex, 2 to 5 percent slopes.	Alluvium	Narrow drainageways.	Very high	Moderate to slow.	Friable to firm.	Silt loam to silty clay.	Gully	Slight to severe.
Judson-Nodaway-Zook complex, 5 to 8 percent slopes.	Alluvium	Narrow drainageways.	High	Moderate to slow.	Friable to firm.	Silt loam to silty clay.	Gully	Slight to moderate.
Kennebec silt loam	Alluvium	Bottom land	Very high	Moderate	Friable	Silt loam	None	Slight.
Kennebec silt loam, channeled	Alluvium	Bottom land	High	Moderate	Friable	Silt loam	None	Slight to moderate.
Marshall silt loam, 0 to 2 percent slopes.	Loess	Upland	Very high	Moderate to moderately slow.	Friable	Silty clay loam.	None	None.
Marshall silt loam, 2 to 5 percent slopes.	Loess	Upland	High	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall silt loam, 5 to 8 percent slopes, moderately eroded.	Loess	Upland	High	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall silt loam, 8 to 11 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall silt loam, 11 to 14 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall silt loam, 14 to 18 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Marshall silt loam, 18 to 28 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Marshall silt loam, bench position, 0 to 2 percent slopes.	Loess	Bench	Very high	Moderate to moderately slow.	Friable	Silty clay loam.	None	None.
Marshall silt loam, bench position, 2 to 5 percent slopes.	Loess	Bench	High	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall silt loam, bench position, 5 to 8 percent slopes, moderately eroded.	Loess	Bench	High	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall silt loam, bench position, 8 to 11 percent slopes, moderately eroded.	Loess	Bench	Medium	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall soils, 5 to 8 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall soils, 8 to 11 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall soils, 11 to 14 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Silty clay loam.	Sheet	None.
Marshall soils, 14 to 18 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Light silty clay loam.	Sheet	None.
Marshall soils, 18 to 23 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Light silty loam.	Sheet	None.
Marshall soils, 23 to 32 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Light silty clay loam.	Sheet	None.
Marshall soils, bench position, 8 to 11 percent slopes, severely eroded.	Loess	Bench	Low	Moderate	Friable	Silty clay loam.	Sheet	None.

See footnote on page 19.

TABLE 2.—*Major characteristics of the soils of Shelby County*—Continued

Soil	Parent material	Topographic position	Content of organic matter in plow layer	Subsoil: Permeability	Subsoil: Consistence when moist	Subsoil: Texture	Usual kind of erosion	Wetness hazard [1]
Marshall soils, bench position, 11 to 14 percent slopes, severely eroded.	Loess	Bench	Low	Moderate	Friable	Silty clay loam.	Sheet	None.
Minden silt loam	Loess	Upland	Very high	Moderate	Friable	Medium silty clay loam.	None	None to slight.
Minden silt loam, bench position.	Loess	Bench	Very high	Moderate	Slightly firm	Medium silty clay loam.	None	None to slight.
Monona silt loam, 2 to 5 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, 5 to 8 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, 5 to 8 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, 8 to 11 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, 8 to 11 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Light silty clay loam.	Sheet and gully.	None.
Monona silt loam, 11 to 14 percent slopes, moderately eroded.	Loess	Upland	Medium	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, 11 to 14 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, 14 to 18 percent slopes, moderately eroded.	Loess	Upland	Low	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, 14 to 18 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, 18 to 23 percent slopes, moderately eroded.	Loess	Upland	Low	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, 18 to 23 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, 23 to 32 percent slopes, severely eroded.	Loess	Upland	Low	Moderate	Friable	Heavy silt loam.	Sheet and gully.	None.
Monona silt loam, bench position, 2 to 5 percent slopes.	Loess	Bench	High	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, bench position, 5 to 8 percent slopes, moderately eroded.	Loess	Bench	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, bench position, 8 to 11 percent slopes, moderately eroded.	Loess	Bench	Medium	Moderate	Friable	Light silty clay loam.	Sheet	None.
Monona silt loam, bench position, 11 to 14 percent slopes, severely eroded.	Loess	Bench	Low	Moderate	Friable	Heavy silt loam.	Sheet	None.
Nodaway silt loam	Alluvium	Bottom land	Medium to low.	Moderate	Friable	Silt loam	None	Slight to moderate.
Nodaway silt loam, shallow to silty clay.	Alluvium	Bottom land	Medium to low.	Moderately slow.	Firm to very firm.	Silty clay	None	Slight to moderate.

Shelby loam, 8 to 11 percent slopes, moderately eroded.	Glacial till	Upland	Medium	Moderately slow.	Friable to firm.	Clay loam	Sheet	None.
Shelby loam, 11 to 14 percent slopes, moderately eroded.	Glacial till	Upland	Medium	Moderately slow.	Friable to firm.	Clay loam	Sheet	None.
Shelby loam, 14 to 18 percent slopes, moderately eroded.	Glacial till	Upland	Low	Moderately slow.	Friable to firm.	Clay loam	Sheet	None.
Shelby loam, 18 to 23 percent slopes, moderately eroded.	Glacial till	Upland	Low	Moderately slow.	Friable to firm.	Clay loam	Sheet	None.
Shelby loam, 23 to 32 percent slopes, moderately eroded.	Glacial till	Upland	Low	Moderately slow.	Friable to firm.	Clay loam	Sheet	None.
Shelby soils, 8 to 11 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Clay loam	Sheet	None.
Shelby soils, 11 to 14 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Clay loam	Sheet	None.
Shelby soils, 14 to 18 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Clay loam	Sheet	None.
Shelby soils, 18 to 23 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Clay loam	Sheet	None.
Steinauer loam, 8 to 11 percent slopes, moderately eroded.	Glacial till	Upland	Medium	Moderately slow.	Slightly firm to firm.	Clay loam	Sheet	None.
Steinauer loam, 11 to 14 percent slopes, moderately eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Light clay loam.	Sheet	None.
Steinauer loam, 14 to 18 percent slopes, moderately eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Light clay loam.	Sheet	None.
Steinauer loam, 18 to 28 percent slopes, moderately eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Light clay loam.	Sheet	None.
Steinauer soils, 8 to 11 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Light clay loam.	Sheet	None.
Steinauer soils, 11 to 14 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Light clay loam.	Sheet	None.
Steinauer soils, 14 to 18 percent slopes, severely eroded.	Glacial till	Upland	Low	Moderately slow.	Slightly firm to firm.	Light clay loam.	Sheet	None.
Zook silty clay	Alluvium	Bottom land	Very high	Very slow	Firm to very firm.	Silty clay	None	Severe to very severe.
Zook silty clay, overwashed	Alluvium	Bottom land	Medium to high.	Very slow	Firm to very firm.	Silty clay	None	Severe to very severe.
Zook silty clay loam	Alluvium	Bottom land	Very high	Slow to very slow.	Firm to very firm.	Silty clay	None	Moderate to severe.
Zook silty clay loam, overwashed.	Alluvium	Bottom land	Medium to high.	Slow to very slow.	Firm to very firm.	Silty clay	None	Moderate to severe.

[1] Hazard resulting from internal wetness and from ponding or overflow.

and to restore nitrogen used by intertilled crops and to improve the soil structure and tilth. Good cropping systems that contain meadow crops will also help in the control of weeds, diseases, insects, and erosion.

The maximum benefits from these cropping systems are obtained when all crop residues and some of the foliage of the legumes and grasses are returned to the soil. Barnyard manure added to soil will furnish organic matter, nitrogen, phosphorus, and potassium.

Table 3 shows the effect of various cropping systems on yields.

TABLE 3.—*Yields per acre of crops grown on Marshall silt loam in stated cropping systems, 1948–57* [1]

Cropping system [2]	First-year corn	Second-year corn	Oats	First-year hay	Second-year hay
	Bu.	*Bu.*	*Bu.*	*Tons*	*Tons*
Corn 1 year and oats 1 year	54. 8	-------	37. 3	-------	-------
Corn 2 years and oats seeded with sweet-clover 1 year	75. 3	65. 2	35. 4	-------	-------
Corn 1 year and oats seeded with sweet-clover 1 year	74. 4	-------	37. 3	-------	-------
Corn 2 years, oats 1 year, and meadow 1 year	90. 0	80. 3	40. 2	3. 05	-------
Corn 2 years,[3] oats 1 year, and meadow 1 year	84. 6	83. 7	41. 2	3. 03	-------
Corn 2 years, oats 1 year, and meadow 2 years	88. 3	83. 9	38. 9	2. 85	3. 52
Corn, oats, and meadow	91. 6	-------	39. 8	2. 79	-------
Corn, oats, and meadow 2 years	91. 8	-------	42. 2	2. 76	3. 54

[1] Data from Soil Conservation Experimental Farm, Shenandoah, Iowa.
[2] Phosphate was applied each year on all plots at the rate of 100 pounds of 0–20–0 per acre.
[3] Manure applied on second-year corn.

Erosion control

Soil erosion removes plant nutrients, creates gullies, makes seedbed preparation more difficult, and causes siltation in ditches and low-lying areas.

Soils on slopes are subject to erosion if cultivated and need special tillage and planting practices. Meadow crops in the cropping system help reduce erosion losses. Generally the steeper the slopes, the higher the percentage of meadow needed to reduce erosion losses to reasonable levels.

Table 4 shows how cropping systems affect soil and water losses from Marshall silt loam.

Terraces, when used with contouring and the suggested cropping systems, help prevent losses of soil and water. They also help prevent loss of lime and fertilizers caused by runoff and erosion. Level terraces and graded terraces are commonly used in Shelby County. Level terraces have no grade and no outlets, and water must soak downward into the soil. Grassed waterways are not usually needed for terrace outlets if level terraces are used. Soils with good permeability, such as Ida, Monona, and Marshall, are suitable for level terraces.

Graded terraces should be used on the less permeable

TABLE 4.—*Soil and water losses from Marshall silt loam in stated cropping systems, 1946–57* [1]

Cropping system	Average annual soil loss per acre	Average annual runoff
	Tons	*Inches*
Corn, oats, and meadow	5. 7	1. 28
Continuous corn	17. 2	2. 00

[1] Location: Soil Conservation Experimental Farm, Shenandoah, Iowa. Plots were on 9 percent slope, 72.6 feet long, and 6 feet wide. They were cropped uphill and downhill from 1946 to 1953 and contoured from 1953 to 1957.

till-derived soils, such as Adair, Shelby, or Steinauer. Graded terraces require outlets into grassed waterways.

Listing and contour cultivation and other tillage practices also help reduce soil loss and runoff. Table 5 shows the effect of tillage practices on soil and water loss when Marshall silt loam and Ida silt loam are in corn.

TABLE 5.—*Runoff and erosion from Marshall silt loam* [1] *and Ida silt loam* [2] *in corn for stated tillage practices* [3]

Tillage practice	Average annual soil loss per acre	Average annual water runoff
MARSHALL SILT LOAM (8 percent slope), 1933–39		
	Tons	*Inches*
Loose listed,[4] uphill and downhill	27. 0	2. 54
Loose listed on the contour	5. 1	. 49
MARSHALL SILT LOAM (10 percent slope), 1943–49		
Loose listed on the contour and cover crop grown	0. 13	0. 33
Loose listed on the contour and cover crop not grown	. 62	. 31
Surface planted on the contour	8. 12	2. 15
MARSHALL SILT LOAM (8 percent slope), 1944–47		
Loose listed, uphill and downhill	25. 0	2. 92
Loose listed on the contour	3. 9	1. 14
IDA SILT LOAM (14 percent slope), 1948–54		
Surface planted, uphill and downhill	26. 1	3. 47
Surface planted on the contour	9. 8	2. 20
Loose listed on the contour	2. 6	1. 30

[1] Data for Marshall silt loam was obtained at the Soil Conservation Experimental Farm, Shenandoah, Iowa.
[2] Data for Ida silt loam was obtained at the Western Iowa Experimental Farm, Castana, Iowa.
[3] Plots were 10.5 feet wide and 72.6 feet long, except for first experiment listed. In that experiment, the uphill and downhill plot was 42 feet wide and 157.5 feet long and the contour plot was 84 feet wide and 157.5 feet long.
[4] Loose listed—soils that have been first plowed, then disked and harrowed, and finally listed with a conventional lister for planting row crops. Hard-ground listing is done without previous tillage of the soil.

Grassed waterways are an important erosion control practice, as they prevent channels from becoming gullies. The grass prevents erosion by holding the soil and slowing the velocity of moving water. If wide enough, grassed waterways allow excess water to flow from the fields with only a small loss of soil and can be crossed more easily with farm machinery. Seed or hay may also be harvested from grassed waterways. When used along with contouring, terracing, good cropping systems, and other soil-saving practices, permanently vegetated waterways can be left for long periods.

Although soil and water are lost mainly from cultivated land, there is some erosion on grassed or forested soils, generally because of overgrazing and scant plant cover.

Tillage

The main goals of proper tillage are to prepare a suitable seedbed, to destroy weeds, and to improve the physical condition of the soil. The kind, amount, and time of cultivation depend on the crop to be planted, or grown, the quantity and kind of weeds, other vegetation and crop residues, the prevalence of disease and insect pests, the quantity and intensity of rainfall, and soil characteristics (*19*).

Drainage

Good yields are not obtained continually from wet soils. Plants growing in wet soils develop shallow root systems, and nutrients are not readily available. If dry weather follows a wet period, the crop may actually be damaged by drought. Corn and alfalfa must be able to root deeply to make their best growth.

Soils that are low to medium in clay can be effectively drained by tile. Those that cannot be drained effectively by tile need special attention. These soils must be recognized and provided with surface ditches that will drain off the excess water.

Fertilizers

Nitrogen, phosphorus, and potassium are among the elements necessary for plant growth. These nutrients are used fairly heavily by crops, and they are often deficient in the soils of this county.

Each crop takes nutrients from the soils. Dissolving and leaching actions also deplete soil fertility. When soils become acid and deficient in available plant nutrients, they can no longer produce satisfactory yields.

Many soils in Shelby County cannot supply adequate nitrogen and phosphorus for highest crop yields. The calcareous soils, such as Ida, are particularly low in available phosphorus. Most Shelby County soils, however, have enough potassium, and this element should not be applied unless tests show the need of it.

Unlike phosphorus and potassium, nitrogen is not one of the soil minerals. It comes mainly from decaying organic matter (humus), leguminous crop residues, manure, and nitrogen fertilizers. Large amounts of nitrogen are necessary for plant vigor and high yields of crops. Many soils in Shelby County are too low in nitrogen for highest crop yields. Consequently, additional nitrogen should be applied through crop residues, especially from legume crops, and through application of barnyard manure or commercial fertilizer.

Decaying organic matter supplies nitrogen and helps keep the soils in good physical condition. Organic matter helps to mellow sticky clay, clay loam, and silty clay loam soils, and to make them easier to till. It also helps to bind together the particles in single-grain soils having a loamy sand and sandy loam texture. Organic matter also helps to retain moisture and retard wind erosion on sandy soils.

Soil tests

Samples of the soils in each field may be tested for available nutrients at the Iowa State University soil testing laboratory. Such tests, together with knowledge of soil type, past management, and desired yields, are the most satisfactory basis for estimating fertilizer needs.

The amount of agricultural lime needed for Shelby County soils can also be determined by soil tests. Some soils need lime to bring the reaction to the level at which the other plant nutrients are most readily available. Since no two farms are alike, the soils of each farm should be tested to determine the need of fertilizer and lime.

The soil map is an excellent guide for soil sampling, as it shows the areas and boundaries of different soils. Reliable test results cannot be obtained if samples are mixed from different kinds of soil or from the same kind of soil that has had widely different management. The largest soil area that should be represented by one soil sample is about 10 acres. Ask your Soil Conservation Service representative or the county extension director for soil testing information.

The Iowa State University soil testing laboratories tested the need for lime in 1,708 soil samples received from Shelby County before July 1, 1954. The results were as follows:

Percentage of samples:	*Tons of lime per acre needed*
10	None (calcareous)
27	None (slightly acid)
39	1.5 to 2.0
23	2.5 to 3.0
1	3.0 to 4.0
0	4.0 or more

Table 6 shows the percentage of tested soil samples having stated degrees of nitrogen, phosphorus, and potassium availability.

TABLE 6.—*Percentage of soil samples containing stated degrees of nitrogen, phosphorus, and potassium availability* [1]

[495 samples were tested for nitrogen and 1,538 for phosphorus and potassium]

Degree of availability of element in soil	Elements tested		
	Nitrogen	Phosphorus	Potassium
	Percent	*Percent*	*Percent*
Very low	6	2	0
Low	64	40	0
Medium	25	33	3
High	5	25	97

[1] The results on phosphorus and potassium are for all samples tested before July 1, 1954. The results for nitrogen are for all samples tested during 1953 and 1954.

Farm planning

When the different soils on a farm have been identified and studied, a plan for their efficient use and management can be developed. Help in planning is available through the Shelby County Soil Conservation District or the county extension director.

Many fields, especially in rolling areas, contain two or more kinds of soil that are suitable for different crops and, consequently, need different management. If one soil area is very small, it may have to be farmed the same as the rest of the field. However, soil areas are often large enough so that field boundaries can be made to follow soil boundaries, and thus each soil can be farmed according to its best use.

Usually several good field arrangements and cropping systems can be worked out for a given farm. More than one cropping system may be needed on some farms. For example, if a farm has undulating soils as well as some bottom land, it may require different crop rotations if the two kinds of soil are to be used most efficiently.

Good management should include the following: Adequate drainage; tests for lime, phosphorus, potassium, and nitrogen; use of limestone, barnyard manure, and commercial fertilizers; use of suitable cropping systems; erosion control; and good tillage.

Farm plans must be put into operation if they are to have value. Desirable changes can be made in almost any order, but if drainage is a problem, perhaps that is the place to start. If alfalfa and bromegrass meadows are to be established, the lime requirements should be determined in advance. Field boundaries can be changed more conveniently while an area is in meadow. Terraces are best constructed on meadow that will be plowed for corn. If contouring is established on first-year corn, headlands and turnrows should be left unplowed so they will not erode.

Many farms have been changed from farming uphill and downhill to farming on the contour or "with the lay of the land." Heavy rains are less likely to cause large losses of soil and water if land is farmed on the contour. In addition, crops tend to stay more green and vigorous in dry weather because of the water that has been stored in the subsoil.

Capability Groups of Soils

Capability grouping is a system of classification used to show the relative suitability of soils for crops, grazing, forestry, and wildlife. It is a practical grouping based on the needs, limitations, and risks of damage to the soils, and also their response to management. There are three levels above the mapping unit in the grouping —unit, subclass, and class.

The capability unit, sometimes called a management group, is the lowest level of grouping. A capability unit is made up of soils similar in kind of management needed, in risk of damage, and in general suitability for use.

The next broader grouping, the subclass, is used to indicate the dominant kind of limitation. The letter symbol "e" indicates that the main limiting factor is risk of erosion if the plant cover is not maintained; "w" means excess water that retards plant growth or interferes with cultivation; and "s" means that the soils are shallow, droughty, or unusually low in fertility.

The broadest grouping, the land class, is identified by Roman numerals. All the soils in one class have limitations and management problems of about the same degree, but they are of different kinds as shown by the subclass. All the land classes except class I may have one or more subclasses.

In classes I, II, and III are soils that are suitable for annual or periodic cultivation of annual or short-lived crops. Class I soils are those that have the widest range of use and the least risk of damage. They are level, or nearly level, productive, well drained, and easy to work. They can be cultivated with almost no risk of erosion and will remain productive if managed with normal care.

Class II soils can be cultivated regularly, but they do not have quite so wide a range of suitability as class I soils. Some class II soils are gently sloping; consequently, they need moderate care to prevent erosion; others may be slightly droughty, or slightly wet, or somewhat limited in depth.

Class III soils can be cropped regularly but have a narrower range of use. These need even more careful management.

In class IV are soils that should be cultivated only occasionally or only under very careful management.

In classes V, VI, and VII are soils that normally should not be cultivated for annual or short-lived crops, but they can be used for pasture or range, as woodland, or as habitats for wildlife.

Class V soils are nearly level and gently sloping but are wet, low in fertility, or otherwise unsuitable for cultivation. No soils in Shelby County were placed in class V.

Class VI soils are not suitable for crops because they are steep, or droughty, or otherwise limited, but they give fair yields of forage or forest products. Some soils in class VI can, without damage, be cultivated enough so that fruit trees or forest trees can be set out or pastured crops can be seeded.

Class VII soils not suited to cultivation; their use is restricted largely to grazing, woodland, or wildlife.

Class VIII soils have practically no agricultural use. Some of the soils have value as watersheds, as wildlife habitats, or as recreational areas. No soils in the county have been placed in class VIII.

The capability classes, subclasses, and management groups in Shelby County are given in the following list.

Class I.—Soils that have few limitations in use.
- Management group 1: Nearly level soils that have no serious drainage or erosion problems.

Class II.—Soils that have some limitations that reduce the choice of plants or require moderate conservation practices.
- Subclass IIe: Gently sloping soils that will erode if not protected.
  - Management group 2: Dark silty soils.
- Subclass IIw: Soils that are wet but that can usually be drained by tile.
  - Management group 3: Imperfectly drained to poorly drained soils of uplands, benches, or bottom lands.

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

Subclass IIIe: Soils severely limited by risk of erosion if not protected.
- Management group 4: Moderately sloping soils formed from loess; moderately to severely eroded.
- Management group 5: Strongly sloping soils formed from loess; moderately to severely eroded.
- Management group 6: Rolling soils formed from loess; moderately to severely eroded.
- Management group 7: Moderately sloping to rolling calcareous soils formed from loess; severely eroded.
- Management group 8: Moderately sloping soils formed from alluvium.
- Management group 9: Strongly sloping to rolling soils formed from glacial till.

Subclass IIIw: Soils that are wet and contain clayey, tight materials that make them difficult to drain satisfactorily with tile.
- Management group 10: Poorly drained soils on bottom land.

Class IV.—Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both.

Subclass IVe: Soils that are very severely limited by risk of erosion if they are not protected.
- Management group 11: Steep, moderately to severely eroded soils formed from loess.
- Management group 12: Steep, severely eroded, calcareous soils formed from loess.
- Management group 13: Moderately sloping to steep soils formed from glacial material.
- Management group 14: Moderately sloping to strongly sloping, wet, seepy soils.

Class VI.—Soils that have severe limitations that make them generally unsuited to cultivation and that limit their use largely to pasture, woodland, or wildlife food and cover.

Subclass VIe: Soils generally not suited to cultivation and severely limited by risk of erosion if cover is not maintained.
- Management group 15: Rolling to very steep (mostly slopes of 11 to 23 percent), moderately or severely eroded soils.

Class VII.—Soils that have very severe limitations that make them unsuitable for cultivation and restrict their use largely to grazing, woodland, or wildlife.

Subclass VIIe: Soils unsuited to cultivation and very severely limited by risk of erosion if cover is not maintained.
- Management group 16: Rolling to very steep (mostly slopes of 18 to 40 percent), moderately or severely eroded soils.

Descriptions of management groups

In this section each management group is described and the soils in it are listed. In addition, suggestions are given on how to use and manage each group of soils.

The rotations suggested are those that provide the maximum amounts of row crops considered suitable for the soils. Contouring and terracing make it possible to use the maximum amount of corn in the rotation. Other cropping systems can also be used if they are suited to the farming system, protect the soils from erosion, and improve and maintain soil fertility.

MANAGEMENT GROUP 1

Nearly level soils that have no serious drainage or erosion problems

Soils on uplands and benches:
- Marshall silt loam, 0 to 2 percent slopes.
- Marshall silt loam, bench position, 0 to 2 percent slopes.
- Minden silt loam.
- Minden silt loam, bench position.

Soils on bottom lands:
- Judson silt loam, 0 to 2 percent slopes.
- Kennebec silt loam.
- Kennebec silt loam, channeled.
- Nodaway silt loam.

These are nearly level soils that are well drained to imperfectly drained. Internal soil wetness is not a serious problem except for channeled areas in Kennebec silt loam, channeled. Flooding is a hazard to varying degrees on the soils on bottom lands but does not occur on the soils on uplands and benches.

All of these soils are friable and easy to work. They are medium to low in available phosphorus and they tend to be medium to low in nitrogen. They are high in available moisture-holding capacity. Lime needs are variable. The soils on uplands and benches in management group 1 are the most productive in the county. The soils on the bottom lands in this group also produce high yields. Because of some infrequent flooding, however, they have somewhat lower average yields than the soils on uplands and benches.

