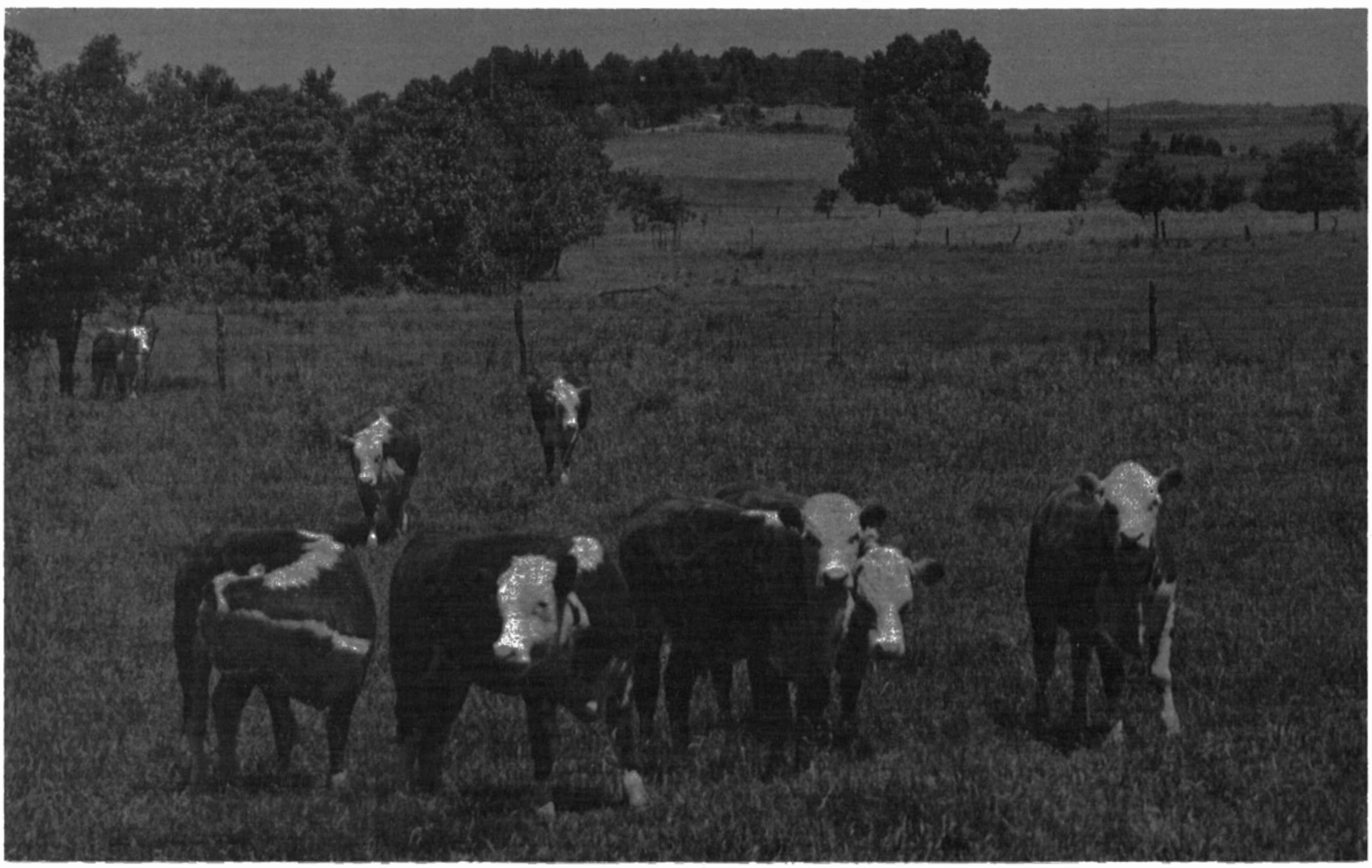
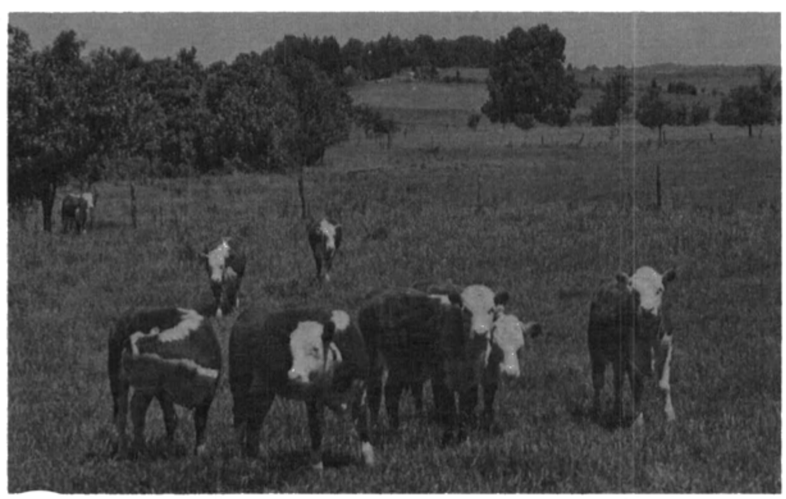
SOIL SURVEY: JOHNSON COUNTY, ILLINOIS

SOIL REPORT 82 UNIVERSITY OF ILLINOIS AGRICULTURAL EXPERIMENT STATION



IN COOPERATION WITH SOIL CONSERVATION SERVICE U.S. DEPARTMENT OF AGRICULTURE SERIES 1959, NO. 39

SOIL SURVEY:



Johnson county is noted for the strides it has made in recent years in improved grassland farming. Here cattle are grazing on improved pasture, with woodland evident in the background. Both pasture and woodland are important crops in the county.

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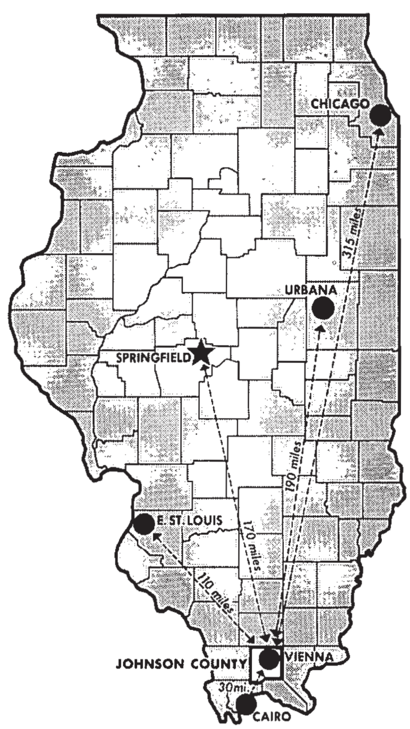
JOHNSON COUNTY, ILLINOIS

University of Illinois Agricultural Experiment Station in cooperation with Soil Conservation Service, U.S. Department of Agriculture.



CONTENTS

Report No. 82 for Johnson county replaces No. 30, which was published in 1925.

Urbana, Illinois

October, 1964

WHAT THE SOIL REPORT IS ABOUT

THIS SOIL SURVEY REPORT, including the soil map, will help all those interested in the proper use and management, understanding, and intelligent improvement of the soils of Johnson county. Farmers, foresters, engineers, planning boards, and many others will find useful information in various sections of the report. In the section on engineering properties of soils, for example, the engineer will find information useful in the design and application of various practices. In the section on use and management of soils for woodland, the farmer and the forester will find information on adapted species, management of existing stands, reforestation, and timber yields.

Considerable information on the management of the soils for common farm crops is also included in this report. Detailed information and specific management suggestions, however, are given in a separate soil management guide entitled, "How to Know Your Soils and Manage Them Wisely, A Personal Guide for Every Farmer in Johnson County, Illinois" (*4*).[1, 2] This guide may be revised from time to time as new management information and techniques become available. The management guide is designed to give the farmer up-to-date, specific management suggestions and a soil map for his own farm.

All readers should carefully study the descriptions of the soils. Sound management, interpretive groupings, and classification of the soils can be accomplished only by understanding the nature and characteristics of the individual soils.

The soil map of the county at the back of this report has been compiled from maps made in the field on aerial photographs. The aerial photographs were made in 1952 and the photomosiac background on the accompanying assembled county map is of that date. Features on the map such as roads, houses, and ditches are those that existed in 1953-54, when the field work was done. In making the 1953-1954 field maps, use was made of previous work in Johnson county by the Soil Conservation Service in the early nineteen-forties.

The soil map shows the extent and location of the various soil types and also the slope and erosion conditions of each area delineated.

[1] Italicized numbers in parentheses refer to literature cited on page 69.

[2] The Johnson county soil management guide is available through the offices of either the Johnson county farm adviser or the Johnson county soil conservation district.