Principal management problems are maintenance or improvement of fertility and some flood prevention practices on the bottom-land soils.

Use and management.—The soils in this group are used intensively for corn, soybeans, and oats. They are suitable for these crops and for alfalfa or other hay and pasture crops. These soils can be used almost continuously for row crops, but 1 year of meadow every 5 years is suggested for most farms. Additional nitrogen and phosphorus are needed for maximum yields. Nitrogen fertilizer is needed when corn follows corn or other row crops, but legumes generally furnish enough nitrogen if corn is grown following a grass-legume meadow. Lime and fertilizer should be applied according to needs determined by soil tests.

Cropping systems suggested for these soils are (a) 3 years of row crops and 1 year of a small grain seeded with a legume for green manure, or (b) 3 years of row crops, 1 year of a small grain, and 1 year of meadow. Capability class I.

MANAGEMENT GROUP 2

Dark silty soils

- Judson silt loam, 2 to 5 percent slopes.
- Judson-Nodaway-Colo complex, 2 to 5 percent slopes.
- Marshall silt loam, 2 to 5 percent slopes.
- Marshall silt loam, bench position, 2 to 5 percent slopes.
- Monona silt loam, 2 to 5 percent slopes, moderately eroded.
- Monona silt loam, bench position, 2 to 5 percent slopes.

These soils are deep and mostly well drained to moderately well drained. They have a high available moisture-holding capacity. They are medium to low in available phosphorus and nitrogen. Lime needs vary. These soils

***Figure 6.*—Marshall silt loam in corn planted on the contour. Turn strip for machinery is in alfalfa and bromegrass to prevent erosion.**

are friable and easy to work. If properly managed, these soils are among the most productive in the county. Wetness is a problem only on the Judson-Nodaway-Colo complex. Erosion control and fertility maintenance are the principal management problems (fig. 6).

Use and management.—These soils are well suited to corn, soybeans, oats, and hay or pasture crops, including alfalfa. Erosion can be controlled through contour cultivation and the use of level terraces. The Judson-Nodaway-Colo complex usually occurs on narrow drainageways and is often used in the same way as the adjacent soils.

Additional nitrogen and phosphorus are needed for maximum yields. Nitrogen is needed when corn follows corn or other row crops. However, a legume generally furnishes enough nitrogen if corn is grown following a meadow that contains a high percentage of legumes. Lime and plant nutrients should be applied in amounts determined by soil tests.

Cropping systems suggested for these soils are (a) with contour cultivation only—2 years of row crops, 1 year of a small grain, and 1 year of grass-legume meadow; (b) with terraces—2 years of row crops and 1 year of a small grain seeded with a legume for green manure. Capability class II, subclass IIe.

MANAGEMENT GROUP 3

Imperfectly drained to poorly drained soils of uplands, benches, or bottom lands

Colo silty clay loam.
Colo silty clay loam, overwashed.
Colo silty clay loam, silty clay substratum.
Corley silt loam.
Corley silt loam, bench position.
Judson-Nodaway-Zook complex, 2 to 5 percent slopes.
Nodaway silt loam, shallow to silty clay.
Zook silty clay loam.
Zook silty clay loam, overwashed.

These soils are moderately slowly to very slowly permeable. All except the Judson-Nodaway-Zook complex are nearly level or slightly depressed, and all except the Corley may be flooded for short periods. The Corley soils are sometimes ponded. Wetness varies from soil to soil and area to area. Erosion is not a problem. The soils are high in available moisture-holding capacity, medium to low in phosphorus, and high in nitrogen. Lime requirements vary. The principal management problems are the prevention of wetness and the improvement of drainage, the control of floods, and the maintenance of fertility.

Use and management.—These soils are used mainly for corn, soybeans, wheat, oats, and meadow. They are suitable for almost continuous row cropping. Some areas not satisfactorily drained are used for permanent pasture. Improvement of drainage and prevention of wetness are needed on these soils. V- or W-type drains, open ditches, or bedding can be used to remove excess water. If suitable outlets can be obtained, tile drainage can be used to remove excess water from the Colo silty clay loam; Colo silty clay loam, overwashed; Corley silt loam; and Corley silt loam, bench position. Other soils in the group are too slowly permeable to be drained adequately with tile. In some places diversion terraces can be used to prevent upland runoff from flooding these soils. The Colo, Nodaway, or Zook soils can sometimes be protected from flooding by levees or by straightening of streams.

There are various reasons for wetness on these soils, and the practices needed to reduce wetness or improve drainage often depend on the combination of conditions in any one area.

Zook silty clay loam is somewhat difficult to work because of the fine-textured surface layer. It may become cloddy when worked too wet or too dry. Tilth can be improved in any of these soils by growing meadow crops.

Fertilizer needs should be determined by soil tests. Amounts needed vary with the cropping system and the soil test level. Suggested cropping systems for these soils are (a) 3 years of row crops, 1 year of small grain, and 1 year of meadow; (b) 3 years of row crops and 1 year of a small grain seeded with a legume for green manure. Capability class II, subclass IIw.

MANAGEMENT GROUP 4

Moderately sloping soils formed from loess; moderately to severely eroded

Marshall silt loam, 5 to 8 percent slopes, moderately eroded.
Marshall silt loam, bench position, 5 to 8 percent slopes, moderately eroded.
Marshall soils, 5 to 8 percent slopes, severely eroded.
Monona silt loam, 5 to 8 percent slopes, moderately eroded.
Monona silt loam, 5 to 8 percent slopes, severely eroded.
Monona silt loam, bench position, 5 to 8 percent slopes, moderately eroded.

These soils are well drained and have a high available moisture-holding capacity. They are low in nitrogen and low to medium in available phosphorus. Lime needs are variable. The soils are easily worked, and, when properly managed, they are among the most productive in the county. The principal management problems are the control of erosion and maintenance of fertility.

Use and management.—These soils are well suited to corn and oats and to hay or pasture crops, including alfalfa. If row crops are grown, the fields should be terraced and cultivated on the contour to control runoff and erosion. Nitrogen and phosphate fertilizers are needed for highest yields. The severely eroded soils will need more fertilizer than the moderately eroded soils. Fertilizer and lime should be applied according to needs determined by soil tests.

Cropping systems suggested for these soils are (a) with contour cultivation only—2 years of row crops, 1 year of a small grain, and 2 years of grass-legume meadow; or (b) with terraces—2 years of row crops, followed by 1 year of a small grain and 1 year of meadow. Capability class III, subclass IIIe.

MANAGEMENT GROUP 5

Strongly sloping soils formed from loess; moderately to severely eroded

Marshall silt loam, 8 to 11 percent slopes, moderately eroded.
Marshall silt loam, bench position, 8 to 11 percent slopes, moderately eroded.
Marshall soils, 8 to 11 percent slopes, severely eroded.
Marshall soils, bench position, 8 to 11 percent slopes, severely eroded.
Monona silt loam, 8 to 11 percent slopes, moderately eroded.
Monona silt loam, 8 to 11 percent slopes, severely eroded.
Monona silt loam, bench position, 8 to 11 percent slopes, moderately eroded.

These soils are deep and well drained. They have a high available moisture-holding capacity. They tend to be low in nitrogen, and they are low to medium in available phosphorus. Lime needs vary. The soils are easily worked. The principal management problems are control of erosion and maintenance of fertility.

Use and management.—These soils are suited to corn and oats and to alfalfa and to other hay or pasture crops. If used for row crops, fields should be terraced and cultivated along the contour to control runoff and erosion (fig. 7). Nitrogen and phosphate fertilizers should be applied for highest yields. The severely eroded soils will require more fertilizer than the moderately eroded soils. Need for fertilizer and lime should be determined by soil tests.

Cropping systems suggested for these soils are (a) with contour cultivation only—1 year of a row crop, 1 year of a small grain, and 2 years of grass-legume meadow; or (b) with terraces—2 years of row crops, 1

***Figure 7.*—Corn on terraced field of Marshall silt loam (12 percent slope). In background, field of oats with waterways in bromegrass. Soils of the Judson-Nodoway-Colo complex along main drainageway that divides the two fields.**

year of a small grain, and 1 year of grass-legume meadow. Capability class III, subclass IIIe.

MANAGEMENT GROUP 6

Rolling soils formed from loess; moderately to severely eroded

Marshall silt loam, 11 to 14 percent slopes, moderately eroded.
Marshall soils, 11 to 14 percent slopes, severely eroded.
Marshall soils, bench position, 11 to 14 percent slopes, severely eroded.
Monona silt loam, 11 to 14 percent slopes, moderately eroded.
Monona silt loam, 11 to 14 percent slopes, severely eroded.
Monona silt loam, bench position, 11 to 14 percent slopes, severely eroded.

These soils are deep and well drained. They have a high moisture-holding capacity, and they have good tilth. They tend to be low in nitrogen, and they are low to medium in available phosphorus. Lime needs vary. The principal management problems are control of erosion and maintenance of fertility.

Use and management.—These soils are hard to manage because of strong slopes. However, they are suited to corn, oats, and hay or pasture crops, including alfalfa. If used for row crops, the fields should be terraced and cultivated along the contour to control runoff and erosion (fig. 8). Nitrogen and phosphate fertilizers are needed for highest yields. The severely eroded soils require more fertilizer than the moderately eroded soils. Fertilizer and lime should be applied in amounts determined by soil tests.

Cropping systems suggested for these soils are (a) with contour cultivation only—1 year of a row crop, 1 year of a small grain, and 4 years of grass-legume meadow; or (b) with terraces—2 years of a row crop, 1 year of a small grain, and 2 years of grass-legume meadow. Capability class III, subclass IIIe.

MANAGEMENT GROUP 7

Moderately sloping to rolling calcareous soils formed from loess; severely eroded

Dow silt loam, 8 to 14 percent slopes, severely eroded.
Ida silt loam, 5 to 8 percent slopes, severely eroded.
Ida silt loam, 8 to 11 percent slopes, severely eroded.
Ida silt loam, 11 to 14 percent slopes, severely eroded.

These soils can hold large amounts of moisture, but they tend to be droughty because the low infiltration rate and moderate slope cause rapid runoff. The rapid runoff causes them to erode easily if they are cultivated. They are friable and easy to work. These soils are very low in available phosphorus, and they are very low in nitrogen. The Ida soils contain excessive lime, and they frequently have concretions of lime on the surface. Some areas of the Dow soil are not calcareous. The principal management problems are control of erosion and improvement of fertility, especially the supply of nitrogen and phosphorus.

Use and management.—These soils are suited to corn and oats and to alfalfa and other hay or pasture crops. Good grain yields can be obtained only if nitrogen and phosphate are added in large amounts. Lime is not needed. Fertilizer should be applied in amounts determined by soil tests. Terraces and contour tillage are needed if these soils are used for row crops.

Cropping systems suggested for these soils are (a) with contour cultivation only—1 year of a row crop, 1 year of a small grain, and 3 years of grass-legume meadow; or (b) with terraces—2 years of row crops, 1 year of a small grain, and 2 years of grass-legume meadow; or 1 year of a row crop, 1 year of a small grain, and 1 year of grass-legume meadow. Capability class III, subclass IIIe.

***Figure 8.*—Level terraces on Monona silt loam.**

MANAGEMENT GROUP 8

Moderately sloping soils formed from alluvium

Judson silt loam, 5 to 8 percent slopes.
Judson-Nodaway-Colo complex, 5 to 8 percent slopes.
Judson-Nodaway-Zook complex, 5 to 8 percent slopes.

These dark-colored soils usually occur in small areas at the foot of slopes and along drainageways. They are medium to high in organic matter and nitrogen but medium to low in phosphorus. The capacity to hold available moisture is high. The principal problem is the control of gully erosion caused by runoff from adjoining slopes. Another problem is drainage in the Colo and Zook soils near the middle of drainageways.

Use and management.—These soils are suited to corn, soybeans, and oats, and to hay and pasture crops, including alfalfa. Some wet or severely gullied areas may be best suited to permanent pasture. These soils can best be protected from gullying and sheet erosion by terracing the adjacent, higher slopes. Contour cultivation alone may control erosion on soils of this group if the higher adjacent slopes are terraced. The sides of waterways and gullies should be sloped, seeded with grass, and then kept permanently in vegetation.

Tile can be used to drain the Judson-Nodaway-Colo complex, but the feasibility of its use on the Judson-Nodaway-Zook complex is doubtful because the Zook soil is slowly permeable. Judson silt loam does not need drainage.

Only medium to small amounts of fertilizer are needed, but application should be governed by soil tests.

Small areas of these soils can be used like the surrounding soils. For large areas, the suggested cropping systems are (a) with contouring only—2 years of row crops, 1 year of a small grain, and 2 years of grass-legume meadow; or (b) with terraces—2 years of row crops and 1 year of a small grain seeded with a legume for green manure. Capability class III, subclass IIIe.

MANAGEMENT GROUP 9

Strongly sloping to rolling soils formed from glacial till

Shelby loam, 8 to 11 percent slopes, moderately eroded.
Shelby loam, 11 to 14 percent slopes, moderately eroded.
Steinauer loam, 8 to 11 percent slopes, moderately eroded.
Steinauer loam, 11 to 14 percent slopes, moderately eroded.

These soils are well drained to moderately well drained. They usually occur as outcrops or in bands on side slopes below the Marshall or Monona soils. They are low in available phosphorus, and they tend to be low in nitrogen. The Steinauer soils are high in lime and are lower in available phosphorus than the Shelby soils. The Shelby soils are acid. The soils in this management group have heavier subsoils than those of the Marshall or Monona soils, and they are not so easy to work. If cultivated, they erode easily. The principal management problems are control of erosion and maintenance of fertility.

Use and management.—These soils are suited to corn, oats, and hay and pasture crops, including alfalfa. If used for row crops, these soils should be terraced or cultivated along the contour.

Nitrogen and phosphate fertilizers are needed for high yields. These and lime should be applied according to needs determined by soil tests.

Suggested cropping systems for these soils are (a) with contour cultivation only—1 year of a row crop, 1 year of a small grain, and 4 years of grass-legume meadow; or (b) with terraces—2 years of row crops, 1 year of a small grain, and 2 years of meadow. Capability class III, subclass IIIe.

MANAGEMENT GROUP 10

Poorly drained soils on bottom land

Zook silty clay.
Zook silty clay, overwashed.

These dark-colored, nearly level soils may be flooded for short periods. The dense, clayey subsoil is slowly permeable to air and water. The Zook silty clay soils become cloddy if worked when they are too dry or too wet. They are medium in available phosphorus, and they tend to be medium to high in nitrogen. The principal management problems are the control of floods and drainage of excess water.

Use and management.—These soils are suited to corn, soybeans, and wheat and to hay and pasture crops that can tolerate excessive moisture. They are not well suited to alfalfa.

Drainage can be improved by V- or W-type ditches, open ditches, or bedding. Tile drainage is not suitable because the subsoil is very slowly permeable. Diversion terraces on the adjoining slopes may help control runoff from adjacent slopes. Lime and fertilizer should be applied in amounts determined by soil tests.

Suggested cropping systems for these soils are (a) with improved drainage—1 year of corn, 1 year of soybeans, and 1 year of wheat seeded with a legume for green manure; or (b) without improved drainage—wheat seeded with a legume for green manure. It would be desirable to include meadow in these cropping systems to improve soil tilth. Capability class III, subclass IIIw.

MANAGEMENT GROUP 11

Steep, moderately to severely eroded soils formed from loess

Marshall silt loam, 14 to 18 percent slopes, moderately eroded.
Marshall soils, 14 to 18 percent slopes, severely eroded.
Monona silt loam, 14 to 18 percent slopes, moderately eroded.
Monona silt loam, 14 to 18 percent slopes, severely eroded.

These soils are deep and well drained. Runoff is rapid, and the soils erode easily when cultivated. They tend to be droughty, although they have the capacity to hold large amounts of water. They are medium to low in available phosphorus, and they tend to be low in nitrogen. Lime needs vary. The principal management problems are control of erosion and maintenance of fertility.

Use and management.—These soils are too steep for frequent row cropping. They can be cultivated occasionally but should be kept in a grass-legume meadow at least half the time. Although slopes are steep, terraces will help control runoff and erosion fairly well. Phosphate fertilizer is needed on all grain, rotation hay or pasture, and permanent pasture. Nitrogen is needed on all permanent pastures that do not contain a legume. The need for fertilizer and lime should be determined by soil tests.

The suggested cropping systems are (a) with terraces —1 year of a row crop, 1 year of oats, and 2 years of grass-legume meadow; or (b) permanent hay or pasture. A mixture of alfalfa and bromegrass is well suited to hay or pasture. Capability class IV, subclass IVe.

MANAGEMENT GROUP 12

Steep, severely eroded, calcareous soils formed from loess

Dow silt loam, 14 to 18 percent slopes, severely eroded.
Ida silt loam, 14 to 18 percent slopes, severely eroded.

These soils erode easily when cultivated because runoff is rapid. They can hold large amounts of moisture but tend to be somewhat droughty because water is slowly absorbed. The supply of available phosphorus and nitrogen is low. The Ida soil contains too much lime and frequently has concretions of it on the surface. The amount of lime is high in some areas of the Dow soil. The principal management problems are control of erosion and improvement of fertility, mainly the supply of nitrogen and phosphorus.

Use and management.—These soils are too steep for frequent row cropping. Even if terraced, they are suitable for only occasional cultivation. They should be in grass-legume meadow for at least 4 years out of 6. Terraces control runoff and erosion fairly well on the steep slopes of these soils. Because these soils are high in lime, phosphate fertilizer is needed in large amounts for grain, all permanent pasture, and rotation hay or pasture. Nitrogen is needed for grain and for permanent pasture that does not contain a legume. Need for lime and fertilizer should be determined by soil tests.

Suggested cropping systems are (a) with terraces—1 year of a row crop, 1 year of a small grain, and 4 years or more of grass-legume meadow; or (b) permanent hay or pasture. A mixture of alfalfa and bromegrass for hay or pasture is well suited. Capability class IV, subclass IVe.

MANAGEMENT GROUP 13

Moderately sloping to steep soils formed from glacial material

Shelby loam, 14 to 18 percent slopes, moderately eroded.
Shelby soils, 8 to 11 percent slopes, severely eroded.
Shelby soils, 11 to 14 percent slopes, severely eroded.
Steinauer loam, 14 to 18 percent slopes, moderately eroded.
Steinauer soils, 8 to 11 percent slopes, severely eroded.
Steinauer soils, 11 to 14 percent slopes, severely eroded.

These well drained to moderately well drained soils usually occur as outcrops on side slopes below the Marshall and Monona soils. They have heavier, more clayey subsoils than the Marshall and Monona soils. The soils in this management group are not easy to work. The supply of available phosphorus and nitrogen is low. The capacity to hold moisture is high. The Steinauer soils are high in lime and are lower in available phosphorus than the Shelby soils. The Shelby soils are acid. The principal management problems are control of erosion and maintenance of fertility.

Use and management.—These soils are too steep or too severely eroded for frequent row cropping. They can be cultivated occasionally if terraced, but they should be kept mainly in a grass-legume meadow. Terraces help control runoff and erosion on cultivated areas.

Phosphate fertilizer is needed on all permanent pasture, rotation hay or pasture, and on all grain crops. Nitrogen is needed on grain and on permanent pasture that does not contain a legume. Lime and fertilizer should be applied according to soil tests. An alfalfa and bromegrass mixture is well suited for use as hay and pasture.

Suggested cropping systems for—

Shelby soils, 8 to 11 percent slopes, severely eroded.
Shelby soils, 11 to 14 percent slopes, severely eroded.
Steinauer soils, 8 to 11 percent slopes, severely eroded.
Steinauer soils, 11 to 14 percent slopes, severely eroded.

—are the following: (a) With contour cultivation only —1 year of a row crop, 1 year of a small grain, and 4 years or more of grass-legume meadow; or (b) with terraces—1 year of a row crop, 1 year of a small grain, and 2 years of grass-legume meadow.

Suggested cropping systems for—

Shelby loam, 14 to 18 percent slopes, moderately eroded.
Steinauer loam, 14 to 18 percent slopes, moderately eroded.

—are the following: (a) With terraces—1 year of a row crop, 1 year of a small grain, and 3 years or more of grass-legume meadow; or (b) permanent hay or pasture. Capability class IV, subclass IVe.

MANAGEMENT GROUP 14

Moderately sloping to strongly sloping, wet, seepy soils

Adair clay loam, 5 to 11 percent slopes, moderately eroded.
Adair soils, 5 to 11 percent slopes, severely eroded.
Clarinda silty clay loam, 5 to 11 percent slopes, moderately eroded.
Clarinda soils, 5 to 11 percent slopes, severely eroded.

These soils occur as outcrops or bands on side slopes below the Marshall and Monona soils. Clay in the subsoil makes them very slowly permeable to air and water. The soils may be wet and seepy in spring and when rain is abundant. They erode easily when cultivated, and they are low in fertility. The principal management problems are control of erosion and seepage and maintenance of fertility.

Use and management.—These soils are suitable for only limited use for cultivated crops. They should be used for hay or pasture at least 2 years out of 4. Yields, however, will be low. Good stands are difficult to establish and maintain, especially on the severely eroded phases.

Seepage can be controlled by use of intercepting tile laid in the more permeable soils that are above the Adair and Clarinda soils. If these soils are cultivated, fields should be terraced or contoured on a slight grade to help drain off excess moisture.

Nitrogen fertilizer is needed for grain and for pastures that do not contain legumes. Phosphate is needed on meadow, pasture, and grain. Needed amounts of plant nutrients and lime should be determined by soil tests.

For these soils the suggested cropping systems are (a) with contour cultivation only—1 year of a row crop, 1 year of a small grain, and 4 years or more of grass-legume meadow; or (b) with terraces—1 year of a row crop, 1 year of a small grain, and 2 years of grass-legume meadow. Capability class IV, subclass IVe.

MANAGEMENT GROUP 15

Rolling to very steep (mostly slopes of 11 to 23 percent) moderately or severely eroded soils

Adair clay loam, 11 to 18 percent slopes, moderately eroded.
Clarinda silty clay loam, 11 to 18 percent slopes, moderately eroded.
Ida silt loam, 18 to 23 percent slopes, severely eroded.
Marshall silt loam, 18 to 28 percent slopes, moderately eroded.
Marshall soils, 18 to 23 percent slopes, severely eroded.
Monona silt loam, 18 to 23 percent slopes, moderately eroded.
Monona silt loam, 18 to 23 percent slopes, severely eroded.
Shelby loam, 18 to 23 percent slopes, moderately eroded.
Shelby soils, 14 to 18 percent slopes, severely eroded.
Steinauer soils, 14 to 18 percent slopes, severely eroded.

These soils are rolling to very steep. Because of slopes or severe erosion, they are poorly suited to cultivated crops. They are best suited to permanent pasture.

Use and management.—Pastures should consist of a mixture of well-suited grasses and legumes. Poor pastures should be fertilized and reseeded with the better forage plants. The renovation of some pastures may be difficult because of steep slopes. All pastures need phosphate fertilizer, and those containing no legumes need nitrogen. Need for fertilizer and lime should be determined by soil tests. Other pasture management consists of mowing weeds and controlling grazing.

The Adair and Clarinda soils produce only fair pasture, even under the best of management. The Ida, Marshall, Monona, Shelby, and Steinauer soils have good moisture-holding capacities and subsoils that are favorable for pasture grasses. They will produce good pasture if properly managed. Capability class VI, subclass VIe.

MANAGEMENT GROUP 16

Rolling to very steep (mostly slopes of 18 to 40 percent) moderately or severely eroded soils

Adair clay loam, 18 to 28 percent slopes, moderately eroded.
Adair soils, 11 to 18 percent slopes, severely eroded.
Clarinda soils, 11 to 18 percent slopes, severely eroded.
Ida silt loam, 23 to 28 percent slopes, severely eroded.
Ida silt loam, 28 to 40 percent slopes, severely eroded.

Marshall soils, 23 to 32 percent slopes, severely eroded.
Monona silt loam, 23 to 32 percent slopes, severely eroded.
Shelby loam, 23 to 32 percent slopes, moderately eroded.
Shelby soils, 18 to 23 percent slopes, severely eroded.
Steinauer loam, 18 to 28 percent slopes, moderately eroded.

Most of these soils are steeper than those in management group 15. Consequently, machinery is harder to operate and pasture renovation and fertilization are more difficult. The soils in this group are normally best suited to permanent pasture. An alternative use is for forest products. The suitable species of trees are quite limited on the Ida soils. Detailed recommendations for tree plantings can be obtained from the Soil Conservation Service, the County Extension Service, or the State Conservation Commission. Capability class VII, subclass VIIe.

Estimated Yields

The estimated average yields that can be expected from the principal crops are shown in table 7. These yields are based on suggested cropping systems, which are also shown in the table, along with the principal management problems for each soil, and the capability class and subclass to which each soil belongs.

The estimated yields assume that wet soils have been drained; flooding has been controlled; lime and fertilizer have been applied in adequate amounts according to soil tests made by Iowa State University; suitable crop varieties have been used; weeds and insects have been controlled; and tillage and other cultural practices are timely and above average in quality.

The average yields given are a fairly reliable estimate of what can be expected at the present time. Year-to-year fluctuations, however, are normal. A few farmers using the best techniques and management known today can be expected to exceed these estimated yields by as much as 10 to 15 percent. New or improved crop varieties, better fertilizer practices, improved farming methods, or other information may make it necessary to revise the average yields.

Genesis, Classification, and Morphology of Soils

This section has three parts. The first describes how the main factors of soil formation have acted to form the soils of the county. In the second part, the soil series are classified according to great soil groups, and the characteristics of each group are described. In the third part, the series are described in detail, and laboratory analyses of the Shelby, Adair, and Clarinda series are given.

Formation of Soils

The factors that have contributed to the differences in soils of Shelby County are parent material, vegetation, climate, time, and relief and natural drainage. These factors are interrelated, and the effects of any one factor is not always readily distinguished from those of the others.

Parent material

The soils of Shelby County were derived from three kinds of parent material—glacial till, loess, and alluvium.

Glacial till is the parent material of the Adair, Clarinda, Shelby, and Steinauer soils. Shelby County has been completely covered by two glaciers—the Nebraskan and then the Kansan (*8*). On melting, these sheets of ice left thick deposits of ground rock called glacial till. The Nebraskan till was covered by the Kansan till, which was deposited at a later period. The area of till-derived soil is small.

Soils began to develop after the Kansan till was deposited. On the level areas, a soil formed that had a dark-gray, plastic clay subsoil that was several feet thick. This subsoil material is called gumbotil (*7*). It can be seen in some deep road cuts as a layer buried beneath the loess that was deposited at a later period. It is also exposed on some slopes as an outcrop.

The time when this soil might have been formed encompasses the Yarmouth interglacial age, the Illinoian glacial age, and the Sangamon interglacial age (*13*). The buried soil has the morphology of a Wiesenboden (Humic Gley) soil, which generally develops under grass. Where the buried soil outcrops on the surface, it was mapped as the Clarinda series. Figure 2 shows the gumbotil as it usually occurs—buried by the loess.

As streams dissected the plain of Kansan till and slopes formed, another soil developed on slopes and plains during a later period of soil formation. This soil, also buried under loess in many places, has some of the morphological characteristics of the present-day Gray-Brown Podzolic soils. The subsoil is reddish-brown clay or silty clay. Similar soils have been identified as late Sangamon in age (*13*). Where they have been exposed on side slopes by geologic erosion, they are mapped as Adair soils.

Erosion has cut through the gumbotil and the reddish soil of late Sangamon age and left a less-weathered Kansan till exposed on the side slopes. This more recently exposed till is the material in which the Steinauer and Shelby soils have developed.

Many thousands of years after the Kansan till was deposited, another material called loess fell over Shelby County in the Early Wisconsin glacial age (*13*). Loess, as deposited, consists mainly of silt-size rock fragments that have been carried and deposited by the wind. This material was picked up by the northwesterly wind from the flood plains of the Missouri River and deposited over much of southwestern Iowa. The layer of loess is thicker in the counties near the river—about 60 feet in Monona County—and gradually thins toward the east and south. On the upland flats of Wayne County, in south-central Iowa, the loess is only about 8 feet thick. Hutton (*6*) studied the relationships between soils and the thickness of the loess along a 170-mile traverse from Monona County to Wayne County in southwestern Iowa.

Hutton (*6*) found that the loess was 40 feet thick on a broad divide in the NW¼NE¼NE¼ sec. 27, T. 81 N., R. 40 W., in the northwest part of Shelby County. In the southeast part of the county (NE¼NE¼ sec. 21, T. 79 N., R. 37 W.) the loess was 28 feet thick. The source of the loess was 33 miles from the first location

TABLE 7.—*Management and*

[Yields are those expected under good management;

Soil	Capability class and subclass	Management group	Amendments usually needed	Principal management problems [1]
Adair clay loam, 5 to 11 percent slopes, moderately eroded.	IVe	14	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Adair, clay loam, 11 to 18 percent slopes, moderately eroded.	VIe	15	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Adair clay loam, 18 to 28 percent slopes, moderately eroded.	VIIe	16	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Adair soils, 5 to 11 percent slopes, severely eroded.	IVe	14	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Adair soils, 11 to 18 percent slopes, severely eroded.	VIIe	16	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Clarinda silty clay loam, 5 to 11 percent slopes, moderately eroded.	IVe	14	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Clarinda silty clay loam, 11 to 18 percent slopes, moderately eroded.	VIe	15	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Clarinda soils, 5 to 11 percent slopes, severely eroded.	IVe	14	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Clarinda soils, 11 to 18 percent slopes, severely eroded.	VIIe	16	Lime, nitrogen, phosphate	Low fertility, seepage, and erosion
Colo silty clay loam	IIw	3	Phosphate	Overflow and drainage
Colo silty clay loam, overwashed	IIw	3	Phosphate	Overflow and drainage
Colo silty clay loam, silty clay substratum.	IIw	3	Phosphate	Drainage and overflow
Corley silt loam	IIw	3	Lime, phosphate	Ponding and drainage
Corley silt loam, bench position	IIw	3	Lime, phosphate	Ponding and drainage
Dow silt loam, 8 to 14 percent slopes, severely eroded.	IIIe	7	Nitrogen, phosphate	Erosion and low in available phosphorus.
Dow silt loam, 14 to 18 percent slopes, severely eroded.	IVe	12	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 5 to 8 percent slopes, severely eroded.	IIIe	7	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 8 to 11 percent slopes, severely eroded.	IIIe	7	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 11 to 14 percent slopes, severely eroded.	IIIe	7	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 14 to 18 percent slopes, severely eroded.	IVe	12	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 18 to 23 percent slopes, severely eroded.	VIe	15	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 23 to 28 percent slopes, severely eroded.	VIIe	16	Nitrogen, phosphate	Erosion and low in available phosphorus.
Ida silt loam, 28 to 40 percent slopes, severely eroded.	VIIe	16	Nitrogen, phosphate	Erosion and low in available phosphorus.
Judson silt loam, 0 to 2 percent slopes	I	1	Lime, phosphate	Slight drainage
Judson silt loam, 2 to 5 percent slopes	IIe	2	Lime, phosphate	Gully erosion

See footnotes at end of table.

yield data for soils

absence of yield indicates crop is not suited to the soil]

Suggested cropping systems or alternative uses [2]			Estimated average acre yields		
Supported with contour cultivation [3]	Supported with terraces [3]	Without supporting practices [4]	Corn	Oats	Hay
			Bu.	*Bu.*	*Tons*
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	35	30	1. 4
Permanent pasture	Permanent pasture	Permanent pasture			
Permanent pasture	Permanent pasture	Permanent pasture			
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	20	20	1. 0
Permanent pasture	Permanent pasture	Permanent pasture			
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	25	20	. 8
Permanent pasture	Permanent pasture	Permanent pasture			
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	20	18	. 8
Permanent pasture	Permanent pasture	Permanent pasture			
([5])	([5])	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	73	45	3. 0
([5])	([5])	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	65	45	3. 0
([5])	([5])	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	65	40	2. 8
([5])	([5])	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	55	40	2. 8
([5])	([5])	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	55	40	2. 8
Corn, a small grain, and 3 years meadow.	Corn, a small grain, and 1 year meadow, or corn 2 years, a small grain, and 2 years meadow.	Corn, a small grain, and 4 years meadow.	45	30	1. 6
Permanent pasture	Corn, a small grain, and 4 years meadow.	Permanent pasture	38	25	1. 8
Corn, a small grain, and 3 years meadow.	Corn 2 years, a small grain, and 2 years meadow, or corn, a small grain, and 1 year meadow.	Corn, a small grain, and 3 years meadow.	55	35	2. 4
Corn, a small grain, and 3 years meadow.	Corn 2 years, a small grain, and 2 years meadow, or corn, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	53	30	2. 2
Corn, a small grain, and 3 years meadow.	Corn 2 years, a small grain, and 2 years meadow, or corn, a small grain, and 1 year meadow.	Permanent pasture	51	28	2. 2
Permanent pasture	Corn, a small grain, and 4 years meadow.	Permanent pasture	38	25	1. 8
Permanent pasture	Permanent pasture	Permanent pasture			
Permanent pasture	Permanent pasture	Permanent pasture			
Permanent pasture	Permanent pasture	Permanent pasture			
Corn 3 years and a small grain seeded with a green-manure crop.	Corn 3 years and a small grain seeded with a green-manure crop.	Corn 3 years and a small grain seeded with a green-manure crop.	72	45	3. 2
Corn 2 years, a small grain, and 1 year meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 2 years meadow.	70	42	3. 2

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TABLE 7.—*Management and*

[Yields are those expected under good management;

Soil	Capability class and subclass	Management group	Amendments usually needed	Principal management problems [1]
Judson silt loam, 5 to 8 percent slopes	IIIe	8	Lime, phosphate	Gully erosion
Judson-Nodaway-Colo complex, 2 to 5 percent slopes.	IIe	2	Phosphate	Gully erosion
Judson-Nodaway-Colo complex, 5 to 8 percent slopes.	IIIe	8	Phosphate	Gully erosion
Judson-Nodaway-Zook complex, 2 to 5 percent slopes.	IIw	3	Lime, phosphate	Gully erosion and drainage
Judson-Nodaway-Zook complex, 5 to 8 percent slopes.	IIIe	8	Lime, phosphate	Gully erosion and drainage
Kennebec silt loam	I	1	Lime, phosphate	Overflow and drainage
Kennebec silt loam, channeled	I	1	Lime, phosphate	Overflow and drainage
Marshall silt loam, 0 to 2 percent slopes	I	1	Lime, nitrogen, phosphate	None
Marshall silt loam, 2 to 5 percent slopes	IIe	2	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, 5 to 8 percent slopes, moderately eroded.	IIIe	4	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, 8 to 11 percent slopes, moderately eroded.	IIIe	5	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, 11 to 14 percent slopes, moderately eroded.	IIIe	6	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, 14 to 18 percent slopes, moderately eroded.	IVe	11	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, 18 to 28 percent slopes, moderately eroded.	VIe	15	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, bench position, 0 to 2 percent slopes.	I	1	Lime, nitrogen, phosphate	None
Marshall silt loam, bench position, 2 to 5 percent slopes.	IIe	2	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, bench position, 5 to 8 percent slopes, moderately eroded.	IIIe	4	Lime, nitrogen, phosphate	Erosion
Marshall silt loam, bench position, 8 to 11 percent slopes, moderately eroded.	IIIe	5	Lime, nitrogen, phosphate	Erosion
Marshall soils, 5 to 8 percent slopes, severely eroded.	IIIe	4	Lime, nitrogen, phosphate	Erosion
Marshall soils, 8 to 11 percent slopes, severely eroded.	IIIe	5	Lime, nitrogen, phosphate	Erosion
Marshall soils, 11 to 14 percent slopes, severely eroded.	IIIe	6	Lime, nitrogen, phosphate	Erosion
Marshall soils, 14 to 18 percent slopes, severely eroded.	IVe	11	Lime, nitrogen, phosphate	Erosion
Marshall soils, 18 to 23 percent slopes, severely eroded.	VIe	15	Lime, nitrogen, phosphate	Erosion
Marshall soils, 23 to 32 percent slopes, severely eroded.	VIIe	16	Lime, nitrogen, phosphate	Erosion
Marshall soils, bench position, 8 to 11 percent slopes, severely eroded.	IIIe	5	Lime, nitrogen, phosphate	Erosion
Marshall soils, bench position, 11 to 14 percent slopes, severely eroded.	IIIe	6	Lime, nitrogen, phosphate	Erosion

See footnotes at end of table.

yield data for soils—Continued

absence of yield indicates crop is not suited to the soil]

Suggested cropping systems or alternative uses [2]			Estimated average acre yields		
Supported with contour cultivation [3]	Supported with terraces [3]	Without supporting practices [4]	Corn	Oats	Hay
			Bu.	*Bu.*	*Tons*
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 3 years meadow.	68	40	3. 2
Corn 2 years, a small grain, and 1 year meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 2 years meadow.	60	40	3. 0
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 3 years meadow.	60	38	2. 8
Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	Corn 3 years, a small grain, and 1 year meadow; or corn 3 years and small grain seeded with a green-manure crop.	60	40	3. 0
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 3 years meadow.	60	38	3. 0
([5])	([5])	Corn 2 years and a small grain seeded with a green-manure crop.	72	45	3. 2
([5])	([5])	Corn 2 years and a small grain seeded with a green-manure crop.	65	40	3. 0
Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years and a small grain seeded with a green-manure crop.	78	45	3. 2
Corn 2 years, a small grain, and 1 year meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 2 years meadow.	76	45	3. 2
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year of meadow.	Corn 2 years, a small grain, and 3 years meadow.	68	42	3. 0
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	64	40	2. 8
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	59	37	2. 6
Permanent pasture	Corn, a small grain, and 2 years meadow.	Permanent pasture	52	35	2. 4
Permanent pasture	Permanent pasture	Permanent pasture			
Corn 3 years and a small grain seeded with a green-manure crop.	Corn 3 years and a small grain seeded with a green-manure crop.	Corn 3 years and a small grain seeded with a green-manure crop.	78	45	3. 2
Corn 2 years, a small grain, and 1 year meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 2 years meadow.	76	45	3. 2
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year of meadow.	Corn 2 years, a small grain, and 3 years meadow.	68	42	3. 0
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	64	40	2. 8
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year of meadow.	Corn, a small grain, and 2 years meadow.	64	39	2. 8
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	60	36	2. 6
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	55	33	2. 4
Permanent pasture	Corn, a small grain, and 2 years meadow.	Permanent pasture	50	30	2. 2
Permanent pasture	Permanent pasture	Permanent pasture			
Permanent pasture	Permanent pasture	Permanent pasture			
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	60	36	2. 6
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	55	33	2. 4

TABLE 7.—*Mangagement and*

[Yields are those expected under good management;

Soil	Capability class and subclass	Management group	Amendments usually needed	Principal management problems [1]
Minden silt loam	I	1	Lime, phosphate	Slight drainage
Minden silt loam, bench position	I	1	Lime, phosphate	Slight drainage
Monona silt loam, 2 to 5 percent slopes, moderately eroded.	IIe	2	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 5 to 8 percent slopes, moderately eroded.	IIIe	4	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 5 to 8 percent slopes, severely eroded.	IIIe	4	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 8 to 11 percent slopes, moderately eroded.	IIIe	5	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 8 to 11 percent slopes, severely eroded.	IIIe	5	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 11 to 14 percent slopes, moderately eroded.	IIIe	6	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 11 to 14 percent slopes, severely eroded.	IIIe	6	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 14 to 18 percent slopes, moderately eroded.	IVe	11	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 14 to 18 percent slopes, severely eroded.	IVe	11	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 18 to 23 percent slopes, moderately eroded.	VIe	15	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 18 to 23 percent slopes, severely eroded.	VIe	15	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, 23 to 32 percent slopes, severely eroded.	VIIe	16	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, bench position, 2 to 5 percent slopes.	IIe	2	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, bench position, 5 to 8 percent slopes, moderately eroded.	IIIe	4	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, bench position, 8 to 11 percent slopes, moderately eroded.	IIIe	5	Nitrogen, phosphate	Erosion and low in available phosphorus.
Monona silt loam, bench position, 11 to 14 percent slopes, severely eroded.	IIIe	6	Nitrogen, phosphate	Erosion and low in available phosphorus.
Nodaway silt loam	I	1	Phosphate	Overflow
Nodaway silt loam, shallow to silty clay.	IIw	3	Phosphate	Overflow and drainage
Shelby loam, 8 to 11 percent slopes, moderately eroded.	IIIe	9	Lime, nitrogen, phosphate	Erosion
Shelby loam, 11 to 14 percent slopes, moderately eroded.	IIIe	9	Lime, nitrogen, phosphate	Erosion
Shelby loam, 14 to 18 percent slopes, moderately eroded.	IVe	13	Lime, nitrogen, phosphate	Erosion
Shelby loam, 18 to 23 percent slopes, moderately eroded.	VIe	15	Lime, nitrogen, phosphate	Erosion
Shelby loam, 23 to 32 percent slopes, moderately eroded.	VIIe	16	Lime, nitrogen, phosphate	Erosion
Shelby soils, 8 to 11 percent slopes, severely eroded.	IVe	13	Lime, nitrogen, phosphate	Erosion
Shelby soils, 11 to 14 percent slopes, severely eroded.	IVe	13	Lime, nitrogen, phosphate	Erosion
Shelby soils, 14 to 18 percent slopes, severely eroded.	VIe	15	Lime, nitrogen, phosphate	Erosion
Shelby soils, 18 to 23 percent slopes, severely eroded.	VIIe	16	Lime, nitrogen, phosphate	Erosion
Steinauer loam, 8 to 11 percent slopes, moderately eroded.	IIIe	9	Nitrogen, phosphate	Erosion and low in available phosphorus.

See footnotes at end of table.

yield data for soils—Continued

absence of yield indicates crop is not suited to the soil]

Suggested cropping systems or alternative uses [2]			Estimated average acre yields		
Supported with contour cultivation [3]	Supported with terraces [3]	Without supporting practices [4]	Corn	Oats	Hay
			Bu.	*Bu.*	*Tons*
[5]	[5]	Corn 3 years and a small grain seeded with a green-manure crop, or, corn 2 years, a small grain, and 1 year meadow.	78	45	3.2
[5]	[5]	Corn 3 years and a small grain seeded with a green-manure crop, or corn 2 years, a small grain, and 1 year meadow.	78	45	3.2
Corn 2 years, a small grain, and 1 year meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 2 years meadow.	73	42	3.0
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 2 years meadow.	65	40	2.8
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 3 years meadow.	62	39	2.6
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	62	38	2.6
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	56	35	2.4
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	56	36	2.4
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	50	32	2.2
Permanent pasture	Corn, a small grain, and 2 years meadow.	Permanent pasture	48	35	2.2
Permanent pasture	Corn, a small grain, and 2 years meadow.	Permanent pasture	45	30	2.0
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Corn 2 years, a small grain, and 1 year meadow.	Corn 2 years and a small grain seeded with a green-manure crop.	Corn 2 years, a small grain, and 2 years meadow.	73	42	3.0
Corn 2 years, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 2 years meadow.	65	40	2.8
Corn, a small grain, and 2 years meadow.	Corn 2 years, a small grain, and 1 year meadow.	Corn, a small grain, and 4 years meadow.	62	38	2.6
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	50	32	2.2
[5]	[5]	Corn 3 years and a small grain seeded with a green-manure crop.	68	45	3.2
[5]	[5]	Corn 3 years, a small grain, and 1 year meadow.	60	42	3.0
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	45	34	2.5
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	40	30	2.2
Permanent pasture	Corn, a small grain, and 3 years meadow.	Permanent pasture	30	28	2.0
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	40	32	2.2
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	35	28	2.0
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Permanent pasture	Permanent pasture	Permanent pasture	----	----	----
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	40	30	2.5

TABLE 7.—*Management and*

[Yields are those expected under good management;

Soil	Capability class and subclass	Management group	Amendments usually needed	Principal management problems [1]
Steinauer loam, 11 to 14 percent slopes, moderately eroded.	IIIe	9	Nitrogen, phosphate	Erosion and low in available phosphorus.
Steinauer loam, 14 to 18 percent slopes, moderately eroded.	IVe	13	Nitrogen, phosphate	Erosion and low in available phosphorus.
Steinauer loam, 18 to 28 percent slopes, moderately eroded.	VIIe	16	Nitrogen, phosphate	Erosion and low in available phosphorus.
Steinauer soils, 8 to 11 percent slopes, severely eroded.	IVe	13	Nitrogen, phosphate	Erosion and low in available phosphorus.
Steinauer soils, 11 to 14 percent slopes, severely eroded.	IVe	13	Nitrogen, phosphate	Erosion and low in available phosphorus.
Steinauer soils, 14 to 18 percent slopes, severely eroded.	VIe	15	Nitrogen, phosphate	Erosion and low in available phosphorus.
Zook silty clay	IIIw	10	Lime, phosphate	Overflow and drainage
Zook silty clay, overwashed	IIIw	10	Lime, phosphate	Overflow and drainage
Zook silty clay loam	IIw	3	Lime, phosphate	Overflow and drainage
Zook silty clay loam, overwashed	IIw	3	Lime, phosphate	Overflow and drainage

[1] Fertility maintenance or improvement is a management problem on all soils, and it is not listed except when fertility is unusually low.

[2] Meadow for more than 1 year consists of an alfalfa and bromegrass mixture; meadow for 1 year is alfalfa and bromegrass or a mixture of red clover and timothy. For permanent pasture, a grass-and-legume mixture is suggested. The pasture should be reseeded, when necessary, and where possible in a nurse crop of oats. Legumes in the pasture or meadow mixture should supply most of the nitrogen needed for growth. Lime and phosphate should be added in amounts determined by soil tests. Permanent pasture usually does not require terraces.

[3] Contouring and terracing allow the maximum use of corn in the rotation. Soybeans or grain sorghums may be substituted for

and 55 miles from the second location. The loess is thinner on the flanks of the divides than on ridgetops (*11*). It also covers the outwash terraces along the West Nishnabotna River as well as much of the upland (*3*). The relationship between the loess and till materials is shown in figure 4.

The loess was calcareous when it was deposited, but in most soils, the lime has been leached from the upper part of the profile. Most of the soils in Shelby County have developed from loess. They belong to the Corley, Dow, Ida, Monona, Marshall, and Minden series.

The Wisconsin loess contains deoxidized (gray) zones, some of which are leached and some unleached (*12*). These zones are believed to have been caused by restricted drainage in a period when rainfall was higher than at present. Dow soils formed where the gray-colored loess is exposed at the surface.

Alluvium occurs on flood plains and in narrow, upland drainageways. It may be silty or clayey, depending on its source or on the way water sorted and deposited it.

The Judson soils have formed in precultural alluvial material that was moved only short distances; for example, from the upper part of a slope to the lower. The Kennebec soils have formed in precultural silty alluvium on the flood plains. The Nodaway soils have formed in postcultural silty alluvium. The Colo and Zook soils have formed on the flood plains from finer textured alluvium.

Native vegetation

Most of the native vegetation in Shelby County was prairie grass, mainly big bluestem. Prairie grasses have dense, fibrous root systems that are concentrated in the upper 12 to 15 inches of soil.

Soils that have developed under grasses generally are darker and contain more organic matter and nitrogen than those that have developed under trees.

The forested areas in Shelby County were mainly along large streams. A few tree-covered areas are on upland slopes that border streams. Loess-derived soils that show the influence of forest vegetation have been included with the Marshall soils. The areas are mainly along the east side of the West Nishnabotna and the East Branch West Nishnabotna Rivers in Center Township. The morphological characteristics of these tree-covered soils indicate that trees have not influenced soil development to any appreciable degree. The Adair soils have developed under trees in the late Sangamon age, but the more recent vegetation has been prairie.