Scenes like this — with bottomland in the foreground, rolling pasture in the middle, and woodland in the background — are typical of much of Johnson county. (Fig. 1)

HOW TO USE THE SOIL MAP AND SOIL REPORT

Examine the soil map. The soil map of Johnson county consists of twenty sheets. Eighteen of the sheets cover one-half township each, and two cover partial half-townships in the southwest part of the county. An index to the numbered map sheets, showing the area covered by each sheet, accompanies the soil map.

The photomosaic background shows up in light and dark shades. Timber usually shows as darkened areas. Soil boundaries and soil symbols are in red, and the streams and cultural features such as roads, houses, and towns are in black.

The soil symbols designate mapping units that are based on three things: soil type, general slope of the area, and erosion condition. Each symbol consists of two or three parts: (1) soil type number; (2) a capital letter indicating the slope group; and (3) sometimes a dash above or below the slope-group letter to indicate the thickness of remaining surface and subsurface soil or erosion condition. Absence of a dash indicates little or no erosion. For example, $214\overline{C}$ is the symbol used for Hosmer silt loam (indicated by the "214"), where the slope is 4 to 7 percent (indicated by the "C"), and where 3 to 7 inches of surface and subsurface soil remain or where moderate erosion exists (indicated by the bar above the letter).

Capital letters were substituted for the soil type numbers in very small areas of three soil types and one soil complex: W for 214, X for 301, Y for 340, and Z for 339-425. Where these were used, the symbol in the soil areas consists of two capital letters. The first capital letter is the alternate symbol for the soil type and the second, with or without bars, refers to the general slope and erosion conditions.

Slope symbols have these meanings:

Symbol	*Name*	*Pct. slope*
A	Nearly level	0–1.5
B	Gently sloping	1.5–4
C	Moderately sloping	4–7
D	Strongly sloping	7–12
E	Very strongly sloping	12–18
F	Steep	18–30
G	Very steep	over 30

The erosion symbol (a bar above or below the slope symbol or the absence of the bar) has the following meanings:

Slope symbol alone (for example, C) denotes no to slight erosion (over 7 inches of surface and subsurface soil or A horizon remaining).

Slope symbol overscored (for example, $\overline{C}$) denotes moderate erosion (3 to 7 inches of surface and subsurface soil or A horizon remaining).

Slope symbol underscored (for example, $\underline{C}$) denotes severe erosion (less than 3 inches of surface and subsurface soil or A horizon remaining).

The various mapping units, arranged according to soil type number, are listed on the soil map legend.

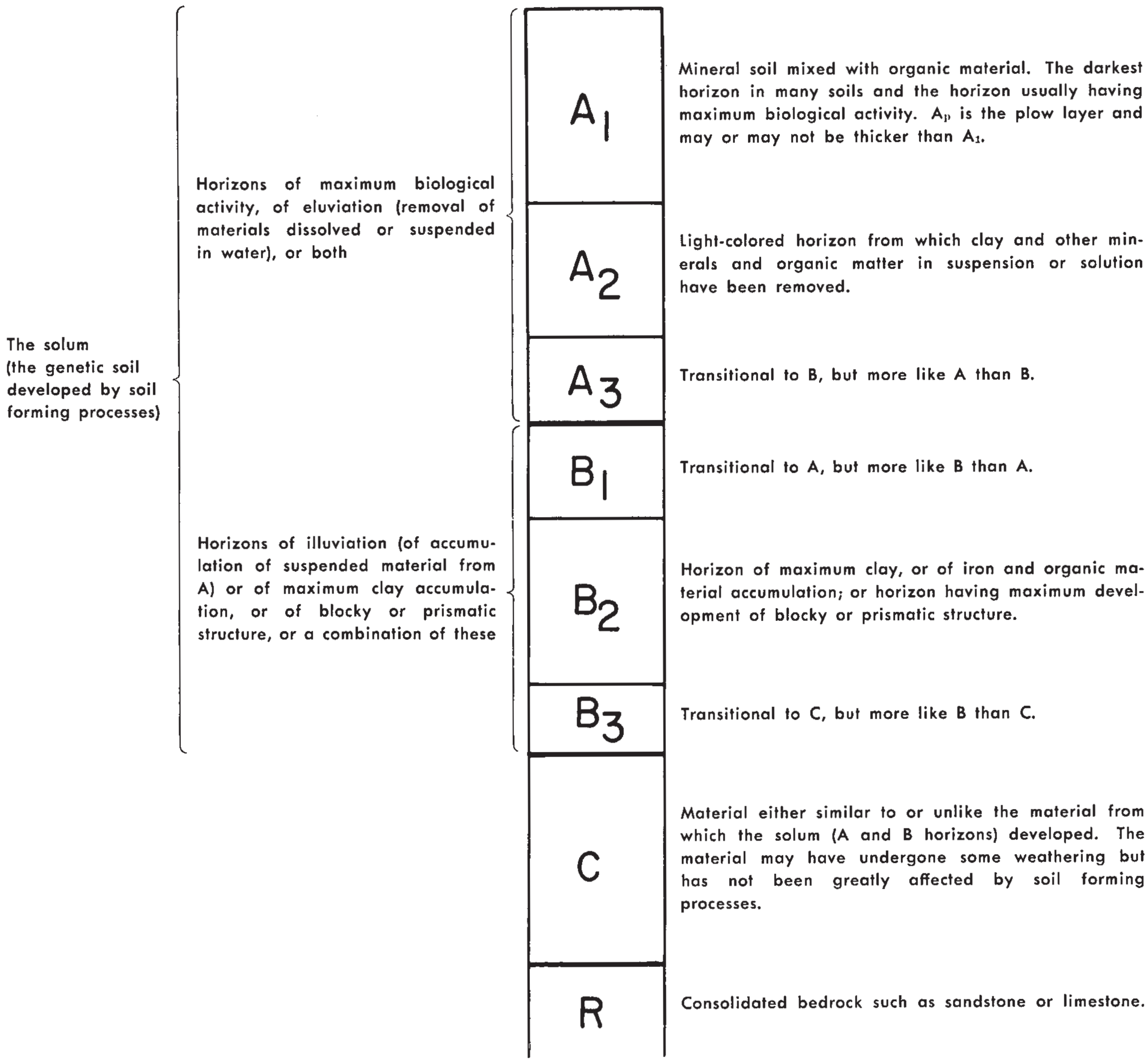
To help in finding a particular farm or tract of land, many cultural features such as roads, railroads, towns, and farmhouses are indicated. Section boundaries, section numbers, township and range numbers, and physical features such as streams, lakes, and reservoirs are also shown. If the legal description is known, a tract of land can be easily located by using township and range and section numbers. Otherwise, you can start with a recognized point, such as a town or crossroad, and if you know the distance and direction of a tract of land, you can easily find it.

Study the characteristics of the soils. After locating a tract of land and identifying the mapping units on it, turn to the Guide to Mapping Units, page 71, to find where the different kinds of soil are described and where their management and other features are discussed.

In studying the soil type descriptions note particularly that soils are separated on the basis of their characteristics to a depth of 40 inches or more, not on surface character alone. The surface or A horizon of one type is frequently little or no different from that of another, and yet the two types may differ widely in agricultural value because of differences in the B horizon. The nature of the B horizon is important in determining the drainability and water-supplying power of most soils, especially during critical periods of excess rainfall or drouths.

Most upland and terrace soils have three or four main horizons, an A, B, C, and sometimes an R. These letter designations of horizons are used in this report and are defined as shown in Figure 2. Not every soil has all the horizons and subhorizons shown in this diagram. A few soils, on the other hand, such as Hosmer and Grantsburg, have a double set of horizons. In these soils a prime is used with the letter designation (for example, A_2', B_2') to indicate the lower set of horizons and the presence of a fragipan or siltpan.

In studying the characteristics of various soils, it is also important to understand that each soil type includes a range in properties and that the boundaries between soil types are not necessarily sharp. Sometimes types are so intermingled that it is impossible to show them separately on the soil map. Wellston and Muskingum are two such intermingled types in Johnson county and are shown as a complex.



Principal horizons of upland soils. Not every horizon and subhorizon shown here, however, is necessarily present in all soils. (Adapted from *Nomenclature of soil horizons*, U.S. Dept. Agr. Handbook 18, pp. 174-183. 1951.) (Fig. 2)

GENERAL FEATURES OF JOHNSON COUNTY

Natural Features

Location and size of county. Johnson county is located near the southern tip of Illinois. The Mississippi river is about 20 miles west of the county; the Ohio river is about 12 miles away on the east and about 4 to 6 miles on the south. The major portion of the county is a nearly square area 18 by 18 miles. In addition, parts of two townships extend south of the southwest corner of the major area, bringing the total area up to 345 square miles. Vienna, the county seat and largest town, is located in the south-central part of the county.