Climate

Shelby County has a moderate, humid to subhumid, continental type of climate. This factor influences soil formation in many ways. Rainfall affects the amount of leaching in soils, and it influences the kind of vegetation on soils. Temperature affects the growth of plants, the activity of micro-organisms, and the speed of chemi-

yield data for soils—Continued

absence of yield indicates crop is not suited to the soil]

Suggested cropping systems or alternative uses [2]			Estimated average acre yields		
Supported with contour cultivation [3]	Supported with terraces [3]	Without supporting practices [4]	Corn	Oats	Hay
			Bu.	*Bu.*	*Tons*
Corn, a small grain, and 4 years meadow.	Corn 2 years, a small grain, and 2 years meadow.	Permanent pasture	35	26	2. 2
Permanent pasture	Corn, a small grain, and 3 years meadow.	Permanent pasture	30	24	2. 0
Permanent pasture	Permanent pasture	Permanent pasture			
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	35	28	2. 2
Corn, a small grain, and 4 years meadow.	Corn, a small grain, and 2 years meadow.	Permanent pasture	30	26	2. 0
Permanent pasture	Permanent pasture	Permanent pasture			
([5])	([5])	Corn, soybeans, and wheat,[6] or wheat.[6]	50	[7] 22	[8] 20
([5])	([5])	Corn, soybeans, and wheat,[6] or wheat.[6]	60	[7] 25	[8] 25
([5])	([5])	Corn 2 years, a small grain, and 1 year meadow.	55	36	2. 5
([5])	([5])	Corn 2 years, a small grain, and 1 year meadow.	60	40	2. 5

corn in the rotations. Other cropping systems with more meadow may be substituted for those given in this table. Any cropping system selected should be suited to the farming system, protect the soil from erosion, and improve or maintain soil fertility. All gullied soils require grassed waterways.

[4] Without supporting practices means without contouring or terracing. Cropping systems suggested for wet soils are the same whether the soils are drained or not. Soybeans or grain sorghums may be substituted for corn in the rotations.

[5] Contouring or terracing generally is not suitable on these soils.

[6] Wheat in this cropping system can contain a legume for green manure.

[7] Soybeans.

[8] Bushels of wheat.

cal actions in the soils. It also affects the length of the plant growing season. Climate is the cause of many of the differences between soils of Shelby County and those in other parts of the world. However, the major differences among soils within the county are attributed to factors other than climate.

Time

The development of soil profiles requires time, usually long periods. Differences in the length of time that geologic materials have been in place are, therefore, commonly reflected in the distinctness of horizons in profiles. The soils in Shelby County range from very young to very old.

The alluvial Nodaway soils on flood plains are examples of very young soils. Climate and vegetation have not modified the parent material to any great extent; consequently, the Nodaway soils have the characteristics of their parent material.

The Clarinda series is an example of very old soils. They have developed on nearly level areas from glacial till. The subsoil is very high in clay and bears little resemblance to the material from which it has formed.

The Marshall soils are intermediate in age between the very young Nodaway and the very old Clarinda soils.

Relief

Many differences in soils can be attributed to variations in relief. On steep slopes, the rainfall runs off faster than on level areas. Consequently, less water soaks into the soil, and there is less leaching. Soil erosion also increases as slopes become steeper. In nearly level or depressed areas, the soils are wet and frequently have gray or mottled subsoils in places because of poor aeration. The Marshall and Minden soils were developed from similar parent material; but the Marshall soils, on slopes, have a yellowish-brown subsoil, whereas the Minden soils, in nearly level areas, have a subsoil that is mottled with olive and gray.

Special studies of Shelby County soils

Hutton (*6*) studied the relationships between soil properties and loess thickness along a northwest to southeast traverse in southwestern Iowa. This traverse passed through Shelby County. From mechanical analyses and base exchange data, Hutton concluded that the processes of soil development are only moderately expressed in the Monona and Marshall soils. The Marshall was considered to be a *medial* Prairie (Brunizem) soil by Smith, Allaway, and Riecken (*15*), and the Monona to be a *minimal* Prairie (Brunizem) soil.

Ulrich (*17*, *18*) studied the nearly level soils in southwestern Iowa along a traverse similar to that of Hutton (*6*). He showed the Minden soil (*17*) had a fairly uniform distribution of clay with the maximum (30.2 percent less than 0.002 mm.) at the 32-inch depth. Southeastward along the traverse, the clay content of the subsoil increases and the maximum occurs at shallower depths.

The solubility of phosphorus in the Minden soil was studied by Godfrey and Riecken (*5*) along the same traverse of soils as that of Ulrich. The more strongly developed profiles to the southeast tended to be lower in soluble phosphorus than the Minden soils.

Corliss and Ruhe (*3*) studied the relationships between the Corley, Minden, and Marshall soils. The Corley profile has considerably more clay in the B_2 horizon (37 percent less than 0.002 mm.) than the Marshall (33 percent less than 0.002 mm.) or Minden (30 percent less than 0.002 mm.). The aeration porosity of the Corley soil is greatly reduced in this zone of clay accumulation.

Classification of Soils

Soils are classified into categories that progressively become more inclusive. The lowest categories commonly used in the field—series, type, and phase—are discussed in the section Soil Survey Methods. Great soil groups (*19*) are the highest category, above the series, used to classify the soils in Shelby County.

The great soil groups consist of soil series that show the same general sort of profile. From such a broad grouping, the soils in this county can be compared with those in other States or in other parts of the world. This grouping, while useful for comparisons, is not suitable in planning the use and management of soils. The soil series of Shelby County soils are classified in the following great soil groups.

Great soil group:

Great soil group	*Series*
Brunizem (Prairie soils)	Adair Judson Kennebec Marshall Minden Monona Shelby
Wiesenboden (Humic Gley soils)	Colo Clarinda Zook
Planosol	Corley
Alluvial	Nodaway
Regosol	Dow Ida Steinauer

The internal characteristics of soils in each great soil group are described on the following pages.

Brunizems

The soils of Shelby County classified as Brunizems (Prairie soils) (*14*) are of the Adair, Marshall, Minden, Monona, and Shelby series. They have black to very dark grayish-brown, fairly thick A_1 horizons when not eroded. Boundaries between the horizons are gradual rather than abrupt. These soils do not have A_2 horizons, but all of them have B horizons that can be distinguished from the A and C horizons by texture, color, structure, or by a combination of two or more of these characteristics. The Judson and Kennebec soils are intergrades to the Alluvial soils and have very weakly developed B horizons.

Wiesenbodens

The soils in the county classified as Wiesenbodens (Humic Gley soils) have thick, black to very dark gray surface horizons high in organic matter, and they have gleyed subsoils. In some profiles of Wiesenboden soils, organic matter masks the gleying to depths of 2 to 3 feet. The soils in this group have developed under prairie grasses and sedges in flat areas or depressions.

The Colo and Zook soils have formed in alluvium and might be considered as intergrades to Alluvial soils. The Clarinda soils in this group were formed in a previous geologic age, and more recent geologic erosion has left them exposed on slopes. On some of the stronger slopes, the thick surface horizon has eroded away and the gleyed layer is now exposed. With this exception, they still retain the internal characteristics of Wiesenbodens.

Planosols

Only the Corley soils in Shelby County are classified as Planosols. Planosols have formed under grass vegetation, usually on depressional topography. They have eluviated surface and subsurface horizons underlain by B horizons more strongly illuviated or compacted than the B horizons of the associated Brunizems. In addition, they have an abrupt boundary between the A and B horizons.

Alluvial soils

The Alluvial soils have developed from water-transported and redeposited sediment. The profile characteristics of these soils are determined mainly by the kinds of sediment deposited, and little, if at all, by soil genesis. In Shelby County, only the Nodaway soils are in this great soil group.

Regosols

In Shelby County the Regosol great soil group includes the Dow, Ida, and Steinauer series. They have only weak horizonation, which consists mainly of a fairly thin A_1 horizon resting on the parent material. They lack stronger horizonation primarily because they occur on steep slopes and because geologic erosion has been active.

Morphology of the Series and Laboratory Analyses

This section contains a representative, detailed profile description for each soil series in the county and laboratory analyses of the Adair, Clarinda, and Shelby soils. Standard methods of analyses were used: Mechanical analyses (*9*); organic carbon by wet combustion; cation-exchange capacity by direct distillation of absorbed ammonia; pH by glass electrode; extractable calcium and magnesium (*10*); moisture tension (*20*); total nitrogen by modified A.O.A.C. procedure (*2*); sodium and potassium by Beckman DU flame spectrophotometer; and soluble calcium and magnesium by titration with EDTA.

ADAIR SERIES

The soils of the Adair series are Brunizems that have developed in fine-textured B horizons of exhumed Sangamon paleosols originally formed from Kansan glacial till under forest vegetation. The dark-colored Brunizemic A_1 horizon of the Adair soils is the result of the current cycle of soil development. The principal characteristic properties of the subsoil, however, are inherited from the paleosol B horizon. They are (1) gritty silty clay or clay texture, (2) very firm consistence, and (3) colors redder than 10YR[2] in the interior of peds coated with distinct clay skins.

Soils of the Adair series occur on the dissected, loess-mantled plain of Kansan till on slopes below the loess-derived Brunizems. They are generally above the till-derived Shelby soils, where these soils are present. The texture of the surface soil is dominantly clay loam, but it ranges from silt loam to clay loam. The soils of this series differ from the Shelby soils in that the subsoil is redder, has a firmer consistence, and contains more clay. In many places where the present ground surface bevels the outcropping paleosol, these soils grade downslope to soils of the Shelby series. The soils of the Adair series differ from Clarinda soils in that their B horizon is less gray and their solum contains more sand and gravel.

Adair clay loam, as mapped, has a surface soil that ranges from light clay loam to heavy loam and gritty heavy silt loam. The maximum clay content in the B horizon ranges from about 40 to 60 percent. The color of the B horizon ranges from reddish brown or dark reddish brown to dark grayish brown or dark brown. There are a few, fine, yellowish-red mottles. In some places the B_2 horizon has mottles that range in color from 10YR 5/2 to 2.5YR 5/2 (moist). Fragments of rock containing feldspar or ferromagnesian minerals, or both, are usually in the B_2 horizon and increase in abundance with depth. A thin concentration of gravel (lag gravel) occurs in many places in the upper part of the B horizon or on the surface of the soil.

Profile of Adair silt loam on a slope of about 12 percent. The modern A_1 layer of the following profile has been removed by erosion. The profile described is a nearly complete, exhumed late Sangamon paleosol that developed in pedisediment over Kansan till. Sample number S55Iowa–83–2–(1–10); location is 30 yards south and 130 yards east of the northwest corner of NW¼NW¼ sec. 30, T. 78 N., R. 38 W.:

A_p 0 to 6 inches, dark-brown (10YR 4/3, moist), friable silt loam; weak, fine, granular structure; loess from higher land mixed in till-like material (pedisediment).

A_{12} 6 to 12 inches, dark-brown (10YR 4/3, moist), friable silty clay loam; moderate, medium, subangular blocky structure; pinholes abundant; boundary abrupt.

A_3B_1 12 to 19 inches, dark-brown (10YR 4/3, moist), friable, medium silty clay loam; common, coarse, prominent, very dark grayish-brown (10YR 3/2, moist) mottles; moderate, medium, subangular blocky structure; pinholes; boundary diffuse.

B_1 19 to 25 inches, dark reddish-brown (5YR 3/4, moist), firm, heavy, gritty silty clay loam; moderate, medium, subangular blocky structure; pinholes; boundary gradual.

B_{21} 25 to 31 inches, dark reddish-brown (5YR 3/4, moist), very firm, gritty clay; few, fine, faint, yellowish-brown (10YR 5/4, moist) mottles; strong, fine, subangular blocky structure; boundary gradual.

B_{22} 31 to 37 inches, same as above horizon except clay loam; boundary diffuse.

B_3 37 to 42 inches, yellowish-brown (10YR 5/6, moist), firm, heavy clay loam; common, fine, distinct, dark reddish-brown (5YR 3/4, moist) mottles; weak, medium, subangular blocky structure; few concretions of iron-manganese; boundary clear.

C_{11} 42 to 46 inches, yellowish-brown (10YR 5/6, moist), firm, heavy clay loam; few, medium, distinct, dark reddish-brown (5YR 3/4, moist) mottles; massive; boundary diffuse.

C_{12} 46 to 55 inches, yellowish-brown (10YR 5/6, moist), firm, medium clay loam; few, fine, faint, reddish-brown (5YR 4/3, moist) and very dark grayish-brown (2.5Y 3/2, moist) mottles; massive; boundary diffuse.

C_2 55 inches +, yellowish-brown (10YR 5/6, moist), firm, medium clay loam; common, fine, distinct, very dark grayish-brown (2.5Y 3/2, moist) mottles; massive; calcareous.

[2] Refers to Munsell notations of hue, value, and chroma.

Laboratory data on this soil are shown in table 8.

Profile of Adair silty clay loam on a slope of about 12 percent; sample number S53Iowa–83–2–(1–6):

A_p 0 to 7 inches, very dark brown (10YR 2/2, moist) silty clay loam; few, very fine, faint, yellowish-red mottles; some thin, gray coatings on peds; weak, medium, granular structure; boundary abrupt.

AB 7 to 16 inches, dark-brown (10YR 3.5/3, moist), slightly gritty, medium to heavy silty clay loam; moderate, very fine, subangular blocky structure; some dark material from A horizon in worm channels; boundary clear.

B_{21} 16 to 22 inches, variegated, very dark grayish-brown (10YR 3/2, moist) or dark-brown (10YR 3/3, moist) to brown (10YR 4/3, moist), gritty silty clay; when crushed, color is dark brown (10YR 3.5/3, moist); some dark coatings on peds and a few, fine, yellowish-red mottles; moderate, very fine, subangular blocky structure with moderate vertical cleavage; boundary clear.

B_{22} 22 to 29 inches, brown (10YR 4.5/3, moist), gritty silty clay; many, very fine, faint, yellowish-red mottles and some dark oxide concretions; moderate, very fine, subangular blocky structure with strong vertical cleavage; clear boundary.

B_3 29 to 36 inches, brown (10YR 5/3), gritty silty clay; many yellowish-red (5YR 4/6) mottles and some dark mottles; weak, very fine, subangular blocky structure with weak vertical cleavage; boundary clear.

C 36 to 45 inches, a mixed matrix of dark grayish-brown (10YR 4/2, moist) and dark-brown (10YR 4/3, moist) to brown (10YR 5/3, moist), gritty, heavy silty clay loam (when crushed, color is 10YR 4/3, moist); numerous, distinct mottles of yellowish red (5YR 4/6, moist); many dark concretions; weak, very fine, subangular blocky structure approaching massive; compact and prismatic when dry.

Laboratory data on this soil are shown in table 9.

CLARINDA SERIES

The Clarinda soils are paleosols of the Yarmouth-Sangamon age that have been exposed on slopes through geologic erosion. They are classified as Wiesenbodens.

These soils generally occur as outcrops on side slopes or at the heads of drainageways in all parts of the county in association with the Shelby soils. The Clarinda soils differ from the Shelby soils in having a much finer textured and grayer B horizon. The solum of the Clarinda soils has developed principally in a fine-textured B horizon of a Yarmouth-Sangamon paleosol now exposed by erosion of the overlying loess mantle.

Profile of Clarinda soils, severely eroded, on a slope of about 12 percent; sample number S55Iowa–83–1–(1–8); location is 200 feet north and 180 feet east of the southwest corner of SE¼SE¼ sec. 16, T. 78 N., R. 38 W.:

A_p 0 to 4 inches, dark-gray (10YR 4/1, moist), friable to slightly firm silty clay; weak, fine, subangular blocky structure.

B_{21} 4 to 7 inches, grayish-brown (2.5Y 5/2, moist), plastic silty clay; dark grayish-brown (10YR 4/2, moist) root channels are common; massive to very weak, subangular blocky structure; very few quartz pebbles; boundary clear.

B_{22} 7 to 11 inches, grayish-brown (2.5Y 5/2, moist), very firm silty clay; few, fine, faint, olive-yellow (2.5Y 6/6, moist) mottles and occasional root channels of very

TABLE 8.—*Laboratory analyses of Adair silt loam on a slope of about 12 percent* [1]

Soil and horizon	Depth	Particle-size distribution: Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	International classification: II (0.2 to 0.02 mm.)	International classification: III (0.02 to 0.002 mm.)	Particles (greater than 2 mm.)	Textural class
Adair silt loam: S55Iowa-83-2-(1-10)	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A_p	0 to 6	0.6	1.4	1.8	4.0	3.6	61.9	26.7	41.0	26.9	-------	Silt loam.
A_{12}	6 to 12	.7	1.8	2.3	4.8	4.2	57.0	29.2	35.7	28.4	(2)	Silty clay loam.
A_3B_1	12 to 19	1.0	3.6	2.8	6.7	4.9	50.2	30.8	34.3	25.0	(2)	Silty clay loam.
B_1	19 to 25	1.7	2.5	2.9	6.8	5.6	44.7	35.8	31.8	22.5	(2)	Silty clay loam.
B_{21}	25 to 31	2.5	2.6	2.9	6.5	5.5	39.0	41.0	28.6	19.8	(2)	Clay.
B_{22}	31 to 37	1.4	2.8	3.3	7.6	6.2	41.1	37.6	31.2	20.7	1.2	Clay loam.
B_3	37 to 42	4.6	3.7	3.9	9.6	7.2	33.2	37.8	28.7	16.8	4.6	Clay loam.
C_{11}	42 to 46	2.3	3.6	4.1	10.5	8.2	33.8	37.5	29.9	17.7	3.4	Clay loam.
C_{12}	46 to 55	2.1	4.3	4.7	11.8	9.1	33.6	34.4	32.1	16.8	1.6	Clay loam.
C_2	55 to 62	2.0	4.2	4.7	11.5	9.0	36.0	32.6	31.7	19.2	4.2	Clay loam.

Soil and horizon	Depth	pH: 1:1 Soil-water suspension	pH: 1:5 Soil-water suspension	pH: 1:10 Soil-water suspension	Organic matter: Organic carbon	Organic matter: Nitrogen	Organic matter: Carbon-nitrogen ratio	Electrical conductivity Ec x 10³ millimhos per cm. at 25° C.	Calcium carbonate equivalent	Moisture tensions: 1/10 Atmosphere	Moisture tensions: 1/3 Atmosphere	Moisture tensions: 15 Atmospheres
Adair silt loam: S55Iowa-83-2-(1-10)	*Inches*				*Percent*	*Percent*			*Percent*	*Percent*	*Percent*	*Percent*
A_p	0 to 6	7.2	7.4	7.6	1.12	.106	10.6	0.6	-------	36.2	25.0	11.2
A_{12}	6 to 12	7.1	7.3	7.4	.44	.056	7.8	.5	-------	34.1	25.2	10.5
A_3B_1	12 to 19	7.1	7.4	7.4	.31	.047	6.6	.5	-------	32.9	25.0	11.0
B_1	19 to 25	7.1	7.3	7.4	.23	.036	6.4	.5	-------	35.5	28.3	12.8
B_{21}	25 to 31	7.2	7.5	7.5	.22	------	-------	.4	-------	36.4	28.2	14.5
B_{22}	31 to 37	7.3	7.5	7.5	.17	------	-------	.4	-------	33.9	26.9	13.4
B_3	37 to 42	7.4	7.6	7.6	.12	------	-------	.4	-------	33.0	26.8	13.7
C_{11}	42 to 46	7.5	7.7	7.8	.12	------	-------	.5	-------	33.4	25.5	13.4
C_{12}	46 to 55	7.4	7.7	7.8	.09	------	-------	.4	-------	32.8	25.2	12.8
C_2	55 to 62	7.9	8.4	8.6	.05	------	-------	.5	4.0	32.2	24.4	12.0

Soil and horizon	Depth	Cation exchange capacity (ammonium acetate) (meq. per 100 grams soil)	Extractable cations (milliequivalents per 100 grams of soil): Calcium	Magnesium	Hydrogen	Sodium	Potassium	Base saturation (ammonium acetate exchange)	Saturation extract soluble (milliequivalents per liter): Sodium	Potassium	Calcium	Magnesium	Moisture at saturation
Adair silt loam: S55Iowa-83-2-(1-10)	*Inches*							*Percent*					*Percent*
A_p	0 to 6	21.7	16.4	5.5	2.1	-------	0.4	100	0.4	0.1	4.2	1.6	48.9
A_{12}	6 to 12	20.7	15.6	5.3	2.5	0.1	.3	100	.6	.1	3.3	1.4	47.0
A_3B_1	12 to 19	20.9	16.2	5.5	2.5	.1	.4	100	.6	-------	2.7	1.3	50.2
B_1	19 to 25	23.4	18.2	5.7	2.5	.1	.4	100	.7	.1	3.2	1.6	50.1
B_{21}	25 to 31	27.2	21.3	7.1	2.9	.2	.5	100	.6	-------	2.0	.7	57.7
B_{22}	31 to 37	25.2	19.5	6.4	2.1	.1	.5	100	.7	-------	2.2	1.1	54.8
B_3	37 to 42	25.5	19.9	6.6	1.7	.2	.5	100	.7	-------	2.2	1.2	55.2
C_{11}	42 to 46	23.9	18.9	6.2	1.3	.1	.5	100	.8	.1	2.5	1.2	58.2
C_{12}	46 to 55	21.3	16.8	5.7	1.2	.1	.4	100	.6	-------	2.0	1.1	58.9
C_2	55 to 62	18.3	23.5	4.8	.4	.1	.4	100	.7	.1	2.9	1.2	55.7

[1] Laboratory numbers: 5360-5369.

[2] Trace.

TABLE 9.—*Laboratory analyses of Adair silty clay loam on a slope of about 12 percent* [1]

Soil and horizon	Depth	Particle-size distribution									Textural class
		Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	International classification II (0.2 to 0.02 mm.)	International classification III (0.02 to 0.002 mm.)	
Adair silty clay loam: S53Iowa–83–2–(1–6)	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A_p	0 to 7	0. 1	0. 3	0. 5	1. 2	2. 3	64. 0	31. 6	41. 6	25. 3	Silty clay loam.
AB	7 to 16	. 2	. 5	. 6	1. 8	2. 5	57. 3	37. 1	37. 3	23. 7	Silty clay loam.
B_{21}	16 to 22	. 1	. 5	. 7	2. 0	3. 0	52. 1	41. 6	33. 3	22. 9	Silty clay.
B_{22}	22 to 29	--------	. 6	. 9	2. 6	3. 7	49. 3	42. 9	32. 0	22. 5	Silty clay.
B_3	29 to 36	. 1	. 9	1. 5	3. 9	4. 2	48. 1	41. 3	31. 0	23. 4	Silty clay.
C	36 to 45	. 2	1. 4	2. 0	5. 2	4. 8	47. 1	39. 3	30. 5	24. 2	Silty clay loam.

Soil and horizon	Depth	pH			Organic matter			Moisture tensions		
		1:1 Soil-water suspension	1:5 Soil-water suspension	1:10 Soil-water suspension	Organic carbon	Nitrogen	Carbon-nitrogen ratio	1/10 Atmosphere	1/3 Atmosphere	15 Atmospheres
Adair silty clay loam: S53Iowa–83–2–(1–6)	*Inches*				*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
A_p	0 to 7	6. 1	6. 4	6. 5	1. 92	. 174	11. 0	40. 8	28. 5	13. 7
AB	7 to 16	6. 0	6. 3	6. 4	1. 09	. 103	10. 6	37. 2	28. 9	15. 0
B_{21}	16 to 22	5. 9	6. 2	6. 4	. 88	. 084	10. 5	40. 4	31. 3	16. 7
B_{22}	22 to 29	5. 8	6. 2	6. 3	. 48	. 052	9. 2	40. 7	32. 4	17. 1
B_3	29 to 36	6. 0	6. 3	6. 5	. 34	----------	----------	40. 1	32. 1	16. 6
C	36 to 45	6. 4	6. 8	6. 9	. 23	----------	----------	40. 3	31. 9	16. 1

Soil and horizon	Depth	Cation exchange capacity (ammonium acetate) (meq. per 100 grams soil)	Extractable cations (milliequivalents per 100 grams of soil)					Base saturation (ammonium acetate exchange)
			Calcium	Magnesium	Hydrogen	Sodium	Potassium	
Adair silty clay loam: S53Iowa–83–2–(1–6)	*Inches*							*Percent*
A_p	0 to 7	24. 8	17. 1	6. 3	6. 3	0. 1	0. 5	97
AB	7 to 16	25. 1	16. 6	7. 6	6. 3	. 1	. 6	99
B_{21}	16 to 22	29. 6	17. 4	8. 8	6. 3	. 2	. 6	91
B_{22}	22 to 29	27. 2	17. 5	9. 0	5. 9	. 2	. 7	100
B_3	29 to 36	25. 3	16. 8	9. 2	4. 6	. 3	. 7	100
C	36 to 45	24. 4	16. 9	8. 4	3. 8	. 3	. 6	100

[1] Laboratory numbers: 5383–5388.

dark grayish brown (10YR 3/2, moist); massive, with tendency to very weak, subangular blocky structure; very few concretions of iron and manganese; very few quartz pebbles; boundary diffuse.

B_{23} 11 to 17 inches, grayish-brown (2.5Y 5/2, moist), very firm silty clay; few, fine, faint, olive-yellow (2.5Y 6/6, moist) mottles and occasional root channels of very dark grayish brown (10YR 3/2, moist); massive; few concretions of iron and manganese; few, fine, quartz pebbles; boundary diffuse.

B_{24} 17 to 23 inches, same as horizon above except texture is clay and very few root channels present.

B_{25} 23 to 31 inches, grayish-brown (2.5Y 5/2, moist), very firm clay; few, fine, faint, olive-yellow (2.5Y 6/6, moist) mottles and occasional very dark grayish-brown (10YR 3/2, moist) root channels; few concretions of iron and manganese; quartz pebbles few to common; boundary diffuse.

B_{26} 31 to 42 inches, grayish-brown (2.5Y 5/2, moist) to strong-brown (7.5YR 5/6, moist), very firm, heavy clay loam; very dark gray (5Y 3/1, moist) clay skins in seams; massive; occasional roots; boundary clear.

B_{31} 42 to 60 inches, strong-brown (7.5YR 5/6, moist), very firm, light clay loam; grayish-brown (2.5Y 5/2, moist) clay skins common in seams; massive; numerous, medium concretions of iron and manganese; numerous pockets of calcium carbonate.

Laboratory data on Clarinda soils, severely eroded, are shown in table 10.

TABLE 10.—*Laboratory analyses of Clarinda soils, severely eroded, on a slope of about 12 percent*[1]

Soil and horizon	Depth	Particle–size distribution: Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	International classification: II (0.2 to 0.02 mm.)	International classification: III (0.02 to 0.002 mm.)	Particles (greater than 2 mm.)	Textural class
Clarinda soils, severely eroded: S55Iowa–83–1–(1–8)	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A_p	0 to 4	0.2	0.5	0.7	1.9	2.4	52.9	41.4	32.7	23.6	--------	Silty clay.
B_{21}	4 to 7	.2	.6	.8	2.4	2.8	47.4	45.8	29.8	21.8	--------	Silty clay.
B_{22}	7 to 11	.5	1.0	1.3	3.6	3.3	43.2	47.1	27.2	21.3	--------	Silty clay.
B_{23}	11 to 17	.5	1.7	1.9	4.9	4.0	40.9	46.1	26.4	21.1	--------	Silty clay.
B_{24}	17 to 23	1.0	2.3	2.4	6.3	5.1	38.9	44.0	27.8	19.6	--------	Clay.
B_{25}	23 to 31	1.2	2.3	2.8	7.3	5.9	37.3	43.2	28.4	18.7	([2])	Clay.
B_{26}	31 to 42	1.8	3.4	4.2	9.0	7.4	35.8	38.4	30.9	17.7	([2])	Clay loam.
B_{31}	42 to 60	2.8	3.4	3.8	8.4	6.7	44.4	30.5	25.2	31.0	3.3	Clay loam.[3]

Soil and horizon	Depth	pH: 1:1 Soil-water suspension	pH: 1:5 Soil-water suspension	pH: 1:10 Soil-water suspension	Organic matter: Organic carbon	Organic matter: Nitrogen	Organic matter: Carbon-nitrogen ratio	Electrical conductivity Ec x 10^3 millimhos per cm. at 25° C.	Calcium carbonate equivalent	Moisture tensions: 1/10 Atmosphere	Moisture tensions: 1/3 Atmosphere	Moisture tensions: 15 Atmospheres
Clarinda soils, severely eroded: S55Iowa–83–1–(1–8)	*Inches*				*Percent*	*Percent*			*Percent*	*Percent*	*Percent*	*Percent*
A_p	0 to 4	5.8	6.3	6.3	1.86	0.171	10.9	0.6	--------	47.7	35.6	18.1
B_{21}	4 to 7	6.0	6.4	6.5	.70	.062	11.3	.3	--------	44.8	35.4	19.4
B_{22}	7 to 11	6.1	6.7	6.7	.32	.026	12.3	.3	--------	42.6	35.1	19.5
B_{23}	11 to 17	6.2	6.9	6.9	.21	.018	11.7	.3	--------	44.4	36.0	19.3
B_{24}	17 to 23	6.4	7.0	7.1	.16	.011	14.5	.4	--------	40.0	31.8	17.6
B_{25}	23 to 31	6.7	7.2	7.2	.10	.007	14.3	.4	--------	37.0	29.9	16.7
B_{26}	31 to 42	6.8	7.2	7.3	.06	------	--------	.4	--------	37.6	29.0	15.0
B_{31}	42 to 60	8.0	8.6	8.8	.03	------	--------	.6	26	30.4	23.3	10.3

Soil and horizon	Depth	Cation exchange capacity (ammonium acetate) (meq. per 100 grams soil)	Extractable cations (milliequivalents per 100 grams of soil): Calcium	Magnesium	Hydrogen	Sodium	Potassium	Base saturation (ammonium acetate exchange)	Saturation extract soluble (milliequivalents per liter): Sodium	Potassium	Calcium	Magnesium	Moisture at saturation
Clarinda soils, severely eroded: S55Iowa–83–1–(1–8)	*Inches*							*Percent*					*Percent*
A_p	0 to 4	31.5	20.4	10.0	6.8	0.1	1.1	100	0.5	0.3	3.7	2.6	66.5
B_{21}	4 to 7	35.3	22.2	11.0	5.1	.2	.7	97	.4	.1	1.8	1.4	69.7
B_{22}	7 to 11	35.8	23.9	12.4	6.4	.2	.7	100	.5	.1	1.6	1.4	72.7
B_{23}	11 to 17	35.8	22.9	11.4	4.3	.2	.7	98	.5	-------	1.5	.9	76.2
B_{24}	17 to 23	33.6	23.0	11.0	3.0	.2	.6	100	.7	.1	1.7	1.1	66.0
B_{25}	23 to 31	32.7	23.0	10.7	2.1	.2	.6	100	.6	-------	1.4	1.3	66.2
B_{26}	31 to 42	29.0	21.7	8.5	1.7	.2	.5	100	.6	-------	1.8	1.0	65.0
B_{31}	42 to 60	16.0	26.3	4.1	.8	.1	.3	100	.7	.1	3.6	1.4	47.7

[1] Laboratory numbers: 5352–5359.
[2] Trace.
[3] $CaCO_3$ present in sand fraction.

Profile of Clarinda silty clay loam on a slope of about 9 percent; S53Iowa–83–4–(1–7); location is the northwest corner of the NW¼NW¼ sec. 1, T. 78 N., R. 37 W.; profile is within the range of the series, as mapped in Shelby County, but it is considered to be less representative than the preceding description of Clarinda soils, severely eroded.

A_p 0 to 6 inches, very dark brown (10YR 2/2, moist) silty clay loam containing some gray streaks; granular structure; boundary abrupt.

B_1 6 to 11 inches, very dark grayish-brown (10YR 3/2, moist), gritty, light silty clay with some darker coatings on peds; very fine, subangular blocky structure with weak vertical cleavage.

B_2 11 to 16 inches, dark-gray to dark grayish-brown (10YR 4/1.5, moist), gritty silty clay; few dark-colored and yellowish-red, oxide concretions; dark coatings on some peds; when crushed, color is dark grayish brown (10YR 4/2, moist); very fine, subangular blocky structure with coarse vertical cleavage.

B_3 16 to 23 inches, dark grayish-brown (2.5Y 4/2, moist), gritty silty clay; numerous, fine, dark, oxide concretions and few, fine, yellowish-red concretions; glossy coatings on peds; very fine, subangular blocky structure with coarse, strong vertical cleavage.

C_f 23 to 33 inches, grayish-brown (2.5Y 5/2, moist), gritty, heavy silty clay loam; common, distinct, strong-brown (7.5YR 5/6, moist) and black (10YR 2/1, moist) mottles; some dark oxide concretions; weak, very fine, subangular blocky structure approaching massive.

C_2 33 to 40 inches, similar to layer above.

C_3 40 to 46 inches, mottled strong-brown (7.5YR 5/6, moist) and grayish-brown (2.5Y 5/2, moist) silty clay; very slightly calcareous.

Laboratory data for this soil are shown in table 11.

COLO SERIES

The Colo series consists of dark-colored, poorly to imperfectly drained soils that have developed from moderately fine textured alluvial material on flood plains and low terraces. The alluvium washed from glacial drift and loess.

The Colo soils are classified as Wiesenbodens, though they may be considered to intergrade to both the Alluvial and to the Brunizem great soil groups. The upper layers are dark enough for the Wiesenboden and Brunizem groups and have a granular to blocky structure without the stratification common to the Alluvial group. The middle and lower horizons likewise have genetic soil structure in contrast to the stratification in the Nodaway soils. Furthermore, the middle and lower horizons have colors that are common in gleyed soils.

The Colo soils occur on the larger flood plains in association with the Nodaway and Judson soils. They differ from the Zook soils in that they are better drained and have a lower clay content in the B horizon. The clay content of the B horizon ranges from 30 to 38 percent in the Colo soils and from 38 to 46 percent in the Zook soils.

Profile of Colo silty clay loam on a slope of about 1 percent; location is SW¼SW¼ sec. 24, T. 81 N., R. 39 W.:

A_p 0 to 7 inches, very dark gray (10YR 3/1, moist), friable, light silty clay loam; silt strata; very dark gray to very dark grayish-brown (10YR 3/1.5, moist) mottles; moderate to weak, fine to medium, subangular blocky structure to weak, thin platy structure; boundary abrupt.

A_3 7 to 24 inches, black (10YR 2/1, moist), friable silty clay loam; moderate, fine, subangular blocky structure; abundant roots; boundary diffuse.

B_2 24 to 34 inches, black to very dark gray (10YR 2.5/1, moist), friable silty clay loam; weak, very fine, subangular blocky structure tending to weak, granular structure; occasional roots; boundary diffuse.

B_{3g} 34 to 42 inches, very dark gray to dark-gray (10YR 3.5/1, moist), slightly firm, heavy silty clay loam; gray (10YR 6/1, moist) coatings on peds; very dark grayish brown to dark brown (10YR 3/2.5, moist) when crushed; strong, medium, subangular blocky structure; numerous pinholes and occasional roots; boundary gradual.

C_g 42 inches +, dark-gray to dark grayish-brown (10YR 4/1.5, moist), friable silty clay loam; few, fine, faint, strong-brown (7.5YR 5/6, moist) mottles; very dark grayish brown to dark brown (10YR 3/2.5, moist) when crushed; gray coatings on peds (10YR 6/1, moist); weak, fine, subangular blocky structure to massive; occasional plant roots.

CORLEY SERIES

The Corley soils are Planosols. They occur in slight depressions on flat-topped divides and on loess-covered benches in association with the Minden and the Marshall soils. They are similar to the Minden soils in many characteristics, and they have developed under similar climate, vegetation, and parent material. Corley soils, however, differ from the Minden soils in that the A_2 horizon is well developed and the subsoil is heavier. The development of the A_2 horizon and the greater amount of clay in the B_2 horizon of the Corley soils is attributed to their occurrence in slight depressions. Here surface water accumulated and caused more rapid leaching and clay translocation.

The Corley soils are not extensive in Shelby County, and individual areas are generally not more than half an acre.

Profile of Corley silty clay loam, without slope; location is in the SE¼SW¼ sec. 20, T. 78 N., R. 38 W.:

A_1 0 to 16 inches, black (10YR 2/1, moist), friable silt loam to light silty clay loam; weak, medium, granular structure.

A_{21} 16 to 23 inches, black to very dark gray (10YR 2.5/1, moist), friable, light silty clay loam; light-gray (10YR 7/2, dry) coatings on peds; moderate, medium to coarse, granular structure.

A_{22} 23 to 28 inches, very dark gray (10YR 3/1, moist) and some grayish-brown (10YR 5/2, moist), friable silt loam; weak, fine to coarse, granular structure; some very weak, thin, platy structure.

A_{23} 28 to 34 inches, very dark gray (10YR 3/1, moist), friable to slightly firm, light silt loam; very dark grayish-brown (10YR 3/2, moist) coatings on peds; gray colors along weakly expressed vertical cleavage; moderate, very fine, granular structure.

A_3B_1 34 to 38 inches, dark grayish-brown (10YR 4/2, moist), slightly firm to firm, light silty clay loam; common, fine, distinct, yellowish-brown (10YR 5/4, moist) mottles; common, grayish-brown (10YR 5/2, moist) coatings and pockets; weak, fine, subangular blocky to moderate, coarse, granular structure.

B_{21} 38 to 45 inches, grayish-brown (10YR 5/2, moist), slightly firm to firm, heavy silty clay loam; many, fine, distinct, dark-brown (7.5YR 4/4, moist) mottles and very dark gray (10YR 3/1, moist) coatings on vertical and horizontal faces of peds; moderate, medium, angular and subangular blocky structure.

B_{22} 45 to 52 inches, grayish-brown (10YR 5/2, moist), slightly firm to firm, heavy silty clay loam; few, medium, distinct, dark-brown (7.5YR 4/4, moist) mottles and very dark gray (10YR 3/1, moist) ped coatings, fewer than in above horizon; moderate, medium, subangular blocky structure.

B_{31} 52 to 66 inches, grayish-brown (10YR 5/2, moist), friable, medium silty clay loam; many, medium, distinct, dark-brown (7.5YR 4/4, moist) mottles; massive with weak vertical cleavage.

B_{32} 66 to 72 inches, light brownish-gray (10YR 6/2, moist),

TABLE 11.—*Laboratory analyses of Clarinda silty clay loam on a slope of about 9 percent* [1]

Soil and horizon	Depth	Particle-size distribution: Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	International classification: II (0.2 to 0.02 mm.)	International classification: III (0.02 to 0.002 mm.)	Particles (greater than 2 mm.)	Textural class
Clarinda silty clay loam: S53Iowa–83–4–(1–7)	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A_p	0 to 6	0.3	0.6	0.9	2.0	1.7	58.9	35.6	33.7	27.9	--------	Silty clay loam.
B_1	6 to 11	.3	.6	.9	1.8	1.6	51.6	43.2	28.6	25.7	--------	Silty clay.
B_2	11 to 16	.4	.6	.7	1.8	1.7	50.1	44.7	25.5	27.4	--------	Silty clay.
B_3	16 to 23	.4	.9	1.1	2.3	2.2	51.3	41.8	28.2	26.7	(2)	Silty clay.
C_1	23 to 33	.5	.9	1.3	2.7	2.2	53.4	39.0	28.8	28.4	(2)	Silty clay loam.
C_2	33 to 40	.4	1.8	2.6	4.6	3.1	48.8	38.7	31.2	23.3	(2)	Silty clay loam.
C_3	40 to 46	.4	1.4	2.1	3.9	3.3	43.8	45.1	29.7	19.7	(2)	Silty clay.[3]

Soil and horizon	Depth	pH: 1:1 Soil-water suspension	pH: 1:5 Soil-water suspension	pH: 1:10 Soil-water suspension	Organic matter: Organic carbon	Organic matter: Nitrogen	Organic matter: Carbon-nitrogen ratio	Moisture tensions: 1/10 Atmosphere	Moisture tensions: 1/3 Atmosphere	Moisture tensions: 15 Atmospheres
Clarinda silty clay loam: S53Iowa–83–4–(1–7)	*Inches*				*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
A_p	0 to 6	5.5	5.8	5.9	2.63	.230	11.4	37.4	30.0	15.0
B_1	6 to 11	5.6	5.8	6.0	1.06	.093	11.4	38.2	30.8	16.4
B_2	11 to 16	5.5	5.6	5.7	.81	.073	11.1	36.0	30.3	17.0
B_3	16 to 23	5.4	5.7	5.8	.43	.040	10.8	37.5	30.1	16.3
C_1	23 to 33	5.8	6.0	6.1	.25	.030	8.3	36.8	30.4	15.1
C_2	33 to 40	6.2	6.5	6.5	.18	----------	----------	36.8	31.9	16.0
C_3	40 to 46	6.4	6.8	6.9	.13	----------	----------	43.4	36.6	19.0

Soil and horizon	Depth	Cation exchange capacity (ammonium acetate) (meq. per 100 grams soil)	Extractable cations (milliequivalents per 100 grams of soil): Calcium	Magnesium	Hydrogen	Sodium	Potassium	Base saturation (ammonium acetate exchange)
Clarinda silty clay loam: S53Iowa–83–4–(1–7)	*Inches*							*Percent*
A_p	0 to 6	28.9	16.4	6.3	10.5	0.1	0.6	81
B_1	6 to 11	28.5	18.1	8.4	8.0	.2	.6	96
B_2	11 to 16	27.5	17.9	8.9	8.5	.2	.6	100
B_3	16 to 23	26.4	16.6	8.6	6.3	.3	.6	99
C_1	23 to 33	23.9	16.0	8.2	4.6	.3	.6	100
C_2	33 to 40	24.5	16.8	8.5	3.4	.4	.6	100
C_3	40 to 46	30.3	19.9	9.5	3.8	.4	.6	100

[1] Laboratory numbers 5389–5395. [2] Trace. [3] Shot (Mn) present in sand fraction.

friable, light silty clay loam; few, fine, distinct, dark-brown (7.5YR 4/4, moist) mottles; massive.

C_1 72 inches +, light brownish-gray (10YR 6/2, moist), friable silt loam; common grayish-brown (10YR 5/2, moist) pockets of silt; few, fine, distinct, dark-brown (7.5YR 4/4, moist) mottles; massive.

DOW SERIES

The Dow soils are Regosols that have developed from loess. The soils are well drained, although their subsurface colors indicate that aeration has been poor at one time. These gray surface colors were apparently acquired during an earlier, wetter geologic period (*12*).

The Dow soils occur as narrow bands on side slopes where the parent material has been exposed through erosion. They differ from the Ida soils in having less carbonates and an olive-gray instead of a yellowish-brown subsoil. In addition they are generally less erodible. Many small areas of Dow soils have been included with Ida silt loam.

Profile of Dow silt loam on a slope of about 15 percent; location is in the NW¼NW¼ sec. 18, T. 79 N., R. 40 W.:

A_1 0 to 7 inches, dark-gray (10YR 4/1, moist), very friable silt loam; few, fine, faint, iron-manganese mottles; weak, fine, granular structure; moderately calcareous; abundant roots; boundary diffuse.

A_3 7 to 16 inches, dark grayish-brown to grayish-brown (2.5Y 4.5/2, moist), very friable silt loam; common, medium, prominent, strong-brown (7.5YR 5/6, moist) mottles; weak, coarse, subangular blocky structure with tendency to massive; moderately calcareous; roots common; boundary gradual.

C_1 16 to 32 inches, olive-gray (5Y 5/2, moist), very friable silt loam; few, fine, faint, strong-brown (7.5YR 5/6, moist) and black (7.5YR 2/0, moist) mottles; few, fine, faint, iron-manganese concretions; massive; mildly calcareous; occasional roots; boundary gradual.

C_2 32 to 55 inches, olive-gray to light olive-gray (5Y 5.5/2 moist), very friable silt loam; few, coarse, distinct, strong-brown (7.5YR 5/6, moist) and black (7.5YR 2/0, moist) mottles; iron bands present; round, medium concretions; massive; occasional roots and channels mottled strong brown (7.5YR 5/6, moist).

C_3 55 inches +, grayish-brown (2.5Y 5/2, moist), friable silt loam; iron bands more pronounced than in C_2 horizon; massive; calcareous; occasional root channels.

IDA SERIES

The Ida soils are well-drained, calcareous Regosols that have developed from loess. They occupy moderate to very steep slopes. In the western part of the county, these soils occur predominantly on side slopes. In the eastern part they are predominantly on the lower parts of slopes and on isolated, narrow, sloping ridgetops.

Profile of Ida silt loam on a slope of about 15 percent; location is NE¼NE¼ sec. 34, T. 80 N., R. 40 W.:

A_1 0 to 4 inches, dark grayish-brown (10YR 4/2, moist), very friable, light silt loam; weak, fine, granular structure tending toward weak, very fine, blocky structure; abundant roots; slightly calcareous; boundary clear.

C_1 4 to 9 inches, dark yellowish-brown to yellowish-brown (10YR 4.5/4, moist), very friable silt loam; weak, granular structure to massive; occasional roots; strongly calcareous; boundary gradual.

C_{21} 9 to 20 inches, yellowish-brown (10YR 5/4.5, moist), very friable silt loam; few, medium, distinct, strong-brown (7.5YR 5/6, moist) mottles with few, medium, distinct, grayish-brown (2.5Y 5/2, moist) streaks; few, fine, faint, iron-manganese mottles; massive; slightly calcareous; occasional roots; boundary gradual.

C_{22} 20 inches +, yellowish-brown (10YR 5/4.5, moist), very friable, light silt loam; many, medium, distinct, strong-brown (7.5YR 5/6, moist) and grayish-brown (2.5Y 5/2, moist) mottles and streaks; abundant iron-manganese mottles; massive; slightly calcareous; occasional roots; few rounded concretions.

JUDSON SERIES

The Judson soils are well drained to moderately well drained Brunizems that intergrade to Alluvial soils. They occur at the base of upland slopes or on alluvial fans at the mouths of small drainageways.

Profile of Judson silt loam on a slope of about 3 percent; location is SE¼NE¼ sec. 6, T. 79 N., R. 38 W.:

A_{1p} 0 to 10 inches, very dark gray (10YR 3/1, moist), friable silt loam; weak, fine, subangular blocky structure; layer includes recent overwash.

A_{12} 10 to 18 inches, black (10YR 2/1, moist), friable silt loam; weak, very fine, subangular blocky structure.

A_{13} 18 to 24 inches, black (10YR 2/1, moist), friable silt loam; weak, very fine, subangular blocky structure.

B_{21} 24 to 35 inches, very dark gray (10YR 3/1, moist), friable, heavy silt loam; few, fine, faint, dark grayish-brown (10YR 4/2, moist) mottles; weak, fine, subangular blocky structure.

B_{22} 35 to 43 inches, very dark grayish-brown (10YR 3/2, moist), friable, heavy silt loam to light silty clay loam; weak, fine, subangular blocky structure.

C_1 43 to 47 inches, dark-gray (10YR 4/1, moist), friable silt loam; weak, fine, subangular blocky structure.

KENNEBEC SERIES

The Kennebec soils are moderately well drained, and they have developed in silty alluvium. They are classified as Brunizems, although they do not have distinct horizons. They intergrade to the Alluvial soils. The Kennebec soils have thick dark-colored, granular horizons common to other Brunizems. The middle and lower horizons have weak genetic structure, although stratification is usually absent. They occur on flood plains throughout the county.

Profile of Kennebec silt loam on a slope of about 1 percent; location is NW¼SW¼ sec. 29, T. 81 N., R. 37 W.:

A_{11} 0 to 4 inches, black (10YR 2/1, moist), friable silt loam; strong, coarse, granular structure; abundant roots; boundary gradual.

A_{12} 4 to 16 inches, black (10YR 2/1, moist), friable silt loam; moderate, medium, fine, subangular blocky structure; abundant roots; boundary gradual.

BC 16 to 40 inches, very dark brown (10YR 2/2, moist), friable silt loam; weak, medium to fine, subangular blocky structure; occasional roots; boundary gradual.

C 40 inches +, very dark gray (10YR 3/1, moist), friable silt loam; brown (10YR 5/3, moist), stratified, thin bands; massive.

MARSHALL SERIES

The Marshall soils are well-drained Brunizems that have developed from loess. They occur on upland divides in the western half of the county and on upland divides and gently rolling to steep side slopes in the eastern half of the county.

The texture of the A_1 horizon ranges from a light silty clay loam to heavy silt loam. A few tree-covered areas of Marshall soils show in the profile some influence of forest cover. These areas have somewhat better structure in the B horizon than elsewhere and faint grayish coatings on the peds when they are dry. Forest-influenced areas of Marshall soils are found mainly along the east side of the West Nishnabotna and the East Branch West Nishnabotna Rivers in Center Township.