Physiography. All of Johnson county except the lowlands along the south county line is in the Shawnee Hills section of the Interior Low Plateau province (*13*). The southern lowlands are in the old Ohio river valley which is now occupied by Cache river and Bay creek. This low-lying area is in the Coastal Plain province and represents one of the northernmost extensions of the Gulf Coastal Plains.

The major portion of the county, in the Shawnee Hills section, is part of the general region of southern Illinois often referred to as the "Illinois Ozarks." A few remnants of flat upland remain on relatively narrow ridges, but for the most part this portion of the county has deeply incised valleys and is highly dissected. Most of the rocky valley slopes are wooded (Fig. 3).

The Pennsylvanian cuesta forms a continuous ridge east and west across the north-central part of the county and divides the watershed of the county to the north and to the south. The north-flowing streams drain either through Crab Orchard creek and Big Muddy river into the Mississippi river to the west or through Saline river into the Ohio to the east. The south-flowing streams drain into the Ohio river through Cache river and Bay creek.

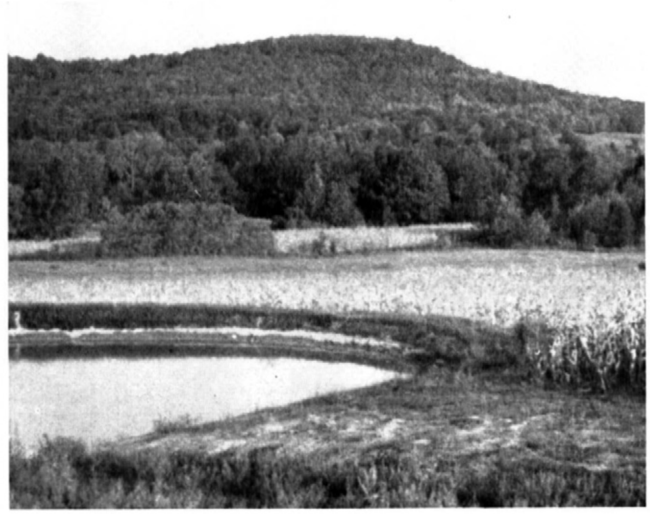
The old Ohio river valley or alluvial plain along the south line of Johnson county is characterized by alluvial terraces and recent floodplains of Cache river and Bay creek. Except for terrace ridges, this area was wet and very poorly drained until dredging and channel straightening were started. Even today some of the floodplains are poorly drained with some cypress and tupelo swamps still present.

Elevations along the drainage divide in the north-central part of the county range from about 740 feet above mean sea level on the east to 840 feet on the west. The terraces along the Cache river floodplain range from 335 feet to about 345 feet. Probably one of the lowest elevations, about 330 feet, is where the Cache river leaves the county in the southwest corner.

Geology. Johnson county lies near the southern rim of the Illinois basin. The bedrock underlying the loess is of Pennsylvanian and Mississippian age, and the regional dip is to the north with numerous local escarpments, faults, and other features. In general, Pennsylvanian rocks are in the northern part of the county and Mississippian rocks are in the southern part.

Practically none of Johnson county was glaciated, although a few extensions of the ice fringe of the Illinoian glacier may have extended upstream into some of the small valleys in the northeastern part of the county. During the glacial period, however, loess was deposited on the uplands, and valleys tended to be filled by sediments (largely loess) washed into them.

Three loess sheets are known to be present, although one or all three may have been eroded from any given small area. The lowest sheet, immediately above the bedrock or the bedrock residuum, is the Loveland loess. It was deposited somewhat earlier than the Illinoian glacial till just north of Johnson county. Considerable soil development took place in the Loveland loess before the second, the Farmdale or Roxana, was deposited. Very little soil development can be found in this second or middle loess. The uppermost loess is of Wisconsinan glacial age and is the parent material of the present loess soils of the area.

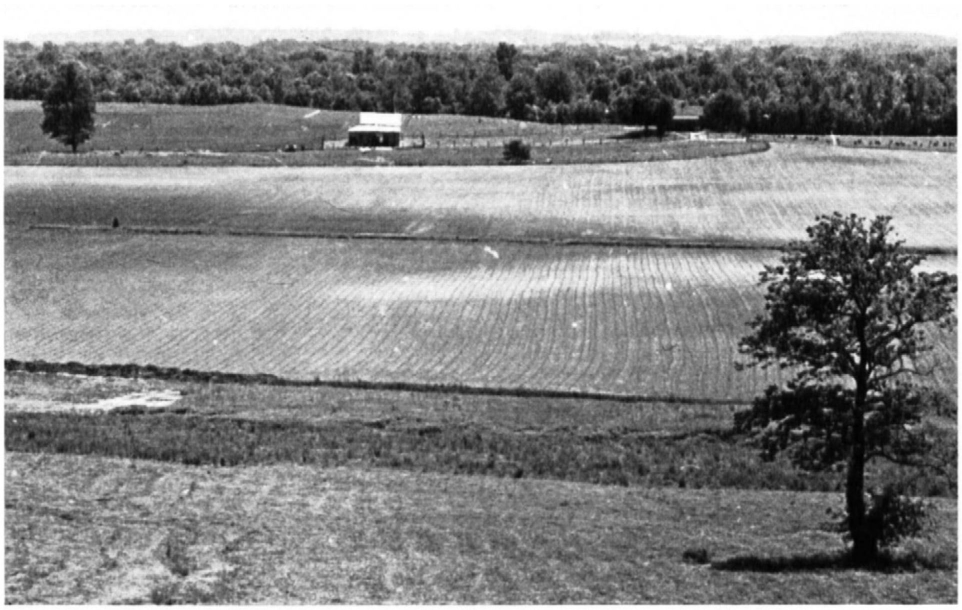


Farm pond with rocky sandstone land on steep slopes in the background. (Fig. 3)

The main source of the loess in Johnson county was the Mississippi river valley to the west and the ancient Ohio river valley along the south county line. Loess thickness on gently sloping, uneroded areas ranges from about 200 inches in the southwestern part of the county to about 70 inches in the northeastern part.

The history of the Ohio river and its drainage changes (*22*) is important in the geology of Johnson county. Before glacial times, much of the present Ohio valley probably drained northward through several rivers. As glaciers from the north filled these valleys, the glacial meltwaters were forced to drain southward, forming the present Ohio river. It is believed that the Wabash, the Green, and perhaps another river ancestral to the Ohio formed one river and flowed southwestward to a point just below the present site of Golconda, Illinois. There the river was probably joined by the Cumberland river from the south. Near this junction the river turned westward through the old Ohio river valley, which skirts most of the south line of Johnson county, and then turned southward and joined the Tennessee river west of what is now Cairo, Illinois. From this point the river continued southward and joined the ancestral Mississippi river in southeastern Missouri or northeastern Arkansas.

After the Ohio river had been formed, glacial meltwaters continued to silt up its floodplain and eventually water spilled over and began to cut through the divide between the Cumberland and Tennessee rivers



View of the terrace and bottomland area previously occupied by the Ohio river along the southern border of Johnson county. (Fig. 4)

east of Paducah, Kentucky. For a time, as glacial flooding continued, the Ohio probably used both its original course along Johnson county and the newly formed course with the lower Tennessee. Eventually enough downcutting occurred in the southernmost channel to carry the Ohio river in normal stage, and the channel now occupied by Cache river and Bay creek was abandoned (Fig. 4). Rather thick loess deposits in southern Johnson county along the old Ohio river valley indicate that this was an important source of loess during glacial times. Most of the stream terrace sediments in this ancient valley, as well as in the present Ohio valley along Illinois, contain more mica than those of the Mississippi and Wabash river terraces.

Mineral resources. Johnson county has several mineral resources, including limestone, coal, sand and gravel, and sandstone. Principal limestone quarries at present are near Buncombe, Cypress, and Whitehill. A limited amount of coal is mined in the northeastern part of the county in the New Burnside area. Some sand and gravel reserves exist in the old Ohio river valley along the south county line. A possibility exists of using limestone and sandstone as building stone, but this industry has not been very active in Johnson county.

Water resources. Johnson county has three kinds of water resources (*17*). Surface storage in ponds, reservoirs, and lakes is the principal resource in the northern part, where rock wells are not very productive. In the southern upland sections, surface storage is used extensively but rock wells also yield water at depths of 300 to 400 feet. Sand and gravel deposits in the Cache river valley contain water supplies suitable for municipal and industrial development.

Climate. Johnson county has mild winters, hot summers, and abundant rainfall. At the New Burnside station (*15*) in northeastern Johnson county, the mean January temperature for 1912 through 1944 was 34.6°F., and the mean July temperature was 78.6°F. Average annual rainfall for 1896 through 1946 was 45.1 inches. Average annual snowfall was 13.9 inches. The lowest annual rainfall, occurring in 1901, was 28.08 inches; the highest, in 1945, was 71.34 inches. Rainfall is usually fairly well distributed, but periods of dry weather which hinder crop growth to some extent occur frequently in July and August.