The Marshall soils differ from the Monona soils mainly in amount of clay in the B horizon. The B horizon of the

Monona soils has light silty clay loam to medium silty clay loam texture, whereas that of the Monona soils has heavy silt loam to light silty clay loam texture. The Marshall soils also differ in having developed in somewhat thinner loess. The main areas of Marshall lie to the east of Shelby County and the main areas of Monona soils lie to the west.

Profile of Marshall silt loam on a slope of about 6 percent; location is SW¼SW¼ sec. 24, T. 79 N., R. 37 W.:

A_1 0 to 7 inches, very dark brown (10YR 2/1.5, moist), friable silt loam; weak, fine granular structure tending to moderate, very thin, platy structure; abundant plant roots; boundary gradual.

A_3B_1 7 to 11 inches, very dark gray to very dark grayish-brown (10YR 3/1.5, moist), friable, heavy silt loam; faint, gray (10YR 5/1, dry) coatings on peds; moderate, very fine, subangular blocky structure; abundant plant roots; boundary gradual.

B_2 11 to 18 inches, dark-brown to dark yellowish-brown (10YR 4/3.5, moist) and dark-brown (10YR 4/3, moist), friable silty clay loam; moderate, fine, subangular blocky structure; abundant roots; boundary gradual.

B_{22} 18 to 29 inches, dark-brown (10YR 4/3, moist), friable silty clay loam; weak, fine, subangular blocky structure to massive; occasional roots; boundary diffuse.

C_1 29 to 40 inches, dark-brown to brown (10YR 4.5/3, moist), friable silt loam; few, fine, distinct, grayish-brown (2.5Y 5/2, moist) mottles; massive; boundary diffuse.

C_2 40 inches +, dark-brown to dark yellowish-brown (10YR 4/3.5, moist), friable silt loam; few, medium, distinct, grayish-brown (2.5Y 5/2, moist) mottles; massive; occasional root channels.

MINDEN SERIES

The Minden soils are imperfectly drained Brunizems that have developed from loess. They occur on the broader, flat divides, and the slopes are rarely over 1 percent. The Minden series differs from the Marshall series, its catenary associate, in that the A horizon is thicker and darker colored. Also, the B horizon of the Minden soils is grayer in color and usually splotched with low-contrast mottles of olive gray and weak olive below depths of 20 to 30 inches.

Profile of Minden silt loam on a slope of about 1 percent; location is SE¼SW¼ sec. 18, T. 79 N., R. 39 W.:

A_{1p} 0 to 7 inches, black (10YR 2/1, moist), friable silt loam; moderate, fine to medium, granular structure; boundary diffuse.

A_{12} 7 to 12 inches, very dark gray (10YR 3/1, moist), friable silt loam; moderate, fine to medium, granular structure; boundary diffuse.

A_{13} 12 to 16 inches, very dark gray (10YR 3/1, moist), friable silt loam; weak, very fine, subangular blocky to granular structure; boundary gradual.

A_3B_1 16 to 22 inches, very dark gray to very dark grayish-brown (10YR 3/1.5, moist), friable silt loam; moderate, fine, subangular blocky structure tending to weak, granular structure; abundant roots; boundary gradual.

B_{21} 22 to 29 inches, olive-gray (5Y 4.5/2, moist), friable, light silty clay loam; moderate, medium, subangular blocky structure; abundant pinholes; occasional roots; boundary gradual.

B_{22} 29 to 34 inches, dark-gray (5Y 4/1, moist), friable silty clay loam; few, fine, faint, strong-brown (7.5YR 5/6, moist) mottles; moderate, fine to medium, subangular blocky structure; clay films on horizontal and vertical cleavage planes; numerous pinholes; boundary gradual.

B_{31} 34 to 46 inches, gray (5Y 5/1, moist), friable to slightly firm silty clay loam; many, medium, distinct strong-brown (7.5YR 5/6, moist) mottles; moderate, medium, subangular blocky structure; clay films on vertical planes, discontinuous on horizontal planes; boundary gradual.

B_{32} 46 to 51 inches, dark-gray to gray (5Y 4.5/1, moist), friable silty clay loam; common, medium, distinct, strong-brown (7.5Y 5/6, moist) mottles; moderate, coarse, subangular blocky structure; discontinuous clay films on horizontal planes; boundary gradual.

C_1 51 inches +, gray (5Y 5/1, moist), friable silt loam; common, medium, distinct, strong-brown (7.5YR 5/6, moist) mottles; massive.

Figure 9.—**The dark soil on the higher lying areas is Monona silt loam (6 percent slope). The light-colored soil on the steeper slope is severely eroded Ida silt loam (15 percent slope).**

MONONA SERIES

The Monona soils are classified as Brunizems. They occur extensively in the western half of the county on side slopes. In the extreme northwestern corner of the county, however, they are on upland divides and side slopes (fig. 9). The Monona soils are associated with the Ida and the Marshall soils.

The texture of the A_1 horizon ranges from heavy silt loam to light silty clay loam. Monona soils differ from the Ida soils in that they have a B horizon, even though weakly developed, and in that carbonates have been leached from the surface soil and subsoil. The B horizon of Monona soils is a heavy silt loam to light silty clay loam, and it is less strongly developed than that in the Marshall soils.

Profile of Monona silt loam on a slope of about 6 percent; location is NE¼NE¼ sec. 15, T. 81 N., R. 40 W.:

A_1 0 to 6 inches, very dark grayish-brown (10YR 3/2, moist), friable silt loam; weak, very fine to fine, granular structure; boundary gradual.

A_{12} 6 to 9 inches, very dark grayish-brown (10YR 3/2, moist), friable silt loam; weak, fine, granular structure to weak, fine, subangular blocky structure; sprinkling of grayish-brown (10YR 5/2, dry) coatings on peds; boundary gradual.

A_3B_1 9 to 13 inches, very dark grayish-brown to dark-brown (10YR 3/2.5, moist), friable silt loam; weak, very fine, subangular blocky structure; boundary gradual.

B_2 13 to 26 inches, dark-brown (10YR 4/3, moist), friable, light silty clay loam; moderate, fine, subangular blocky structure; abundant root channels and worm casts; boundary gradual.

B_3C_1 26 to 35 inches, dark yellowish-brown (10YR 4/4, moist) and dark-brown (10YR 4/3, moist), friable silt loam; moderate, fine, granular to weak, fine, subangular blocky structure; numerous root channels and worm casts; boundary gradual.

C_2 35 inches +, yellowish-brown (10YR 5/4, moist), friable silt loam; common, medium, distinct, dark-brown (7.5YR 3/2, moist) and grayish-brown (2.5Y 5/2, moist) mottles; massive; abundant roots and worm casts.

NODAWAY SERIES

The Nodaway series consists of light-colored, medium-textured Alluvial soils. The alluvium has washed mainly from glacial till and loess since cultivation began. The Nodaway soils occur extensively on the broad flood plains of streams. In the western part of the county the Nodaway soils occur in association with the Judson-Nodaway-Colo complex. In the eastern part they are associated with the Kennebec and the Zook soils and with Nodaway silt loam, shallow to silty clay. Distinct stratified bands of silt occur in the upper and middle parts of the profile. Buried, black soils may occur below 20 to 40 inches.

Profile of Nodaway silt loam on a slope of about 1 percent; location is SE¼NE¼ sec. 9, T. 79 N., R. 40 W.:

A_{11} 0 to 13 inches, very dark grayish-brown (10YR 3/2, moist), friable silt loam; weak, fine, granular structure; boundary gradual.

A_{12} 13 to 20 inches, very dark grayish-brown (10YR 3/2, moist), very friable silt loam; weak to moderate, fine granular structure; thin strata of dark grayish-brown (10YR 4/2, moist) silt; boundary gradual.

C_1 20 to 30 inches, very dark gray to very dark grayish-brown (10YR 3/1.5, moist), very friable silt loam; few, medium, distinct, reddish-brown (5YR 4/4, moist) mottles; massive; boundary gradual.

A_{1b} 30 to 43 inches, black to very dark brown (10YR 2/1.5, moist) and very dark grayish-brown to dark grayish-brown (10YR 3.5/2, moist), friable silt loam; massive to weak, very fine, granular structure; boundary clear (buried profile).

A_{3b} 43 inches +, black (10YR 2/1, moist), friable, heavy silt loam; weak, fine, subangular blocky structure.

SHELBY SERIES

The Shelby soils are well drained to moderately well drained Brunizems that occupy gently rolling to steep slopes. They occur on the points of slopes and on side slopes bordering drainageways. The parent material is calcareous clay loam till deposited during the Kansan glacial age, but it is considered to have been exposed to weathering only during and after the Late Wisconsin glacial substage. Seams of secondary lime occur locally; they are generally 3½ to 4 feet below the surface.

The Shelby soils are associated with Adair clay loam and in many places occur downslope from this soil. They differ from this soil in having a clay loam B horizon that is dominantly yellowish brown rather than reddish brown. The texture of the A horizon may be loam, clay loam, or silty clay loam. Loam is the dominant texture.

Profile of Shelby loam on a slope of about 12 percent; sample number S55Iowa–83–3–(1–7); location is 265 feet east and 125 feet north of the southwest corner of the NW¼ sec. 25, T. 79 N., R. 37 W.:

A_p 0 to 6 inches, black to very dark gray (10YR 2.5/1, moist), friable clay loam;[3] clods break into weak, fine, crumb structure; noncalcareous; boundary gradual.

A_3 6 to 11 inches, very dark grayish-brown (10YR 3/2, moist) and dark-brown (10YR 3/3, moist), friable, medium clay loam; moderate, fine and very fine, subangular blocky structure; noncalcareous; boundary clear.

B_{21} 11 to 16 inches, very dark grayish-brown (10YR 3/2, moist) and dark-brown (10YR 4/3, moist), slightly firm, gritty, medium clay loam; weak, fine, subangular blocky structure; noncalcareous; boundary gradual.

B_{22} 16 to 22 inches, dark-brown to dark yellowish-brown (10YR 4/3.5, moist), firm, medium clay loam; weak, medium and fine, subangular blocky structure; thin, discontinuous, colloidal coatings on peds; noncalcareous; boundary gradual

B_3 22 to 30 inches, dark-brown (10YR 4/3, moist), firm, medium clay loam; few, fine, faint, dark yellowish-brown (10YR 4/4, moist) and strong-brown (7.5YR 5/6, moist) mottles; weak, medium, subangular blocky structure; noncalcareous; boundary clear.

C_1 30 to 48 inches, dark yellowish-brown (10YR 4/4, moist), firm, light clay loam; common, fine, distinct, yellowish-brown (10YR 5/4, moist) and grayish-brown (10YR 5/2, moist) mottles; finely disseminated, white carbonate concretions; a few large, white, carbonate concretions 3 to 4 inches in diameter and at depths of 42 to 48 inches; weak, medium and coarse, subangular blocky structure; boundary diffuse.

C_2 48 to 54 inches, yellowish-brown (10YR 5/4, moist), firm, light to medium clay loam; strong-brown (7.5YR 5/6, moist) and gray (10YR 5/1, moist) mottles; massive; calcareous.

The content of coarse sand and gravel increases with depth.

Laboratory data of this soil are shown in table 12.

Profile of Shelby loam on a slope of about 15 percent; sample number S53Iowa–83–3–(1–6); location is the northeastern corner of NE¼ sec. 11, T. 79 N., R. 39 W., on a convex, north-facing slope; sample taken 42 feet downslope from an outcrop of the late Sangamon paleosol B horizon; surface of site sampled was 5 feet lower in elevation than the top of the paleosol B horizon.

This profile is within the range of the Shelby series as mapped in Shelby County, but it is considered to be less typical than the profile of Shelby loam previously described.

A_1 0 to 7 inches, very dark gray (10YR 3/1, moist), friable silty clay loam;[4] granular structure; some gray coatings on peds; boundary clear.

B_1 7 to 12 inches, brown (10YR 4.5/3, moist), firm, heavy clay loam; dark grayish brown to dark brown (10YR 4/2.5, moist) when crushed; very fine, subangular blocky structure; some streaks of very dark gray (10YR 3/1, moist) material; boundary clear.

B_2 12 to 22 inches, yellowish-brown (10YR 5/5, moist), firm, heavy clay loam; very fine, subangular blocky structure; boundary gradual.

B_3 22 to 30 inches, olive-brown to light olive-brown (2.5Y 4.5/4, moist), firm, heavy clay loam; some of the material is dark yellowish brown (10YR 4/4, moist); fine, subangular blocky structure; gradual boundary.

C_1 30 to 42 inches, light olive-brown (2.5Y 5/3, moist), firm, medium clay loam; some dark yellowish-brown (10YR 4/4) mottlings; weak, subangular blocky structure to massive with strong vertical cleavage; some dark oxide concretions and some carbonate concretions; slightly calcareous; boundary gradual.

C_2 42 to 46 inches, similar to above horizon but has numerous dark yellowish-brown mottles; massive with strong vertical cleavage.

Laboratory data of this soil are shown in table 13.

[3] Some areas with a clay loam surface soil were mapped as Shelby loam in this county.

[4] Some areas with a silty clay loam surface soil were mapped as Shelby loam in this county.

TABLE 12.—*Laboratory analyses of Shelby loam on a slope of about 12 percent* [1]

Soil and horizon	Depth	Particle-size distribution: Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	International classification: II (0.2 to 0.02 mm.)	International classification: III (0.02 to 0.002 mm.)	Particles (greater than 2 mm.)	Textural class
Shelby loam: S55Iowa-83-3-(1-7)	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A_{1p}	0 to 6	1. 4	3. 5	4. 5	12. 5	8. 4	39. 5	30. 2	38. 8	16. 0	0. 5	Clay loam.[2]
A_3	6 to 11	1. 9	3. 4	4. 1	11. 2	8. 0	37. 0	34. 4	35. 1	16. 1	. 9	Clay loam.
B_{21}	11 to 16	2. 1	3. 7	4. 2	11. 5	8. 1	36. 0	34. 4	34. 2	16. 1	2. 9	Clay loam.
B_{22}	16 to 22	2. 7	4. 0	4. 1	10. 8	8. 1	35. 8	34. 5	32. 7	17. 2	1. 8	Clay loam.
B_3	22 to 30	2. 6	4. 2	4. 3	10. 0	8. 2	37. 9	32. 8	32. 0	20. 3	1. 8	Clay loam.
C_1	30 to 48	4. 9	4. 3	4. 0	9. 4	8. 3	41. 4	27. 7	31. 1	24. 4	2. 8	Clay loam.[3]
C_2	48 to 54	3. 4	4. 0	4. 3	10. 0	8. 8	42. 5	27. 0	33. 7	23. 9	1. 8	Clay loam.

Soil and horizon	Depth	pH: 1:1 Soil-water suspension	pH: 1:5 Soil-water suspension	pH: 1:10 Soil-water suspension	Organic matter: Organic carbon	Organic matter: Nitrogen	Organic matter: Carbon-nitrogen ratio	Electrical conductivity Ec x 10^3 millimhos per cm. at 25° C.	Calcium carbonate equivalent	Moisture tensions: 1/10 Atmosphere	Moisture tensions: 1/3 Atmosphere	Moisture tensions: 15 Atmospheres
Shelby loam: S55Iowa-83-3-(1-7)	*Inches*				*Percent*	*Percent*			*Percent*	*Percent*	*Percent*	*Percent*
A_{1p}	0 to 6	5. 4	5. 6	5. 8	1. 82	. 161	11. 3	0. 5	---	33. 1	22. 9	11. 7
A_3	6 to 11	5. 7	5. 9	6. 0	1. 46	. 125	11. 7	. 5	---	31. 0	24. 6	12. 7
B_{21}	11 to 16	5. 8	6. 0	6. 1	1. 14	. 099	11. 5	. 4	---	29. 4	23. 7	12. 3
B_{22}	16 to 22	6. 1	6. 2	6. 4	. 89	. 081	11. 0	. 4	---	28. 9	23. 4	12. 1
B_3	22 to 30	6. 7	6. 8	6. 9	. 56	. 054	10. 4	. 5	---	29. 7	23. 2	11. 9
C_1	30 to 48	8. 0	8. 5	8. 6	. 24	---	---	. 6	14	28. 8	22. 2	10. 4
C_2	48 to 54	8. 0	8. 4	8. 6	. 07	---	---	. 7	11	30. 0	24. 1	11. 2

Soil and horizon	Depth	Cation exchange capacity (ammonium acetate) (meq. per 100 grams soil)	Extractable cations (milliequivalents per 100 grams of soil): Calcium	Magnesium	Hydrogen	Sodium	Potassium	Base saturation (ammonium acetate exchange)	Saturation extract soluble (milliequivalents per liter): Sodium	Potassium	Calcium	Magnesium	Moisture at saturation
Shelby loam: S55Iowa-83-3-(1-7)	*Inches*							*Percent*					*Percent*
A_{1p}	0 to 6	22. 0	14. 3	3. 3	8. 7	---	0. 4	82	0. 5	0. 2	3. 3	1. 3	45. 1
A_3	6 to 11	22. 8	16. 0	3. 4	6. 7	---	. 4	87	. 4	. 2	3. 2	1. 2	46. 8
B_{21}	11 to 16	22. 2	15. 7	3. 0	5. 8	---	. 4	86	. 4	. 2	3. 1	1. 0	47. 3
B_{22}	16 to 22	21. 0	15. 8	2. 6	5. 0	---	. 4	90	. 4	. 1	2. 7	. 8	50. 4
B_3	22 to 30	19. 4	16. 6	2. 2	2. 9	0. 1	. 4	99	. 5	. 1	3. 6	. 6	54. 8
C_1	30 to 48	14. 6	29. 2	1. 6	1. 2	. 1	. 3	100	. 5	. 1	4. 6	. 8	48. 3
C_2	48 to 54	13. 4	26. 4	2. 0	. 8	. 1	. 3	100	. 7	. 1	4. 7	1. 2	48. 5

[1] Laboratory numbers: 5370–5376.
[2] Some areas with a clay loam surface soil were mapped as Shelby loam in this county.
[3] Some calcium carbonate is in sand fraction.

TABLE 13.—*Laboratory analyses of Shelby loam on a slope of about 15 percent* [1]

Soil and horizon	Depth	Particle-size distribution: Very coarse sand (2 to 1 mm.)	Coarse sand (1 to 0.5 mm.)	Medium sand (0.5 to 0.25 mm.)	Fine sand (0.25 to 0.10 mm.)	Very fine sand (0.10 to 0.05 mm.)	Silt (0.05 to 0.002 mm.)	Clay (less than 0.002 mm.)	International classification II (0.2 to 0.02 mm.)	International classification III (0.02 to 0.002 mm.)	Particles (greater than 2 mm.)	Textural class
Shelby loam: S53Iowa-83-3-(1-6)	*Inches*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	
A_1	0 to 7	1. 2	1. 7	2. 2	5. 6	5. 2	52. 4	31. 7	38. 1	23. 1	(2)	Silty clay loam.[3]
B_1	7 to 12	2. 9	2. 7	2. 7	6. 6	6. 3	39. 5	39. 3	30. 2	19. 9	0. 7	Clay loam.
B_2	12 to 22	1. 4	2. 7	3. 2	7. 7	7. 0	38. 6	39. 4	29. 6	20. 8	(2)	Clay loam.
B_3	22 to 30	2. 1	3. 1	3. 4	8. 4	7. 5	40. 2	35. 3	30. 3	22. 6	(2)	Clay loam.
C_1	30 to 42	2. 8	2. 8	3. 3	8. 1	7. 6	41. 7	33. 7	31. 5	23. 0	(2)	Clay loam.
C_2	42 to 46	2. 4	3. 0	3. 1	8. 7	7. 7	41. 7	33. 4	31. 9	22. 4	(2)	Clay loam.

Soil and horizon	Depth	pH: 1:1 Soil-water suspension	pH: 1:5 Soil-water suspension	pH: 1:10 Soil-water suspension	Organic matter: Organic carbon	Organic matter: Nitrogen	Organic matter: Carbon-nitrogen ratio	Moisture tensions: 1/10 Atmosphere	Moisture tensions: 1/3 Atmosphere	Moisture tensions: 15 Atmospheres
Shelby loam: S53Iowa-83-3-(1-6)	*Inches*				*Percent*	*Percent*		*Percent*	*Percent*	*Percent*
A_1	0 to 7	5. 9	6. 2	6. 3	2. 91	0. 236	12. 3	37. 1	27. 5	15. 1
B_1	7 to 12	6. 0	6. 3	6. 4	. 73	. 076	9. 6	31. 0	25. 1	14. 3
B_2	12 to 22	5. 8	6. 1	6. 3	. 37	. 034	10. 9	30. 5	25. 3	13. 2
B_3	22 to 30	5. 5	5. 7	5. 9	. 26	. 028	9. 3	30. 6	24. 8	12. 7
C_1	30 to 42	5. 4	5. 7	5. 8	. 22	----------	----------	29. 4	24. 5	12. 7
C_2	42 to 46	5. 7	6. 1	6. 1	. 19	----------	----------	31. 3	25. 6	12. 8

Soil and horizon	Depth	Cation exchange capacity (ammonium acetate) (meq. per 100 grams soil)	Extractable cations (milliequivalents per 100 grams of soil): Calcium	Magnesium	Hydrogen	Sodium	Potassium	Base saturation (ammonium acetate exchange)
Shelby loam: S53Iowa-83-3-(1-6)	*Inches*							*Percent*
A_1	0 to 7	27. 0	19. 4	4. 4	7. 9	----------	0. 7	91
B_1	7 to 12	26. 0	19. 0	5. 0	5. 9	0. 1	. 7	95
B_2	12 to 22	25. 2	18. 5	4. 8	6. 7	. 1	. 6	95
B_3	22 to 30	23. 0	17. 1	3. 9	5. 4	. 1	. 5	94
C_1	30 to 42	21. 7	16. 7	3. 3	5. 1	. 1	. 5	95
C_2	42 to 46	21. 7	18. 2	2. 9	3. 3	. 1	. 5	100

[1] Laboratory numbers: 5377–5382.
[2] Trace.
[3] Some areas with a silty clay loam surface soil were mapped as Shelby loam in this county.

STEINAUER SERIES

The soils of the Steinauer series are classified as Regosols. They are gently rolling to hilly and occur on hillsides in the western part of the county, and as hillside outcrops in the eastern part of the county. The parent material was Kansan till of calcareous clay loam. The Steinauer soils differ from the Shelby soils in that they are calcareous at or near the surface, are without B horizons, and have no evidence of clay accumulation.

Profile of Steinauer loam on a slope of about 15 percent; location is NW¼NE¼ sec. 10, T. 78 N., R. 39 W.:

A_{1p} 0 to 7 inches, black to very dark gray (10YR 2.5/1, moist), friable, medium heavy loam; moderate, fine, granular structure; a few pieces of coarse gravel on surface; noncalcareous.

A_{12} 7 to 11 inches, black (10YR 2/1, moist), friable, heavy loam; moderate to strong, fine and very fine, subangular blocky structure; a few pebbles; weakly calcareous in places.

AC 11 to 14 inches, very dark gray (10YR 3/1, moist) and dark grayish-brown to dark-brown (10YR 4/2.5, moist), friable, light clay loam; moderate, fine, subangular blocky structure; coarse sand and pebbles; calcareous.

C_1 14 to 20 inches, dark-brown (10YR 4/3, moist) and very dark gray (10YR 3/1, moist), slightly firm, light clay loam; moderate, fine, subangular blocky structure; sand and pebbles; calcareous.

C_{21} 20 to 25 inches, dark yellowish-brown (10YR 4/4, moist), firm, light to medium clay loam; few, fine, faint, dark-brown (10YR 4/3, moist) mottles; a few iron-manganese concretions; many stones; thin band of lime concretions; calcareous.

C_{22} 25 to 52 inches, light olive-brown (2.5Y 5/4, moist), firm, medium clay loam; few, medium, faint, grayish-brown (2.5Y 5/2, moist) and yellowish-brown (10YR 5/4, moist) mottles; weak, fine, subangular blocky structure; sand and pebbles; calcareous.

Lime concretions are in the profile to a depth of 36 inches. Gray and brown mottles increase with depth. Soft lime concretions are common in the deeper parts of the soil.