Rains in the winter and early spring are usually of the general type associated with low-pressure storms, whereas summer rains are usually thunder showers. Numerous thunder showers accompanied by wind occur every year, but in general, highly destructive storms such as tornadoes are less frequent in Johnson county than in areas to the north and west in southern and central Illinois (*3*).

From 1921 through 1946, the average date of the last killing frost in the spring was April 17 and the average date of the first killing frost in the fall was October 21. These are approximately the mean dates for the last 32°F. freeze in the spring and the first 32°F. freeze in the fall. The probability of a frost later in spring or earlier in fall is 50 percent (*10*). The average growing season is about 187 days, but growing seasons of over 200 days are not uncommon.

Cultural Features

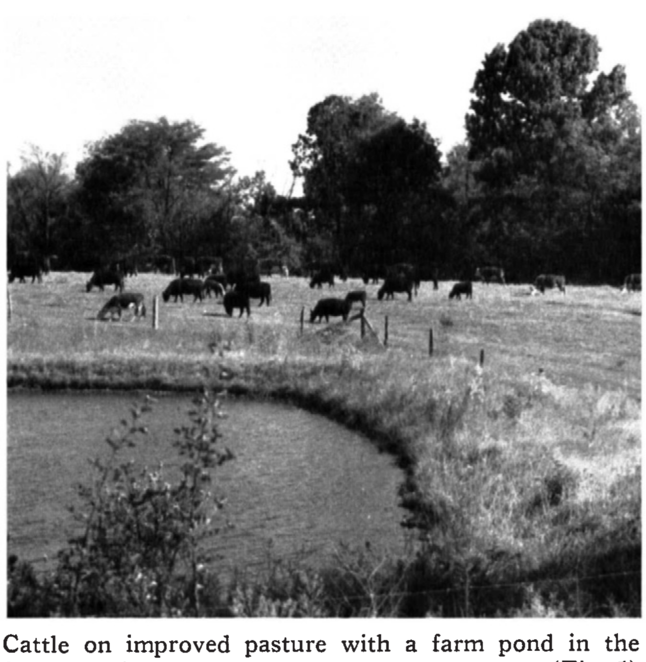
Organization and population. In 1812, Ninian Edwards, Governor of the Illinois territory, established Johnson county by proclamation. At that time the county was much larger than now. Various portions were taken from Johnson county to form other counties until it reached its present boundaries in 1843.

Population of Johnson county, according to U.S. Census data, has steadily declined since about 1900. Population for the county and six of the towns from 1910 to 1960 is given in Table 1.

Transportation and industrial development. Johnson county has good transportation facilities including several major state and federal highways and branches of the Chicago, Burlington, and Quincy, the New York Central, the Chicago and Eastern Illinois, and Illinois Central railroads. Most of the county and township roads are graveled. Industry is not well developed, although some lumbering is carried on.

Agriculture. Farming has been the most important occupation in Johnson county since its beginning. In recent years, the county has made notable strides in improved grassland farming (Fig. 5). Many of the newly adopted practices have been proven at the nearby Dixon Springs Experiment Station in Pope county. This station (*18*), which has been under the direction of the University of Illinois since 1940, and the U.S. Department of Agriculture have been major forces in improving agriculture in this general area.

Forestry and forestry products, important in the early days, seem destined for a comeback if the rough, broken land is properly used. Improved woodland management has been advanced in the area by several cooperating state and federal agencies.



Cattle on improved pasture with a farm pond in the foreground. (Fig. 5)

As shown in Table 2, the percentage of land in various crops declined from 1950 to 1960. Land not in farms increased considerably during this same period. Woodland in farms has shown a gradual decline since 1910. It should be pointed out, however, that considerable acreage of the land not in farms is in the Shawnee National Forest and is woodland. Apple and peach production, once rather important in the county, has declined over the past 30 years.

Livestock and chicken numbers for various years are given in Table 3. From 1950 to 1960, horses and mules, dairy cattle, and chicken numbers declined considerably. Swine and sheep numbers stayed about the same, and beef cattle showed a sizable gain.

Table 1. — POPULATION OF JOHNSON COUNTY AND OF SIX TOWNS IN THE COUNTY

County or town	1910	1930	1950	1960
Johnson county	14,331	10,203	8,729	6,928
Vienna	1,124	874	1,085	1,094
Goreville	554	531	581	625
Cypress	311	377	357	264
New Burnside	369	299	244	227
Belknap	.....	275	247	203
Buncombe	.....	241	210	200

Table 2. — PERCENT OF LAND USED FOR VARIOUS CROPS AND FOR OTHER PURPOSES IN JOHNSON COUNTY, 1910-1960

Land use	1910	1930	1950	1960
	percent of total acreage			
Corn	17.8	10.1	9.0	4.9
Soybeans	....	1.0	2.4	1.5
Winter wheat	2.9	.1	.6	.5
Oats	.5	.3	.2	.1
Hay	7.2	9.2	8.3	4.4
Woodland in farms	25.5	18.5	17.2	13.9
Pasture and other land in farms	....	34.6	38.4	29.4
Orchard or tree fruits	....	3.3	1.4	.5
Land not in farms	9.6	22.9	22.5	44.8

Table 3. — LIVESTOCK AND CHICKEN NUMBERS IN JOHNSON COUNTY, 1910-1960

Kind of animal	1910	1930	1950	1960
Swine	15,489	7,910	12,672	12,022
Sheep	8,412	2,342	868	773
Dairy cattle	3,247	4,067	3,291	1,065
Beef cattle	5,405	6,223	10,805	12,271
Horses and mules	7,189	4,286	2,097	745
Chickens	83,318	80,140	79,261	31,042

GENERAL SOIL AREAS OF JOHNSON COUNTY

In Johnson county, as in most Illinois counties, soils vary from area to area because of variations in soil parent materials, drainage, slope, vegetation, and other features. Within any one area, however, the soil pattern or soil association is repeated over and over. A generalized picture of the six different soil areas in the county is given in the following paragraphs. The accompanying general soil map shows the location and extent of these six areas. The map and the following discussion are for those interested in a broad picture of the soil resources and soil conditions in the county. This information is too general, however, for the study and solution of problems on individual farms.

Area N — Weinbach, Ginat Association — Nearly level to very strongly sloping, poorly drained to well-drained, terrace soils along lower Cache river floodplain

This area occurs in the old Ohio river valley. It is occupied by light-colored soils developed under forest from sediments left by the river. The major soils — Ginat, Weinbach, Sciotoville, and Wheeling — differ mainly in characteristics associated with degrees of wetness. Ginat is naturally poorly drained, Weinbach is imperfectly drained, Sciotoville is moderately well drained, and Wheeling is well drained.

These soils are moderately developed and have silt loam A horizons and silty clay loam B horizons with coarser, sandy material at various depths. Wheeling and Sciotoville soils, which usually occur on the terrace breaks into bottomlands or on ridges, ordinarily have sandy material at depths between 35 and 50 inches. Similar material under the flatter Weinbach and Ginat soils is somewhat deeper. Unity, the other soil in this area, is a well-drained sandy loam and has a sandy clay loam to loam subsoil.

All of these soils require considerable fertilization for good crop yields. They are responsive soils, however, and are used mainly for corn, soybeans, wheat, meadow, and some pasture. A few wet areas are in woods.

Drainage of some of this area was improved several years ago by the opening of the Post creek cut-off which runs about due south from the eastern end of area N, across Pulaski county for about 5 miles, to the Ohio river (Fig. 6). Area N, in general, is underlain by water-bearing sands and gravels, and irrigation wells are a distinct possibility.