ZOOK SERIES

The Zook soils are classified as Wiesenbodens. They are poorly drained and have developed in fine-textured alluvium on flood plains and low terraces. They are associated with the Colo, Judson, and Nodaway soils. The parent material is of mixed lithology, having been derived mainly from loess and glacial till. The subsoil contains from 38 to 46 percent clay, and it is heavier than that of the Colo soils. The Zook soils do not have strongly developed B horizons. They have the thick, dark, granular to blocky upper layers common to Wiesenbodens. The middle and lower horizons also have blocky structure. Colors of the middle and lower horizons are dominated by organic matter, although such horizons are believed to be gleyed.

Profile of Zook silty clay loam on a slope of about 1 percent; location is SE¼SW¼ sec. 30, T. 79 N., R. 38 W.:

A_{1p} 0 to 8 inches, black (10YR 2/1, moist), friable, medium silty clay loam; fine to medium, weak, subangular blocky structure.

A_{12} 8 to 18 inches, black (10YR 2/1, moist), slightly firm, medium silty clay loam; weak, fine and very fine to medium, subangular blocky structure.

B_1 18 to 28 inches, black (10YR 2/1, moist), firm silty clay; weak, very fine, subangular blocky structure.

B_2 28 to 40 inches, black to very dark gray (10YR 2.5/1, moist), very firm, medium silty clay; weak, fine, subangular blocky structure.

B_3C_1 40 to 52 inches, very dark gray (10YR 3/1, moist), very firm silty clay; few, fine, distinct, reddish-brown (5YR 4/3, moist) mottles; weak, fine, subangular blocky structure to massive; some evidence of gleying.

General Information

This section provides information that will be of interest to people who are not familiar with the county.

Vegetation

The native vegetation on most of the upland in Shelby County was tall prairie grasses—mostly big bluestem. Few, if any, areas of the original prairie remain.

Along the streams, boxelder, green ash, cottonwood, elm, and willow are the principal trees. Upland timber areas are on the steeper slopes in the northwestern part of Shelby County and on the steeper slopes adjacent to the principal streams. The main species are bur oak, red oak, shagbark hickory, walnut, elm, honeylocust, and basswood. The tree-covered land is used mainly for low-grade pasture and as a source of fuel or fenceposts. Little of it is properly managed.

Climate

Temperature and precipitation data compiled from United States Weather Bureau records are given in table 14. Shelby County has a humid to subhumid and continental climate, with characteristically hot summers and cold winters.

The range between summer and winter temperature is fairly wide. The average annual temperature for the summer months is 72.5 degrees, and for the winter months it is 22.8 degrees. The average frost-free season is 152 days. The average date of the last killing frost is May 4, and that of the first is October 4. The latest frost recorded in spring was May 31, and the earliest in autumn was September 13. Fieldwork usually begins before the last killing frost in spring and continues for some time after the first killing frost in fall. The grazing season averages about 180 days, and it is ordinarily longer than the frost-free period.

More than half the annual precipitation falls during the growing season. Average rainfall in Shelby County is not enough to produce corn yields as high as those from comparable soils in eastern Iowa, where average rainfall is higher. Precipitation in summer may come as gentle rains or in short, heavy showers with thunderstorms. The long, gentle rains often cover large areas. Thunderstorms are local and usually occur after temperatures have been abnormally high. At times, hail accompanies thunderstorms, and it damages crops in an area 1 to 2 miles wide and several miles long.

Spring rains occasionally delay planting but seldom long enough to prevent maturing of corn before the first killing frost. Fall rains and occasional snow may interfere with the harvest of corn, but the weather in October and November usually allows the crop to dry.

In some years long drought severely damages crops. The damage is most severe on south- and west-facing slopes and on ridges that are exposed to hot winds.

In summer the prevailing winds are from the southwest; in winter they are from the northwest. Occasional strong winds in winter blow from the north and northwest and cause moderate snowstorms or blizzards.

Water

Drilled or dug wells are the source of water on most farms in the county. Water for domestic use is obtained mainly from wells. Streams and wells provide most of the water for livestock. Many farms have electrically operated pump systems; some use windmills for pumping power. Few farms do not have water piped into houses and barns.

Drilled wells are usually located on the higher uplands. Most of the dug wells are at the heads of drainageways and along the flood plains of streams. Water for Harlan, the county seat, is obtained from a gravel bed along the West Nishnabotna River.

TABLE 14.—*Temperature and precipitation at Harlan, Shelby County, Iowa*

[Elevation, 1,200 feet]

Month	Temperature [1]			Precipitation [2]			
	Average	Absolute maximum	Absolute minimum	Average	Driest year (1894)	Wettest year (1896)	Average snowfall
	° F.	° F.	° F.	Inches	Inches	Inches	Inches
December	24. 6	68	−23	0. 84	1. 24	0. 45	4. 3
January	20. 3	68	−26	. 78	. 37	. 10	8. 2
February	23. 4	65	−26	. 91	. 31	. 23	5. 2
Winter	22. 8	68	−26	2. 53	1. 92	. 78	17. 7
March	37. 4	85	−21	1. 23	. 62	1. 01	6. 8
April	50. 0	90	4	2. 36	4. 48	8. 16	1. 7
May	60. 5	106	27	3. 59	1. 03	8. 06	. 1
Spring	49. 3	106	−21	7. 18	6. 13	17. 23	8. 6
June	69. 8	107	37	4. 48	2. 69	4. 81	(3)
July	75. 0	114	42	3. 56	1. 31	8. 05	0
August	72. 7	111	38	3. 92	1. 63	3. 82	0
Summer	72. 5	114	37	11. 96	5. 63	16. 68	(3)
September	64. 6	103	25	3. 82	2. 94	4. 62	(3)
October	52. 5	91	16	2. 20	2. 71	3. 17	. 3
November	37. 2	79	−16	1. 46	. 26	2. 55	2. 9
Fall	51. 4	103	−16	7. 48	5. 91	10. 34	3. 2
Year	49. 0	114	−26	29. 15	19. 59	45. 03	29. 5

[1] Average temperature based on a 56-year record, through 1955; maximum and minimum temperatures based on a 22-year record, through 1952.

[2] Average precipitation based on a 64-year record, through 1955; wettest and driest years based on a 64-year record, in the period 1890–1955; snowfall based on a 21-year record, through 1952.

[3] Trace.

Transportation and Markets

The county has many railroad facilities. The Chicago, Milwaukee, St. Paul and Pacific Railroad (Chicago to Omaha line) crosses the western part of the county. It passes through Defiance, Earling, Panama, and Portsmouth. The Chicago Great Western Railway (Minneapolis to Omaha line) crosses the central part of the county in a northeasterly to a southwesterly direction. It passes through Botna, Irwin, Kirkman, Harlan, and Tennant. The Chicago and Northwestern Railway also uses this track. The Chicago, Rock Island and Pacific Railroad Company spur line from Avoca serves Harlan, Corley, and Shelby. Towns without railroad facilities are Elk Horn, Jacksonville, and Westphalia.

Two concrete highways pass through the county. U.S. Highway No. 59 runs north and south, and Iowa Highways 39 and 64 run east and west. Besides the main highways, the county has a large number of good black top and gravelled farm-to-market roads. The county still has some dirt roads.

The Harlan Municipal Airport is located 5 miles south of Harlan on U.S. Highway No. 59.

Livestock, livestock products, and crops produced in the county are hauled on the network of roads and rail lines.

Community Facilities

Shelby County has many churches, most of them in towns and villages.

Educational facilities are available for all children in the county. Grade school and high school instruction are available at the Elk Horn-Kimballton, Irwin, Tennant, and Shelby consolidated schools for pupils in these areas. The Harlan Independent School District provides grade school and high school instruction for pupils in the district and for rural pupils who pay tuition. The rural schools in the county provide instruction through the eighth grade, but the number of these schools is gradually diminishing.

Parochial grade and high schools are in Portsmouth, Earling, Defiance, Panama, and Westphalia.

Electricity and telephone service are on most farms. Rural delivery of the mail extends to all parts of the county.

Physiography, Relief, and Drainage

Shelby County is part of an undulating to hilly plain. Originally, the plain was fairly smooth, but it has been moderately dissected by streams. The county is divided into two distinct topographic divisions: The gently rolling to rolling uplands and the nearly level, narrow valleys of streams. Most of the upland consists of gently sloping divides with rounded hills and long, smooth slopes. Relief is greatest in the northwestern part of the county. The upland area greatly exceeds that of the stream valleys.

The major streams and tributaries extend into all uplands. The largest streams—the West Nishnabotna and the East Branch West Nishnabotna Rivers—flow in a southerly direction and leave the county south of Harlan, at points about 2 miles apart. The main tributaries of these two rivers are Elm Creek, Long Branch, Elk Creek, and Kidds Creek. Other tributaries are Rock Ditch and Mill, Pigeon, Mosquito, Keg, Silver, Little Silver, and Indian Creeks. Mill Creek flows toward the west; the rest flow in a southerly direction.

Elevations (*4*) are highest along the northern edge of the county and less at the southern boundary.

Manning, in Carroll County, a few miles northeast of Botna, has an elevation of 1,328 feet above sea level. Avoca, in Pottawattamie County, south of Harlan, has an elevation of 1,144 feet. Towns in Shelby County have the following elevations: Irwin, 1,266; Kirkman, 1,232; Harlan, 1,200.

Early Settlers

Shelby County originally was part of Keokuk County. The present boundaries were established in 1850, and the county was named for Gen. Isaac Shelby, an officer in the Revolutionary War. The first county seat was located in 1853 at Shelbyville, in Grove Township. Harlan, the present county seat, is in central Shelby County. It was laid out in 1858 and named for the first Republican United States Senator from Iowa.

Among the first settlers, in 1848–49, were Mormons from Nauvoo, Ill. Later on, they settled along the Missouri River. The people of the county are mainly of Danish, Norwegian, German, and Irish descent. Elk Horn, near the eastern edge of the county, is the center of the largest Danish settlement in the United States.

Agricultural Statistics

The farm population and the number of farms have decreased slightly since 1945; the size has increased. More farmland is operated by tenants than by owners. In 1954, Shelby County had an estimated 1,978 farms that, according to the U.S. Census of Agriculture, were grouped as follows:

	Number
Field-crop farms other than vegetable and fruit and nut	275
Dairy	60
Poultry	25
Livestock farms other than dairy and poultry	1,347
General farms	245
Miscellaneous and unclassified	26

Other farm-land statistics, according to the Census of Agriculture in 1954, were:

	Acres
Average size of farm	183.4
Cropland harvested	263,739
Cropland used only for pasture	53,820
Cropland not harvested and not pastured	2,022
Woodland pastured	5,237
Woodland not pastured	762
Other pasture	14,075
Other land (house lots, roads, wasteland, etc.)	23,129
Land in farms	362,784
Tenure:	
Operated by full owners	116,936
Operated by part owners	57,559
Operated by managers	1,991
Operated by tenants	186,298

The acreage of the principal crops, as reported by the 1954 census, is given for stated years in table 15.

Livestock in the county, as reported by the Census of Agriculture, is shown in table 16.

TABLE 15.—*Acreage of the principal crops in stated years*

Crops	1939	1949	1954
	Acres	*Acres*	*Acres*
Corn for all purposes	123, 376	144, 324	125, 539
Harvested for grain	120, 755	141, 808	122, 149
Cut for silage or fodder; hogged or grazed	2, 621	2, 516	3, 390
Oats threshed or combined	36, 538	96, 111	91, 014
Wheat threshed or combined	3, 191	2, 089	298
Barley threshed or combined	27, 796	620	401
Rye threshed or combined	847	169	8
Soybeans grown for all purposes	2, 051	373	1, 734
Popcorn harvested	193	504	1, 787
Hay:			
Clover, timothy, and mixtures of clover and grasses cut for hay	2, 473	8, 682	21, 713
Alfalfa and alfalfa mixtures cut for hay (and for dehydrating)	19, 297	14, 411	19, 343
Oats, wheat, barley, rye, or other small grains cut for hay	3, 077	1, 747	503
Other hay cut	2, 026	2, 212	484
Alfalfa seed harvested	492	53	35
Timothy seed harvested	(1)	407	433
Red clover seed harvested	(1)	1, 581	1, 544
Bromegrass seed harvested	(1)	445	174

[1] Not reported.

TABLE 16.—*Number of livestock on farms in stated years*

Livestock	1939	1949	1954
	Number	*Number*	*Number*
Horses and mules	[1] 9, 767	2, 594	809
Cattle and calves	[1] 50, 883	59, 302	82, 880
Milk cows	10, 174	9, 837	9, 002
Sheep and lambs	[2] 7, 896	3, 033	8, 642
Hogs and pigs	[3] 55, 620	128, 134	150, 045
Chickens	[3] 313, 920	[3] 315, 403	[3] 371, 048

[1] Over 3 months old.
[2] Over 6 months old.
[3] Over 4 months old.

Engineering Interpretations[5]

This soil survey report for Shelby County, Iowa, contains informations that can be used by engineers to—

1. Make soil and land use studies that will aid in the selection and development of industrial, business, residential, and recreational sites.
2. Help in the design of drainage and irrigation structures and in planning dams and other structures for water and soil conservation.
3. Make reconnaissance surveys of soil and ground conditions that will aid in selecting highway and airport locations and in planning detailed soil surveys for the intended locations.
4. Locate sources of sand and gravel.
5. Correlate pavement performance with types of soil and thus develop information that will be useful in designing and maintaining the pavements.
6. Determine the suitability of soil units for cross-country movements of vehicles and construction equipment.
7. Supplement information obtained from other published maps and reports and aerial photographs, for the purpose of making soil maps and reports that can be used readily by engineers.

The mapping and the descriptive report are somewhat generalized, however, and should be used only in planning more detailed field surveys to determine the in-place condition of the soil at the site of the proposed engineering construction.

Soil Science Terminology

Some of the terms used by the agricultural soil scientist may be unfamiliar to the engineer, and some words—for example, soil, clay, silt, and sand—may have special meaning in soil science. Many terms used in the soil survey report are defined in the Glossary. Attention is also called to the usage of the following terms by soil scientists:

Aggregate. A cluster of primary soil particles held together by internal forces to form a clod or fragment.

Granular structure. Individual grains grouped into rounded

[5] This section was prepared in cooperation with the Iowa State Highway Commission and the Division of Physical Research, Bureau of Public Roads. The test data in table 17 were obtained in the Soils Laboratory, Bureau of Public Roads.

aggregates that have indistinct sides. Highly porous granules are commonly called crumbs.

Soil. The natural medium for the growth of land plants. It is a natural body of organic and mineral materials in which plants grow.

Topsoil. Presumably fertile soil material used to topdress roadbanks, gardens, and lawns.

Soil Test Data and Engineering Soil Classifications

To be able to make the best use of the soil maps and the soil survey reports, the engineer should know the physical properties of the soil materials and the in-place condition of the soil. After testing soil materials and observing the behavior of soils when used in engineering structures and foundations, the engineer can develop design recommendations for the soil units delineated on the maps.

Soil test data

Two soil samples of Marshall silt loam from different locations in Shelby County, and two of Monona silt loam were tested by the Division of Physical Research, Bureau of Public Roads according to standard procedures (*1*) to help evaluate the soils for engineering purposes. One of the samples of Monona silt loam is from Monona County, Iowa; it is included in this report for comparison. The test data are shown in table 17.

The engineering soil classifications in table 17 are based on data obtained by mechanical analyses and on tests made to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods. Percentages of clay obtained by the hydrometer method should not be used in naming textural classes for soil classification.

The tests for liquid limit and plastic limit measure the effect of water on the consistence of the soil material. As the moisture content of a clayey soil increases from a very dry state, the material changes from solid to semisolid or plastic. As the moisture content is further increased, the material changes from plastic to liquid. The plastic limit is the moisture content at which the soil material passes from solid to plastic. The liquid limit is the moisture content at which the material passes from plastic to liquid. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic.

Table 17 also gives compaction (moisture-density) data for the tested soils. If a soil material is compacted at successively higher moisture content, assuming that the compactive effort remains constant, the density of the compacted material will increase until the "optimum moisture content" is reached. After that, the density decreases with increase in moisture content. The highest dry density obtained in the compaction test is termed "maximum dry density." Moisture-density data are important in earthwork, for, as a rule, optimum stability is obtained if the soil is compacted to about the maximum dry density when it is at approximately the optimum moisture content.

Engineering classification systems

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (*1*). In this system, soil materials are classified in seven principal groups. The groups range from A–1, which is gravelly soil of high bearing capacity to A–7, which consists of clay soil having low strength when wet. In each group, the relative engineering value of the soil material is indicated by a group index number. Group index numbers range from 0 for the best materials to 20 for the poorest. The group index number is shown in parentheses, following the soil group symbol, in the next to last column in table 17.

Some engineers prefer to use the Unified Soil Classification System (*21*). In this system, soil materials are identified as coarse grained, 8 classes; fine grained, 6 classes; and highly organic soils. An approximate classification of soils by this system can be made in the field. The last column in table 17 shows the classification of the tested soils according to the Unified system.

Engineering Data and Recommendations

Some of the engineering information can be obtained from the soil map. It will often be necessary, however, to refer to other sections of the report, particularly to those entitled: Use and Management of Soils, Descriptions of the Soils, and Genesis, Classification, and Morphology of Soils.

The soil engineering data in table 18 are based on the soil tests shown in table 17, on information given in the rest of the soil survey report, and on experience with the same kinds of soils in other counties.

Soil characteristics that affect highway construction

In general, the soils of Shelby County consist of thick loess that covers Kansan glacial till. The thickness of loess ranges from 25 to 30 feet on the crests of hills and ridges to a thin film where glacial till outcrops on the lower slopes near drainageways.

The loess soils are fine grained, and they are classified as A–4, A–6, and A–7 according to the AASHO system and as ML, CL, and CH, according to the Unified system. Soils classified as A–4 are most common in the western part of the county; those classified as A–6 are mainly in the eastern part; and those classified as A–7 are on flat land or gentle slopes. Frost heaving generally is not a problem in loess soils because the material is uniform and the water table is deep. However, highway pavement may heave on excavations that have only a thin mantle of loess over the heterogeneous glacial till. The soils derived from loess are very susceptible to erosion where runoff water concentrates. Consequently, sodding, paving, or check dams are needed in gutters and ditches to prevent extensive erosion.

The Kansan glacial till under the loess is very heterogeneous. The less dissected areas are underlain by the weathered surface of the original Kansan till plain. In some areas, the upper layer of this till is very stiff, plastic clay, called gumbotil, which is classified as A–7–6 (18–20). Gumbotil is unstable in highway subgrades, and it should not be used within 5 feet of grade. The more rolling original till plain contains a reddish-brown, pebbly layer. Wherever glacial soils are exposed, either the gumbotil or the pebbly layer is generally uppermost in the outcrop. Beneath these interface layers, the soils

TABLE 17.—*Engineering*

Soil name and location	Parent material	Bureau of Public Roads report No.	Depth	Horizon	Moisture-density [2]	
					Maximum dry density	Optimum moisture content
			Inches		*Lb. per cu. ft.*	*Percent*
Marshall silt loam:						
NW¼SW¼SW¼ sec. 24, T. 79 N., R. 37 W. (Modal profile).	Loess	S31841	0 to 7	A_1	97	21
		S31842	11 to 18	B_{21}	97	22
		S31843	29 to 40	C_1	104	19
110 feet W. of SE corner SW¼SE¼ sec. 16, T. 81 N., R. 38 W.	Loess	S31844	0 to 6	A_1	99	21
		S31845	12 to 17	B_2	102	19
		S31846	23+	C_2	104	19
Monona silt loam:						
200 feet W. of SE corner SE¼ sec. 18, T. 81 N., R. 39 W.	Loess	S31847	0 to 5	A_1	95	23
		S31848	9 to 17	B_3C_1	98	22
		S31849	28+	C_3	105	19
NE corner of SE¼NE¼ sec. 23, T. 82 N., R. 42 W.[6]	Loess	88188	2 to 8	A_p	97	23
		88189	12 to 18	B	102	21
		88190	30 to 36	C	107	19

[1] Tests performed by Bureau of Public Roads according to standard procedures of the American Association of State Highway Officials (AASHO) (*1*).

[2] According to the American Association of State Highway Officials Designation: T 99-57, Method A.

[3] According to the American Association of State Highway Officials Designation: T 88. Results by this procedure frequently may differ somewhat from results that would have been obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material, including that coarser than

are predominantly A-6, but any soil texture may occur, from sand and gravel pockets to plastic clay lenses, depending on how the material was deposited. Glacial soils containing sand or gravel pockets with large quantities of free water are subject to frost heaving if the overlying fine-grained soil is in the zone of frost penetration. A perched water table may be present in layers or pockets of sandy or gravelly soil that are underlain by clay.

In the loess soils, a seasonally high water table generally occurs above the interface of the glacial till and the loess. The in-place density of loess is not enough to prevent the accumulation of moisture if water is available. This high content of moisture may cause instability in slopes that are steeper than 30 degrees and in embankments that are placed without moisture-density control. Because of high in-place density, the Kansan glacial till generally is not excessively high in moisture. In grading operations, shrinkage factors of about 30 percent for loess and 10 percent for glacial till are used in computing earth quantities.

The lower parts of flood plains occupied by the Colo, Zook, Kennebec, and Nodaway soils are flooded part of the time. The alluvial fan or foot slopes occupied by the Judson soils are flooded less often. Roads in these bottom lands should be constructed on embankments that are above the level of flooding. The fine sand and silt in alluvial soils are subject to different degrees of frost heave. Consequently, when pavements are constructed only a few feet above the water level, the roadbed should be properly drained and made of material that is not subject to frost action. The water table in flood plains varies with the seasons, but moisture in the soils is generally high, and the in-place densities are low. Moisture-density control of embankments made of Colo, Zook, Kennebec, and Nodaway soils is needed.

The only granular deposits mapped in Shelby County are the small areas of sand and gravel in Shelby and Steinauer soils, which are indicated on the soil map with a gravel symbol. These deposits generally vary in texture, but they are commonly high in coarse sand and are very good sources of borrow. The limited extent of these sandy and gravelly deposits minimizes their economic importance. However, they provide granular material for small-scale local improvements.

Table 18 shows the suitability of Shelby County soils as material for road construction and as topsoil to promote the growth of vegetation on embankments and slopes and in ditches. Topsoil material is generally unsuitable on highway shoulders, especially if there is traffic during wet periods.

On many construction sites, wide variations in soil may occur within the depth of a proposed excavation, and several soils may occur within a short distance. The soil map, profile descriptions, and the engineering data and recommendations should be used in planning detailed surveys of soils at construction sites. The information in soil survey reports allows the soils engineer to concentrate on the most important soil units. Thus, fewer soil samples will be needed for laboratory testing, and adequate soil investigation can be made at minimum cost.

test data [1]

Mechanical analysis [3]						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—		Percentage smaller than—						AASHO [4]	Unified [5]
No. 60 (0.25 mm.)	No. 200 (0.074 mm.)	0.05 mm.	0.02 mm.	0.005 mm.	0.002 mm.				
100	99	95	64	37	32	43	18	A-7-6(12)	ML-CL
----------	100	97	70	43	35	52	24	A-7-6(16)	MH-CH
----------	100	97	71	37	31	45	21	A-7-6(13)	CL
100	99	96	68	41	34	44	17	A-7-6(12)	ML-CL
----------	100	97	68	38	32	46	20	A-7-6(13)	ML-CL
----------	100	97	67	35	30	41	17	A-7-6(11)	ML-CL
100	99	95	64	35	29	44	15	A-7-6(11)	ML
----------	100	96	65	36	31	44	16	A-7-6(11)	ML-CL
----------	100	95	62	33	25	39	15	A-6(10)	ML-CL
100	99	97	69	35	28	48	20	A-7-6(14)	ML-CL
100	99	98	84	35	29	46	20	A-7-6(13)	ML-CL
100	99	96	77	30	23	38	14	A-6(10)	ML-CL

2 mm. in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 mm. in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes for soils.

[4] According to the Classification of Soils and Soil-Aggregate Mixtures for Highway Purposes, AASHO Designation: M 145-49.

[5] According to the Unified Soil Classification System (*21*).

[6] Sample from Monona County, Iowa, representing the coarser textured range of Monona silt loam.

Soil characteristics that affect soil and moisture conservation

Soil properties that affect the construction of terraces, drainage systems, and farm ponds and the practice of irrigation are discussed in this section.