Area Q — Hosmer, Zanesville Association — Nearly level to very steep, imperfectly drained to well-drained, moderately thick loess and sandstone, upland soils

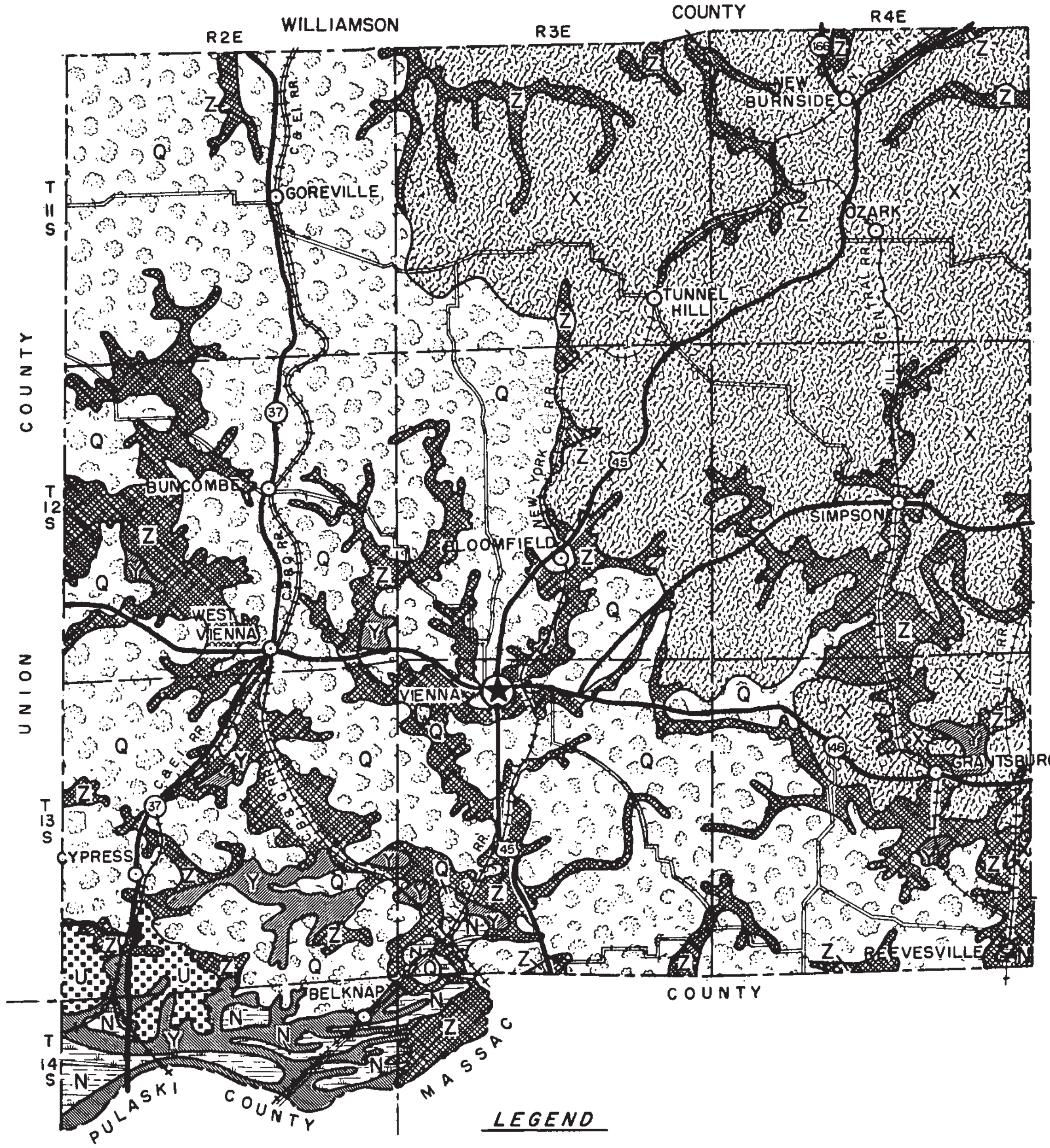
This area occupies somewhat more than the southwest half of the uplands of the county. Hosmer, Stoy, Zanesville, Wellston and Muskingum — all light-colored forest soils — occur in the area, as does Rocky sandstone land.

Hosmer and Stoy generally occur on ridge tops on the thicker loess. Stoy is the imperfectly drained associate of the moderately well-drained Hosmer and is of minor extent in Johnson county. On the other hand, Hosmer is the most extensive soil in the county, occupying about 30 percent of the total area. In the lower part of its subsoil Hosmer has a slightly to moderately developed, brittle siltpan or fragipan which hinders root penetration to some extent. The fragipan of Hosmer, however, is not as strongly developed as that of Grantsburg in area X, and it is mainly because of differences in development that the two soils areas were separated. The nature of fragipans is discussed more fully on page 36.

Zanesville occurs on slopes where loess thickness

The Post creek cut-off helps drain the lowland area previously occupied by the Ohio river. (Fig. 6)

GENERAL SOIL MAP
JOHNSON COUNTY, ILLINOIS



LEGEND

N — WEINBACH-GINAT—NEARLY LEVEL TO VERY STRONGLY SLOPING, POORLY TO WELL DRAINED, TERRACE SOILS ALONG LOWER CACHE RIVER FLOODPLAIN

Q — HOSMER-ZANESVILLE—NEARLY LEVEL TO VERY STEEP, IMPERFECTLY TO WELL DRAINED, MODERATELY THICK LOESS AND SANDSTONE, UPLAND SOILS

U — WARTRACE-HOSMER—GENTLY SLOPING TO STEEP, MODERATELY WELL AND WELL DRAINED, LOESS ON LIMESTONE, UPLAND SOILS

X — GRANTSBURG-ZANESVILLE—NEARLY LEVEL TO VERY STEEP, IMPERFECTLY TO WELL DRAINED, THIN LOESS AND SANDSTONE, UPLAND SOILS

Y — KARNAK-DUPO—NEARLY LEVEL, POORLY TO IMPERFECTLY DRAINED SOILS OF THE LOWER CACHE RIVER FLOODPLAIN

Z — SHARON-BELKNAP—NEARLY LEVEL TO GENTLY SLOPING, POORLY TO WELL DRAINED SOILS OF THE UPPER CACHE RIVER FLOODPLAIN AND SMALL CREEK BOTTOMLANDS

SCALE IN MILES
0 1 2 3 4 5 6

ranges from about 20 to 40 or 45 inches. This soil also has some fragipan development in its lower subsoil but to a lesser degree than does Hosmer. Wellston occurs where the loess is thinner than about 20 inches and lacks the fragipan development of Zanesville and Hosmer. Some residuum may be present in the lower part of the Wellston profile, but usually total depth to bedrock is not great and drouthiness is often a problem. Muskingum may have a few inches of loess in its upper profile, although it is always a rather thin, stony, drouthy soil. Rocky sandstone land, which has many rock outcrops, is of little economic value at present. Most of it is in forest and should remain so for watershed protection. It has some scenic value and may be protection for wildlife.

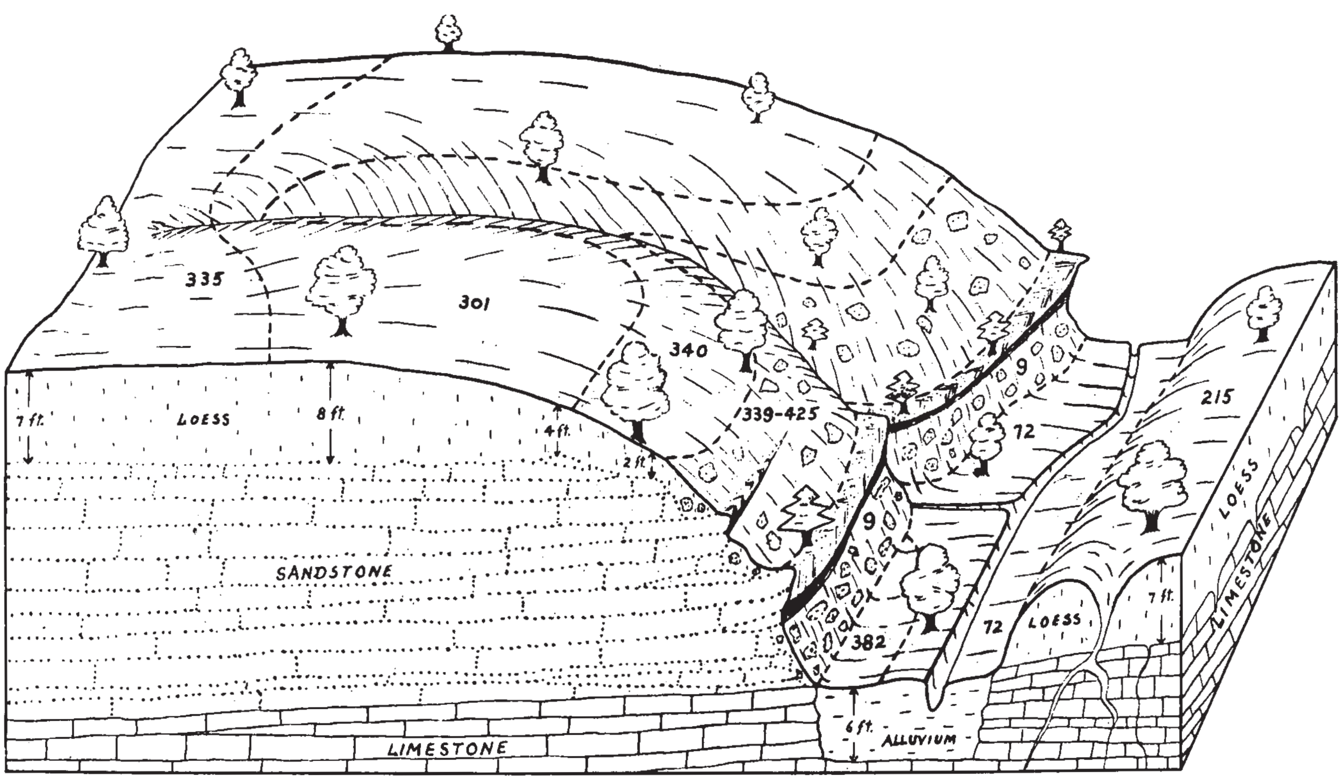
The general occurrence of soils in area Q is quite similar to that of soils in area X (Fig. 7). In fact, Zanesville, Wellston, Muskingum, and Rocky sandstone land occur in both areas. The occurrence of Hosmer and Stoy in area Q corresponds to that of Grantsburg and Robbs in area X.

The soils of area Q are acid and relatively low in plant nutrients. Most sloping areas that have been farmed are eroded, and considerable effort is needed to restore them to profitable pasture or forest production. Besides pasture and woodland on the more rolling and steep slopes, some corn, wheat, and hay are produced on the gently sloping ridgetops. A few apple and peach orchards remain in this area, but fruit production has declined over the last 25 years.

Many farmers in this area depend on farm ponds for water. Wells and cisterns are also used.

Area U — Wartrace, Hosmer Association — Gently sloping to steep, moderately well- and well-drained, loess on limestone, upland soils

This is a small area in southwestern Johnson county where the loess is underlain by limestone. In some places numerous sink holes into the limestone make for complex slopes and serious erosion problems. Two light-colored forest soils, Wartrace and Hosmer, are found in this area. Hosmer occurs on the lower foot



Relationship of soils in general soil area X (to the left of the bottomland), of two soils of area Z (in the bottomland), and of Wartrace of area U (to the right of the bottomland) to slope, loess depth, and kind and topography of bedrock. Numbers on the landscape represent the following soils: 355 — Robbs silt loam, 301 — Grantsburg silt loam, 340 — Zanesville silt loam, 339-425 — Wellston silt loam-Muskingum stony silt loam complex, 9 — Rocky sandstone land, 382 — Belknap silt loam, 72 — Sharon silt loam, and 215 — Wartrace silt loam. (Fig. 7)

slopes, and the well-drained Wartrace occurs on the ridge tops. Wartrace does not have a fragipan in the lower part of its subsoil as does Hosmer. The more permeable subsoil permits greater root penetration in the Wartrace (*5*) and it is a more productive soil than Hosmer.

Some of the thickest loess in the county is in area U, and the soils are generally among the most productive. Where slopes are not too great, some corn, wheat, and hay are grown. Steep slopes are devoted to pasture and woodland. Some rock outcrops are present and several limestone quarries are located in this area.

Area X — Grantsburg, Zanesville Association — Nearly level to very steep, imperfectly drained to well-drained, thin loess and sandstone, upland soils

The soils in area X in northeastern Johnson county are similar in some respects to those of area Q. The Grantsburg and Robbs of area X, however, are more highly developed and weathered than the Hosmer and Stoy of area Q. The Zanesville, Wellston, and Muskingum soils and Rocky sandstone land of the two areas are the same. The siltpan or fragipan in the Grantsburg is more strongly cemented and more restrictive to plant roots than that of the Hosmer soils.

The general landscape occurrence of the various soils in area X is shown to the left of the bottomland in Figure 7. In addition, two alluvial soils of area Z, Sharon and Belknap, are shown in the bottomland. To the right, the relationship of the Wartrace (area U) to underlying limestone bedrock is evident. The soils of area X are all light colored, acid, and rather low in fertility. They are, however, responsive to proper soil treatment and good management, and except for the steep, shallow-to-bedrock soils, are well adapted to pasture or grassland farming.

The Dixon Springs Experiment Station (*18*) in western Pope county, just east of the Johnson county line, is located on the same kind of soils as those in area X. The results of various trials of different crops and livestock management systems as well as various aspects of woodland management can be seen at this station.

A sizable acreage of area X along the eastern edge of Johnson county is in the Shawnee National Forest.

Area Y — Karnak, Dupo Association — Nearly level, poorly to imperfectly drained soils of the lower Cache river floodplain

This area occurs mainly in the southwestern part of Johnson county in the lowlands along Cache river. It is of minor extent, occupying less than 3 percent of the total area of the county.

The Karnak, Dupo, Darwin, and Piopolis soils comprise area Y. These soils are derived largely from sediments left by the Ohio river when it flowed through this valley, although the Dupo has more recent silty wash in its upper profile. Dupo is slightly acid to neutral throughout its profile, and the light-colored silty wash is underlain by moderately dark to dark silty clay loam or silty clay at depths between 15 and 40 inches. Piopolis is an acid silty clay loam to a depth of 40 inches or more. Darwin is a slightly acid to neutral, moderately dark-colored, fine-textured soil. Karnak, which is also fine textured, is lighter colored and generally more acid than Darwin.

Many areas of Darwin, Piopolis, and Karnak are low lying and wet. Drainage is often a problem because of poor outlets and the slow permeability of these soils. Some areas are cultivated; others are in pasture or woodland. Dupo, which is somewhat better drained than the other three soils, is used for grain crops as well as for pasture and hay.

Area Z — Sharon, Belknap Association — Nearly level to gently sloping, poorly drained to well-drained soils of the upper Cache river floodplain and small creek bottomlands

The four soils in this area are Sharon, Belknap, Bonnie, and Burnside. All are light-colored, acid silt loams derived from local sediments washed from leached upland soils. Sharon is moderately well to well drained, Belknap is imperfectly drained, and Bonnie is poorly to very poorly drained. Burnside is imperfectly to moderately well drained and differs from the other three soils mainly in that sandstone rubble or solid sandstone bedrock occurs at depths between about 12 and 36 or 40 inches.

The soils are used for grain crops as well as for pasture and woodland. Many wet areas, especially on the Bonnie and Belknap, are in native forest. Most shallow, rocky areas of Burnside are also in trees.

DESCRIPTIONS OF JOHNSON COUNTY SOILS

Descriptions of Johnson county soils will be found on the following pages. The general occurrence, formation, relationship to other soils, and profile characteristics of each soil type are given. The profile characteristics, shown by a drawing with a detailed description, are for an extensive mapping unit which has not been severely eroded. The drawings show the major horizons, but do not indicate all detailed variations that may be found in the soils. In the profile descriptions, the horizons are designated by letters as discussed on page 4. Munsell color notations[1] and consistence are for moist soils.

Mapping units of each soil type are listed, and they are briefly described where the name does not adequately indicate how they differ from the other mapping units.

The mapping units have been given names that show the soil type, the range in slope gradient, and the degree of erosion if it is moderate or severe. If erosion is not indicated in the mapping unit name, the soil has had little or no erosion.

The soil types are described in alphabetical order on the following pages but are in numerical order in Table 4. The area of each type and also of each mapping unit (combination of soil type, slope, and erosion) in the county is shown in the table. A complete Guide to Mapping Units will be found on pages 71 and 72.

Belknap silt loam (382)

Belknap silt loam is an imperfectly drained, light-colored soil type derived from acid, medium-textured sediments on the floodplains of small streams in Johnson county. It occurs on slopes of less than 4 percent in association with Bonnie silt loam (108) and Sharon silt loam (72), and in many respects is intermediate between these two soils.

Providing drainage, improving fertility, and maintaining good tilth are the major problems on Belknap. Although tile will function satisfactorily in many areas under good management, open ditches are usually better for securing adequate drainage. Belknap is moderately to strongly acid, and low in available phosphorus, available potassium, and organic matter. It responds well to soil amendments if adequately drained. Sod crops in the rotation will help provide fresh supplies of organic matter and will help maintain good physical condition in the surface soil.

Belknap is used for corn, soybean, and pasture production (Fig. 8). Because of overflow and wetness in late winter and early spring, growing small grains on this soil is hazardous.

Belknap is the most extensive bottomland soil in Johnson county, occupying 16,167 acres or 7.32 percent of the total area. Two mapping units, differing mainly in slope, are shown on the soil map. These are **Belknap silt loam, 0- to 1.5-percent slopes (382A)** and **Belknap silt loam, 1.5- to 4-percent slopes (382B)**. Both are in management group IIw-1 (page 44), woodland group 1 (page 57).

Some swampy areas of Belknap occur in Johnson county and are indicated on the soil map by a swamp symbol immediately preceding the soil type number. The swampy areas are similar to the other areas of Belknap except wetness and drainage problems are more intense.