TERRACES

The following factors generally are considered in the construction of terraces: Purpose of terrace, slope of land, and condition of soil.

The most common reason for terracing is to divert runoff and prevent erosion. Diversion terraces are built on a grade, and they are larger and carry more water than field terraces.

Terraces may be built on any slope on which earthmoving machinery can operate. However, on the steeper slopes, they must be closer together or larger and, consequently, are more difficult to farm. Terraces will control sheet and gully erosion very successfully on slopes of less than 14 percent. Success is fair to good on slopes of 14 to 18 percent. Terraces on slopes stronger than 18 percent have been reported as satisfactory by some farmers, but few have been constructed.

Soil material for terraces must be evaluated to determine if it is satisfactory for terrace construction and if it is suitable for level terraces or for graded terraces. Level terraces have no grade, and the water they impound must soak into the soil. Level terraces are only built where the subsoil allows a fairly rapid, downward movement of water. Graded terraces allow excess water to drain from the end of the terrace into waterways. Graded terraces are constructed where the subsoil restricts the downward movement of water.

Nearly all of the upland soils in Shelby County are suitable for terraces. Only graded terraces with outlets into grassed waterways should be built on the Adair, Clarinda, Shelby, and Steinauer soils. These soils developed in glacial till, and they are not permeable enough to absorb accumulated terrace water in a short time. If level terraces are built on these soils, water will pond in the channel.

The Marshall, Monona, Ida, and Dow soils have developed in loess, and they are permeable enough for level terraces. Terrace outlets are generally not necessary. However, a few tree-covered areas of Marshall soil may have enough clay in the subsoil to prevent the rapid absorption of terrace water.

DRAINAGE AND IRRIGATION

The Corley soils may not be drained most effectively by tile. They are generally in small depressions and have a fairly fine textured, slowly permeable layer between about 30 and 55 inches. Surface drainage can be used to advantage in most places. The fine-textured Zook soils can generally be drained more effectively by surface drains than by tile.

The Clarinda and Adair soils are nearly impermeable, but their main drainage problem is caused by seepage through the overlying loess. Tile, placed so as to intercept the seepage, will satisfactorily drain these soils.

TABLE 18.—*Engineering characteristics of Shelby County soils*

Soil series or soil complex	Parent material	Brief description of soil profile and ground condition	Dominant slope	Engineering soil classification		Depth to seasonally high water table	Suitability as source of—	
				AASHO	Unified		Vegetative topsoil	Borrow for highway construction
			Percent			*Feet*		
Adair	Weathered glacial till; in places some loesslike material is in surface layer.	Moderately well drained to imperfectly drained; firm to very firm, silty clay loam or silty clay subsoil containing some small stones.	5 to 28	A-7	CL or CH	[1]	Unsuitable	Poor.
Clarinda	Weathered glacial till (gumbotil); in places some loesslike material is in surface layer.	Imperfectly drained to poorly drained; extremely firm clay subsoil.	5 to 18	A-7	CH	[1] 0-3	Unsuitable	Unsuitable.
Colo	Alluvium	Slightly firm to firm, imperfectly to poorly drained silty clay loam on flood plains; high in organic matter, which extends to depths of 1½ to 2 feet.	0 to 1	A-7	OL or CH	1-3	Good to depth of 1½ feet.	Unsuitable.
Corley	Loess	Imperfectly to poorly drained silt loam; firm to very firm, heavy, silty clay loam subsoil.	0 to 1 (depressions).	A-7	CL or CH	[1] 1½-3	Fair for depth of dark surface layer.	Poor.
Dow	Loess	Well-drained silt loam; friable silt loam subsoil; often calcareous.	8 to 18	A-4 to A-6	ML-CL	[2]	Poor	Fair.
Ida	Loess	Well-drained silt loam; friable silt loam subsoil; calcareous.	5 to 40	A-4 to A-6	ML-CL	[2]	Poor	Fair.
Judson	Alluvium	Friable, well drained to moderately well drained silt loam on alluvial fans and footslopes; fairly high in organic matter, which extends to depths of 2 or 3 feet.	0 to 8	A-7	OL or CL	[2]	Good to depth of 2 feet.	Fair to poor.
Judson-Nodaway-Colo complex.	Alluvium	See Judson, Nodaway, and Colo soils.	2 to 8			1-3		
Judson-Nodaway-Zook complex.	Alluvium	See Judson, Nodaway, and Zook soils.	2 to 8			1-3		
Kennebec	Alluvium	Friable, well drained to moderately well drained silt loam on flood plains; fairly high in organic matter, which extends to depths of 2 or 3 feet.	0 to 1	A-6 to A-7	OL or CL	1-3	Good to depth of 2 to 3 feet.	Fair to poor.
Marshall	Loess	Well-drained silt loam to light silty clay loam; slightly firm; light to medium silty clay loam subsoil.	0 to 32	A-7	ML-CL	[2]	Good for depth of dark surface layer.	Fair.
Minden	Loess	Imperfectly drained silt loam to light silty clay loam; slightly firm, light to medium silty clay loam subsoil.	0 to 1	A-7	ML-CL	[2]	Good for depth of dark surface layer.	Fair.
Monona	Loess	Well-drained silt loam to light silty clay loam; friable silt loam subsoil; calcareous at depths of 2 to 3 feet in places.	2 to 32	A-6 to A-7	ML-CL	[2]	Good for depth of dark surface layer.	Fair.

Nodaway	Alluvium	Friable, well-drained to imperfectly drained silt loam on flood plains (in places has dark-colored, fine-textured material below depth of 20 inches).	0 to 1	A-6 to A-7	ML-CL	1-3	Good to fair	Fair.
Shelby	Glacial till	Well drained to moderately well drained soils; firm clay loam subsoil; a few pebbles, stones, and sand pockets; subsoil may be calcareous below 4 feet; a little, very firm gumbotil-like material may be included.	8 to 32	A-6 to A-7	SC, CL, or CH.	(2)	Fair for depth of dark surface layer.	Fair.
Steinauer	Glacial till	Well-drained loam; firm, calcareous clay loam subsoil; a few pebbles, stones, and sand pockets.	8 to 28	A-6 to A-7	SC, CL, or CH.	(2)	Fair for depth of dark surface layer.	Fair.
Zook	Alluvium	Very firm, poorly drained, silty clay loam or silty clay on flood plains; fairly high in organic matter, which extends to depths of 1½ to 3 feet.	0 to 1	A-7	OH or CH	1-3	Fair to poor	Unsuitable.

[1] Soil has a perched water table during wet periods only.

[2] Water table is normally below 5 feet or more.

Detailed information on drainage and irrigation can be obtained from guides prepared cooperatively by the Soil Conservation Service, the Iowa Agricultural Experiment Station, and the Iowa Agricultural Extension Service. Two of these guides, published by Iowa State College in 1955, are Iowa Sprinkler Irrigation Guide, Special Report No. 11, and Iowa Drainage Guide, Special Report No. 13.

GULLY CONTROL

The control of gullies, particularly in the alluvial soils, is a serious problem in Shelby County. The solution of this problem is complicated, and technical assistance should be obtained through the Shelby County Soil Conservation District.

FARM PONDS

Water cannot be satisfactorily impounded on the loess soils in the county because they are too permeable. If suitable sites can be found on the glacial Shelby, Steinauer, Adair, and Clarinda soils, prospects are good that water can be impounded. Technical assistance can be obtained from the Shelby County Soil Conservation District, or other sources, to examine proposed sites and make recommendations for pond construction.

Water can be impounded behind most gully-control structures on the alluvial soils in Shelby County. Ponds of this type generally are used as a source of livestock water, but the primary object of these structures is permanent gully control. Costly mistakes can be avoided if technical advice and an engineering survey are obtained before constructing these erosion control structures.

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Glossary

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

Alluvial fan. An alluvial deposit of a stream where it issues from a side valley upon an open plain.

Available moisture-holding capacity. Moisture held in the soil and available to plants; moisture held between field capacity and the wilting coefficient.

Bench. A topographic shelf or terrace that breaks the continuity of a slope. In this county, "bench position" means that the mapping unit is on a bench.

Calcareous soil. Soil containing enough calcium carbonate to effervesce when treated with dilute hydrochloric acid. Soil alkaline in reaction because of the presence of calcium carbonate.

Clay. Mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that contains 40 percent or more of clay, less than 45 percent of sand, and less than 40 percent of silt.

Concretions. Local concentrations of calcium carbonate or other chemical compounds that form hard grains or nodules of mixed composition and of various sizes, shapes, and coloring.

Contour tillage. Tillage of soil at right angles to the direction of the slope and at the same level throughout.

Drainage class, soil:

Imperfectly or somewhat poorly drained. Water is removed from the soil slowly enough to keep it wet for significant periods but not all of the time. Imperfectly drained soils commonly have a slowly permeable layer within the profile, a high water table, additions through seepage, or a combination of these conditions. The growth of crops is restricted to a marked degree unless artificial drainage is provided.

Moderately well drained. Water is removed from the soil somewhat slowly so that the profile is wet for a small but significant part of the time. Moderately well drained soils commonly have a slowly permeable layer within or immediately beneath the solum, a relatively high water table, additions of water through seepage, or a combination of these conditions. Artificial drainage is seldom needed on moderately well drained soils.

Poorly drained. Water is removed so slowly that the soil remains wet for a large part of the time. The water table is commonly at or near the surface during a considerable part of the year. The poor drainage results from a high water table, a slowly permeable layer within the profile, seepage, or some combination of these. The water that remains in and on the poorly drained soils prohibits the growing of field crops under natural conditions in many years. Artificial drainage is usually necessary for satisfactory crop production.

Well drained. Water is removed from the soil readily but not rapidly. Well-drained soils are commonly intermediate in texture. Crop production is not improved by tile drainage of well-drained soils. Well-drained soils commonly retain optimum amounts of moisture for plant growth after rains.

Glacial till. Unstratified glacial drift consisting of intermingled clay, sand, gravel, and boulders transported or deposited by ice.

Horizon, soil. A layer of soil, approximately parallel to the soil surface, and having characteristics produced by soil-forming processes.

Loess. A sediment, commonly nonstratified and unconsolidated and deposited primarily by wind, composed mainly of silt-size particles, with subordinate amounts of very fine sand or clay or both.

Mottled. Irregularly marked with spots of color.

Organic matter. Products of the decomposition of plant and animal materials in the soil.

Parent material. The unconsolidated mass from which the soil profile developed.

Phase, soil. The subdivision of a soil type having variations in characteristics significant to the use and management of the soil. Examples of the variations recognized by phases of soil types include differences in slope, stoniness, and degree of erosion.

Sand. Small rock or mineral fragments ranging in diameter from 0.05 millimeter to 2.0 millimeters. The textural class name of any soil that contains 85 percent or more of sand and not more than 10 percent of clay.

Series, soil. A group of soils that have horizons similar in differentiating characteristics and arrangement in the soil profile, except for the texture of the surface soil, and that formed from a particular type of parent material.

Silt. Small grains of mineral soil ranging in diameter from 0.05 millimeter to 0.002 millimeter. The textural class name of any soil that contains 80 percent or more of silt and less than 12 percent of clay.

Slope classes. The slope of a nearly level soil ranges from 0 to 2 percent; gently sloping soil—2 to 5 percent; moderately sloping—5 to 8 percent; strongly sloping—8 to 11 percent; rolling—11 to 14 percent; steep—14 to 18 percent; very steep—18 to 40 percent.

Structure, soil. The aggregation of primary soil particles into compound particles, or clusters of primary particles, which are separated from adjoining aggregates by surfaces of weakness. Soil structure is classified according to grade, class, and type.

Grade. Degree of distinctness of aggregation. It expresses the differential between cohesion within aggregates and adhesion between aggregates. Terms: Structureless (single grain or massive), weak, moderate, and strong.

Class. Size of soil aggregates. Terms: Very fine or very thin, fine or thin, medium, coarse or thick, and very coarse or very thick.

Type. Shape and arrangement of individual natural soil aggregates. Terms: Platy, prismatic, columnar, blocky, subangular blocky, granular, and crumb. Example of soil-structure grade, class, and type: Moderate, medium, subangular blocky.

Upland. High ground; ground elevated above the lowlands along rivers or between hills.

V-ditches. Drainage ditches that are either narrow with vertical sides or V-shaped with flat side slopes.

W-ditches. Two parallel drainage ditches. The excavated material is placed between them. One ditch takes the water from one side of the excavated material, and the other, the water from the other side.

GUIDE TO MAPPING UNITS AND MANAGEMENT GROUPS

Map symbol	Soil name	Described on page—	Management group	Described on page—
AdD2	Adair clay loam, 5 to 11 percent slopes, moderately eroded	5	14	28
AdF2	Adair clay loam, 11 to 18 percent slopes, moderately eroded	5	15	28
AdH2	Adair clay loam, 18 to 28 percent slopes, moderately eroded	5	16	28
AsD3	Adair soils, 5 to 11 percent slopes, severely eroded	5	14	28
AsF3	Adair soils, 11 to 18 percent slopes, severely eroded	5	16	28
CdD2	Clarinda silty clay loam, 5 to 11 percent slopes, moderately eroded	6	14	28
CdF2	Clarinda silty clay loam, 11 to 18 percent slopes, moderately eroded	6	15	28
CnD3	Clarinda soils, 5 to 11 percent slopes, severely eroded	6	14	28
CnF3	Clarinda soils, 11 to 18 percent slopes, severely eroded	6	16	28
Cm	Colo silty clay loam	7	3	24
Co	Colo silty clay loam, overwashed	7	3	24
Cr	Colo silty clay loam, silty clay substratum	7	3	24
Cs	Corley silt loam	7	3	24
Ct	Corley silt loam, bench position	7	3	24
DoE3	Dow silt loam, 8 to 14 percent slopes, severely eroded	7	7	26
DoF3	Dow silt loam, 14 to 18 percent slopes, severely eroded	7	12	27
IdC3	Ida silt loam, 5 to 8 percent slopes, severely eroded	8	7	26
IdD3	Ida silt loam, 8 to 11 percent slopes, severely eroded	8	7	26
IdE3	Ida silt loam, 11 to 14 percent slopes, severely eroded	8	7	26
IdF3	Ida silt loam, 14 to 18 percent slopes, severely eroded	8	12	27
IdG3	Ida silt loam, 18 to 23 percent slopes, severely eroded	8	15	28
IdH3	Ida silt loam, 23 to 28 percent slopes, severely eroded	8	16	28
IdI3	Ida silt loam, 28 to 40 percent slopes, severely eroded	8	16	28
JdA	Judson silt loam, 0 to 2 percent slopes	9	1	23
JdB	Judson silt loam, 2 to 5 percent slopes	9	2	23
JdC	Judson silt loam, 5 to 8 percent slopes	9	8	26
JnB	Judson-Nodaway-Colo complex, 2 to 5 percent slopes	9	2	23
JnC	Judson-Nodaway-Colo complex, 5 to 8 percent slopes	9	8	26
JzB	Judson-Nodaway-Zook complex, 2 to 5 percent slopes	9	3	24
JzC	Judson-Nodaway-Zook complex, 5 to 8 percent slopes	10	8	26
Kb	Kennebec silt loam	10	1	23
Kc	Kennebec silt loam, channeled	10	1	23
MaA	Marshall silt loam, 0 to 2 percent slopes	10	1	23
MaB	Marshall silt loam, 2 to 5 percent slopes	10	2	23
MaC2	Marshall silt loam, 5 to 8 percent slopes, moderately eroded	11	4	24
MaD2	Marshall silt loam, 8 to 11 percent slopes, moderately eroded	11	5	25
MaE2	Marshall silt loam, 11 to 14 percent slopes, moderately eroded	11	6	26
MaF2	Marshall silt loam, 14 to 18 percent slopes, moderately eroded	11	11	27
MaH2	Marshall silt loam, 18 to 28 percent slopes, moderately eroded	11	15	28
MbA	Marshall silt loam, bench position, 0 to 2 percent slopes	11	1	23
MbB	Marshall silt loam, bench position, 2 to 5 percent slopes	11	2	23
MbC2	Marshall silt loam, bench position, 5 to 8 percent slopes, moderately eroded	11	4	24
MbD2	Marshall silt loam, bench position, 8 to 11 percent slopes, moderately eroded	11	5	25
McC3	Marshall soils, 5 to 8 percent slopes, severely eroded	11	4	24
McD3	Marshall soils, 8 to 11 percent slopes, severely eroded	11	5	25
McE3	Marshall soils, 11 to 14 percent slopes, severely eroded	11	6	26
McF3	Marshall soils, 14 to 18 percent slopes, severely eroded	11	11	27
McG3	Marshall soils, 18 to 23 percent slopes, severely eroded	11	15	28
McI3	Marshall soils, 23 to 32 percent slopes, severely eroded	11	16	28
MdD3	Marshall soils, bench position, 8 to 11 percent slopes, severely eroded	11	5	25
MdE3	Marshall soils, bench position, 11 to 14 percent slopes, severely eroded	11	6	26
Me	Minden silt loam	12	1	23
Mn	Minden silt loam, bench position	12	1	23
MoB2	Monona silt loam, 2 to 5 percent slopes, moderately eroded	12	2	23
MoC2	Monona silt loam, 5 to 8 percent slopes, moderately eroded	12	4	24
MoC3	Monona silt loam, 5 to 8 percent slopes, severely eroded	12	4	24
MoD2	Monona silt loam, 8 to 11 percent slopes, moderately eroded	12	5	25
MoD3	Monona silt loam, 8 to 11 percent slopes, severely eroded	12	5	25
MoE2	Monona silt loam, 11 to 14 percent slopes, moderately eroded	12	6	26
MoE3	Monona silt loam, 11 to 14 percent slopes, severely eroded	12	6	26
MoF2	Monona silt loam, 14 to 18 percent slopes, moderately eroded	12	11	27
MoF3	Monona silt loam, 14 to 18 percent slopes, severely eroded	12	11	27
MoG2	Monona silt loam, 18 to 23 percent slopes, moderately eroded	13	15	28
MoG3	Monona silt loam, 18 to 23 percent slopes, severely eroded	13	15	28
MoI3	Monona silt loam, 23 to 32 percent slopes, severely eroded	13	16	28
MtB	Monona silt loam, bench position, 2 to 5 percent slopes	13	2	23
MtC2	Monona silt loam, bench position, 5 to 8 percent slopes, moderately eroded	13	4	24
MtD2	Monona silt loam, bench position, 8 to 11 percent slopes, moderately eroded	13	5	25
MtE3	Monona silt loam, bench position, 11 to 14 percent slopes, severely eroded	13	6	26
No	Nodaway silt loam	13	1	23
Ns	Nodaway silt loam, shallow to silty clay	13	3	24
ShD2	Shelby loam, 8 to 11 percent slopes, moderately eroded	13	9	27
ShE2	Shelby loam, 11 to 14 percent slopes, moderately eroded	13	9	27
ShF2	Shelby loam, 14 to 18 percent slopes, moderately eroded	14	13	28

GUIDE TO MAPPING UNITS AND MANAGEMENT GROUPS—Continued

Map symbol	*Soil name*	Described on page—	Management group	Described on page—
ShG2	Shelby loam, 18 to 23 percent slopes, moderately eroded	14	15	28
ShH2	Shelby loam, 23 to 32 percent slopes, moderately eroded	14	16	28
SoD3	Shelby soils, 8 to 11 percent slopes, severely eroded	14	13	28
SoE3	Shelby soils, 11 to 14 percent slopes, severely eroded	14	13	28
SoF3	Shelby soils, 14 to 18 percent slopes, severely eroded	14	15	28
SoG3	Shelby soils, 18 to 23 percent slopes, severely eroded	14	16	28
SrD2	Steinauer loam, 8 to 11 percent slopes, moderately eroded	14	9	27
SrE2	Steinauer loam, 11 to 14 percent slopes, moderately eroded	14	9	27
SrF2	Steinauer loam, 14 to 18 percent slopes, moderately eroded	14	13	28
SrG2	Steinauer loam, 18 to 28 percent slopes, moderately eroded	14	16	28
SsD3	Steinauer soils, 8 to 11 percent slopes, severely eroded	15	13	28
SsE3	Steinauer soils, 11 to 14 percent slopes, severely eroded	15	13	28
SsF3	Steinauer soils, 14 to 18 percent slopes, severely eroded	15	15	28
Zc	Zook silty clay	15	10	27
Zo	Zook silty clay, overwashed	15	10	27
Zs	Zook silty clay loam	15	3	24
Zy	Zook silty clay loam, overwashed	15	3	24

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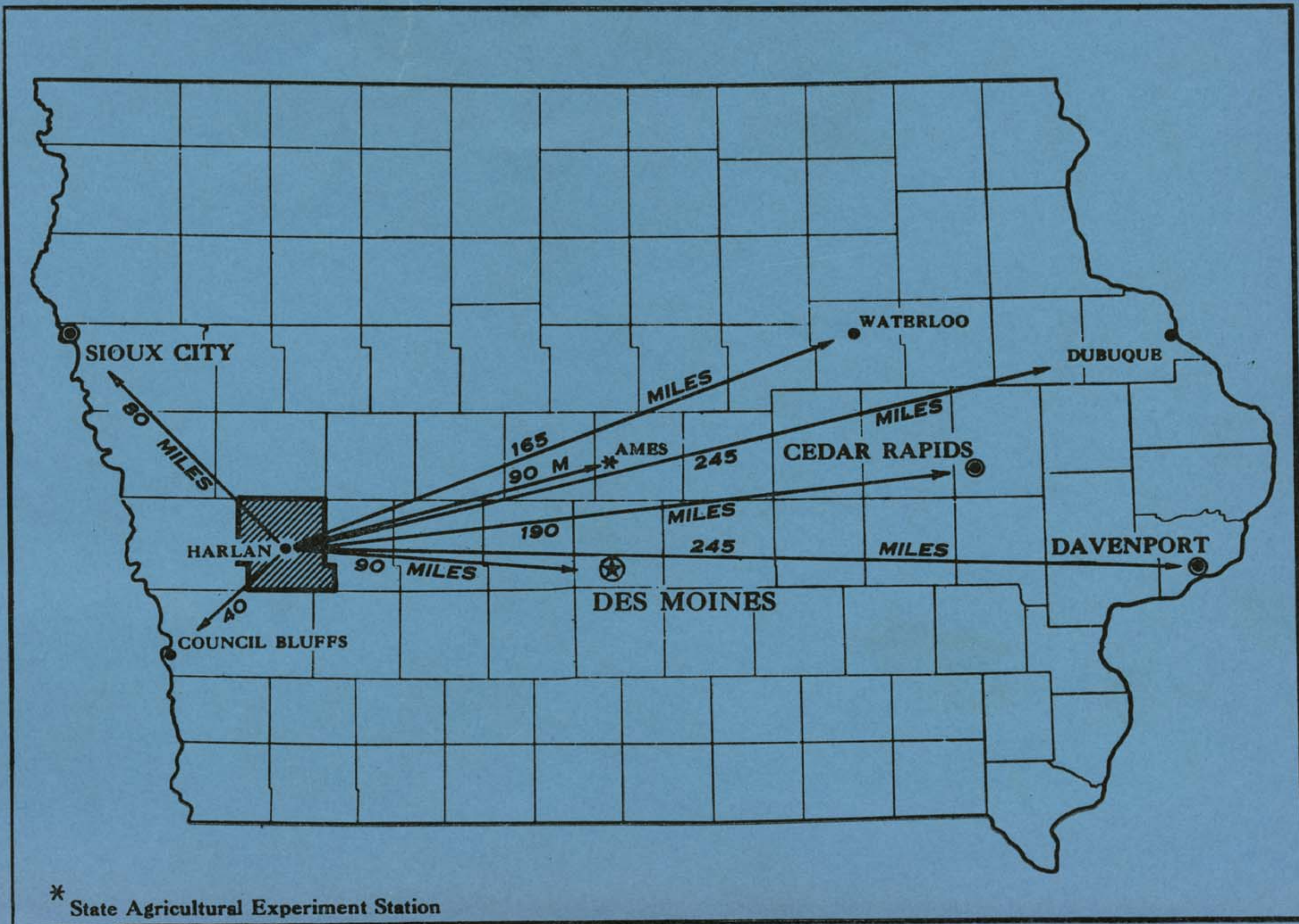

Location of Shelby County in Iowa.