A cultivated area of Belknap silt loam in a small bottomland. (Fig. 8)

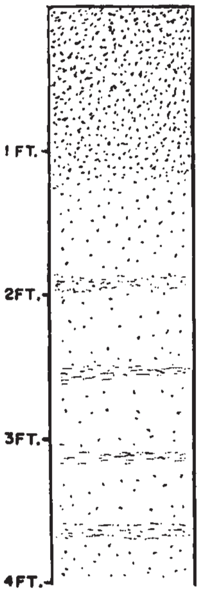
[1] These notations refer to soil color standards developed by the Munsell Color Company, Inc. The notations consist of three variables: hue, value, and chroma. In the notation 10YR 4/2, for example, the hue is denoted by the 10YR (YR = yellow-red), the value by the 4, and the chroma by the 2. Hue is the dominant spectral (rainbow) color and is related to the dominant wave length of the light. Value refers to the relative lightness of color and is a function of the total amount of light. Chroma is the relative purity or strength of the spectral color.

Table 4. — JOHNSON COUNTY SOILS: Areas of the Different Types Grouped According to Slope and Erosion

Type No.	Type name	Percent of total area	Area in square miles	Area in acres	Acres of various slope and erosion groups: Erosion group[a]	A slope 0–1.5%	B slope 1.5–4%	C slope 4–7%	D slope 7–12%	E slope 12–18%	F slope 18–30%	G slope over 30%
9	Rocky sandstone land	6.37	21.94	14,043	Moderate	.....	.....	.....	.....	464	3,934	9,645
71	Darwin clay	.28	.98	628	None to slight	628	.....	.....	.....	.....	.....	.....
72	Sharon silt loam	4.12	14.23	9,106	None to slight	8,658	448	.....	.....	.....	.....	.....
94	Rocky limestone land	.13	.44	283	Moderate	.....	.....	.....	.....	.....	62	221
108	Bonnie silt loam	4.78	16.48	10,543	None to slight	10,543	.....	.....	.....	.....	.....	.....
164	Stoy silt loam	.06	.20	128	None to slight	59	69	.....	.....	.....	.....	.....
175	Unity sandy loam	.03	.09	59	None to slight	19	20	.....	.....	.....	.....	.....
					Moderate	.....	.....	20	.....	.....	.....	.....
180	Dupo silt loam	.27	.94	602	None to slight	602	.....	.....	.....	.....	.....	.....
214	Hosmer silt loam	30.48	105.08	67,253	None to slight	.....	10,568	3,500	251	13	.....	.....
					Moderate	.....	541	12,152	6,244	2,263	338	.....
					Severe	.....	.....	806	20,480	9,974	123	.....
215	Wartrace silt loam	.32	1.10	704	None to slight	.....	198	90	.....	.....	.....	.....
					Moderate	.....	.....	226	10	49	16	.....
					Severe	.....	.....	.....	13	102	.....	.....
301	Grantsburg silt loam	16.44	56.77	36,331	None to slight	.....	6,371	1,827	72	.....	.....	.....
					Moderate	.....	152	7,551	2,917	300	.....	.....
					Severe	.....	.....	1,189	14,783	1,169	.....	.....
335	Robbs silt loam	.23	.80	506	None to slight	291	215	.....	.....	.....	.....	.....
339–425	Wellston-Muskingum complex	12.32	42.48	27,189	Moderate	.....	.....	.....	65	4,551	17,189	4,103
					Severe	.....	.....	.....	64	1,031	186	.....
L339–425	Wellston-Muskingum complex, limestone variants	.05	.18	115	Moderate	.....	.....	.....	.....	22	42	.....
					Severe	.....	.....	.....	.....	.....	51	.....
340	Zanesville silt loam	11.96	41.30	26,432	None to slight	.....	.....	.....	34	.....	.....	.....
					Moderate	.....	.....	.....	438	4,794	1,256	.....
					Severe	.....	.....	.....	3,288	16,290	332	.....
382	Belknap silt loam	7.32	25.26	16,167	None to slight	15,455	712	.....	.....	.....	.....	.....
420	Piopolis silty clay loam	.52	1.79	1,150	None to slight	1,150	.....	.....	.....	.....	.....	.....
426	Karnak clay	1.76	6.06	3,877	None to slight	3,877	.....	.....	.....	.....	.....	.....
427	Burnside silt loam	.54	1.88	1,200	None to slight	528	672	.....	.....	.....	.....	.....
460	Ginat silt loam	.57	1.99	1,274	None to slight	1,274	.....	.....	.....	.....	.....	.....
461	Weinbach silt loam	.53	1.82	1,166	None to slight	738	365	.....	.....	.....	.....	.....
					Moderate	.....	.....	63	.....	.....	.....	.....
462	Sciotoville silt loam	.43	1.47	941	None to slight	355	401	.....	.....	.....	.....	.....
					Moderate	.....	.....	150	35	.....	.....	.....
463	Wheeling silt loam	.10	.36	230	None to slight	.....	156	.....	.....	.....	.....	.....
					Moderate	.....	.....	26	.....	16	.....	.....
					Severe	.....	.....	.....	32	.....	.....	.....
	Quarry	.02	.08	53								
	Water	.37	1.28	820								
	TOTAL	**100.00**	**345.00**	**22,800**		**44,177**	**20,888**	**27,600**	**48,726**	**41,038**	**23,529**	**13,969**
	Area of each erosion and slope group											
	None to slight	31.78	109.62	70,159	None to slight	44,177	20,195	5,417	357	13		
	Moderate	36.16	124.76	79,855	Moderate		693	20,188	9,709	12,459	22,837	13,969
	Severe	31.67	109.26	69,913	Severe			1,995	38,660	28,566	692	

[a] Erosion groups have the following meanings: none to slight — over 7 inches of surface and subsurface soil or A horizon remaining; moderate — 3 to 7 inches of surface and subsurface soil or A horizon remaining; severe — less than 3 inches of surface and subsurface soil or A horizon remaining.

Belknap silt loam, 0- to 1.5-percent slopes (382A), representative profile



A_1 (0-15″)	Dark grayish-brown (10YR 4/2) to brown (10YR 5/3) friable silt loam with weak crumb to weak platy structure. pH 5.4.
C (15-22″)	Brown (10YR 5/3) friable silt loam. Generally massive. pH 5.3.
C (22″+)	Very pale brown (10YR 7/3) to light gray (10YR 7/2), mottled with yellowish-brown (10YR 5/8), friable silt loam. Massive. Numerous iron concretions. pH 5.2.

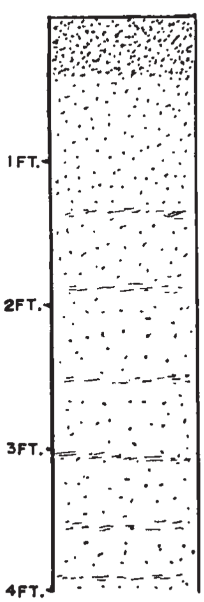
Bonnie silt loam (108)

Bonnie silt loam is a gray, poorly to very poorly drained soil type found in low-lying bottomland areas that have had poor natural drainage outlets. It occurs in association with the imperfectly drained Belknap (382) and the moderately well-drained to well-drained Sharon (72) soils. Besides being more poorly drained than Belknap and Sharon, Bonnie also has a thinner surface horizon (less than 8 inches thick). It has developed from light-colored, acid, medium-textured sediments.

Bonnie is strongly acid and low in available phosphorus and available potassium. Besides having a fertility problem, Bonnie also has a drainage problem. Because of slow permeability, tile seldom function satisfactorily in this soil and open ditches are commonly used to remove excess water. Low organic-matter content of the surface soil makes maintaining good physical condition a problem.

If adequately drained and fertilized, Bonnie produces reasonably good crops of corn and soybeans.

Bonnie silt loam (108A), representative profile



A_1 (0-4″)	Dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) friable silt loam with weak crumb to platy structure. pH 4.7.
C (4-15″)	Light brownish-gray (10YR 6/2) to light gray (10YR 7/2) friable silt loam with numerous very dark grayish-brown (10YR 3/2) iron stains and concretions. Nearly structureless. pH 4.7.
C (15″+)	Mixed light brownish-gray (10YR 6/2) and white (10YR 8/1) friable silt loam with numerous iron concretions. Massive, breaking out in large irregular clods when dry. pH 4.5.

However, many areas are used for pasture and some are in timber.

Only one mapping unit — **Bonnie silt loam (108A)** — is shown on the soil map. It is in management group IIIw-2 (page 47), woodland group 2 (page 57). Bonnie occupies 10,543 acres in Johnson county.

Some swampy areas of Bonnie occur in the county and are indicated on the soil map by a swamp symbol immediately preceding the soil type number. The swampy areas are similar to the other areas of Bonnie except wetness and drainage problems are more intense.

Burnside silt loam (427)

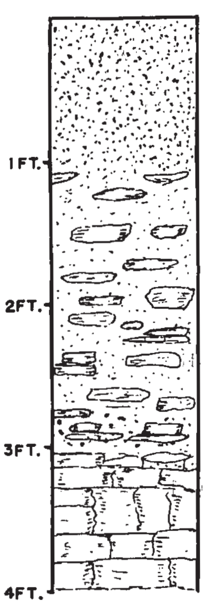
Burnside silt loam is a light-colored, imperfectly to moderately well-drained bottomland soil type which occurs in small valleys, usually bordered by steep valley slopes of Rocky sandstone land or the Wellston-Muskingum complex, or both. The silty alluvial material is mixed with broken sandstone fragments at depths ranging from about 12 to 36 inches. In some areas the broken sandstone extends several feet below 36 inches, and in others consolidated sandstone occurs above 36 inches. The silty alluvial material is similar in many respects to that of Belknap silt loam (382) and Sharon silt loam (72), two other bottomland soil types often associated with Burnside.

Burnside is medium to strongly acid and generally low in available phosphorus and available potassium. Some areas that are not too stony are used for grain crops. Most areas, however, are in pasture or woodland. Because of the shallowness to rock, this soil type is somewhat drouthy.

Two mapping units of Burnside are shown on the soil map, occupying a total of 1,200 acres in Johnson county. These are **Burnside silt loam, 0- to 1.5-percent slopes (427A)** and **Burnside silt loam, 1.5- to 4-percent slopes (427B).** The silty alluvial material in the 427B unit is generally somewhat thinner than on the nearly level Burnside, but this variation is not consistent for all areas. This unit is also slightly more drouthy than the nearly level unit.

Both mapping units are in management group IIs-1 (page 45), woodland group 7 (page 60).

Burnside silt loam, 0- to 1.5-percent slopes (427A), representative profile



A (0-12″) Dark brown (10YR 3/3) to brown (10YR 5/3) friable silt loam with weak, fine crumb structure and occasional broken sandstone rock. pH 4.6.

AC (12-36″) Dark yellowish-brown (10YR 4/4) with some light yellowish-brown (10YR 6/4) coatings and mottles. Friable silt loam to gravelly loam containing iron-manganese concretions and considerable sandstone fragments. pH 5.0.

R (36″+) Bedrock (sandstone).

Darwin clay (71)

Darwin clay is a moderately dark-colored bottomland soil type that occurs in association with Karnak clay (426) in the Cache river lowland area. It is a very fine-textured, poorly to very poorly drained soil.

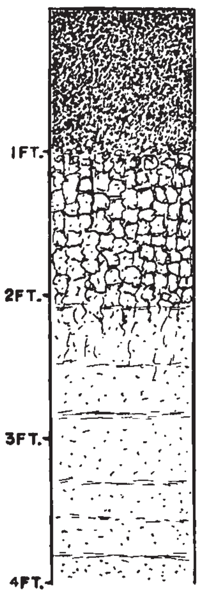
Darwin clay is usually difficult to drain and farm. Water passes through it very slowly, making tile drainage impractical. Open ditches are commonly used to remove excess water, but sometimes it is difficult to obtain suitable outlets. Maintaining tilth in the surface soil is also a problem. Darwin is slightly acid to neutral and about medium in available phosphorus and available potassium.

Some areas are used for corn and soybean production if drainage can be provided without undue costs. Many areas, however, are used for pasture and hay. Very wet areas are used for timber or wildlife.

Only one mapping unit — **Darwin clay (71A)** — is shown on the soil map. It is in management group IIIw-1 (page 46), woodland group 2 (page 57). Darwin occupies 628 acres in Johnson county.

Some chemical and physical properties of Darwin clay are given in Table 17, as well as in Figure 18.

Darwin clay (71A), representative profile



A_1 (0-12″) Very dark gray (10YR 3/1) to dark gray (10YR 4/1) very firm clay to silty clay with fine blocky to granular structure. pH 6.1.

BC (12-24″) Gray (10YR 5/1 to 6/1) very firm clay to silty clay, mottled slightly with yellowish-brown (10YR 5/8). Weak, coarse blocky structure breaking to coarse granular in upper part. pH 6.3.

C (24″+) Olive-gray (5Y 5/2) very firm clay. Massive. pH 6.5.

Dupo silt loam (180)

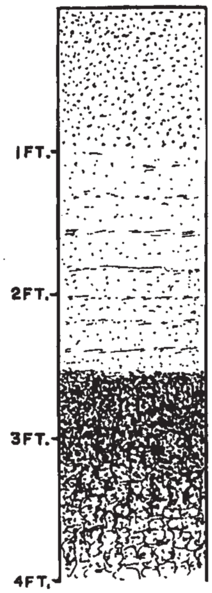
Dupo silt loam is an imperfectly to poorly drained bottomland soil type consisting of light-colored silt loam, ranging in thickness from 15 to 40 inches, over moderately dark-colored silty clay loam to clay (Fig. 9). Dupo occurs in the Cache river bottomland area in southwestern Johnson county in association with Darwin, Karnak, and Piopolis soils.

Dupo is slightly acid to neutral and is generally one of the most productive soils in the county. It is used largely for grain crops. Dupo occupies 602 acres in the county or slightly less than one square mile.

Only one mapping unit — **Dupo silt loam (180A)** — is shown on the soil map. It is in management group I-1 (page 42), woodland group 1 (page 57).

Profile of Dupo silt loam. Note that near the spade handle, where the profile has been cleaned, the upper 15 to 20 inches is much lighter colored than below. (Fig. 9)

Dupo silt loam (180A), representative profile



A_1 (0-11") Dark brown (10YR 4/3) to dark grayish-brown (10YR 4/2) friable silt loam with weak crumb to weak platy structure. pH 6.5.

AC (11-30") Somewhat stratified dark brown (10YR 4/3) and grayish-brown (10YR 5/2) friable silt loam with little if any structure. pH 6.5.

C (30"+) Very dark gray (10YR 3/1 to 2.5Y 3/0) firm silty clay loam to clay with weak blocky structure to massive. pH 7.0.

Ginat silt loam (460)

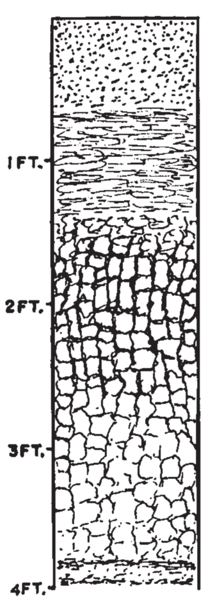
Ginat silt loam is a light-colored, poorly drained soil type. It developed under forest from terrace sediments deposited by the Ohio river while it flowed through the large valley which fringes on a part of the southern boundary of Johnson county. Ginat is the poorly drained associate of the imperfectly drained Weinbach silt loam (461), the moderately well-drained Sciotoville silt loam (462), and the well-drained Wheeling silt loam (463).

All of these soils have developed from material derived largely from sandstone, siltstone, shale, and quartzite. There is also, no doubt, some admixture of loess and local silty wash. A high mica content seems to be characteristic of these soils.

Ginat is usually drained by surface ditches and furrows. It is acid and fairly low in fertility but responds well to proper soil treatment if adequately drained. It is used mainly for grain and pasture.

One mapping unit — **Ginat silt loam (460A)** — is shown on the soil map. It is in management group IIIw-3 (page 47), woodland group 3 (page 58). Ginat occupies 1,274 acres in Johnson county.

Ginat silt loam (460A), representative profile



A_p (0-7") Dark grayish-brown (10YR 4/2) friable silt loam with weak crumb to weak platy structure. pH 6.0.

A_2 (7-17") Light brownish-gray (10YR 6/2) to light gray (10YR 7/2) in lower part, friable silt loam with weak platy structure to nearly massive. pH 4.8.

B_{21} (17-26") Light brownish-gray (10YR 6/2), with common, distinct reddish-yellow (7.5YR 6/6) mottles, firm silty clay loam with weak, medium subangular blocky to coarse blocky structure. Iron concretions and numerous mica flakes present. pH 4.6.

B_{22} (26-37") Light brownish-gray (10YR 6/2), with many medium brown (10YR 5/3) mottles, firm silty clay loam with weak, coarse blocky structure. Iron concretions and mica flakes present. pH 5.4.

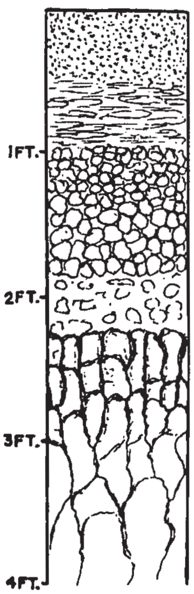
B_3 (37-46") Grayish-brown (10YR 5/2), mottled with yellowish-red (5YR 4/6), firm silty clay loam with weak, coarse blocky structure to massive. pH 5.6.

C (46"+) Grayish-brown (10YR 5/2) light silty clay loam to silt loam containing some sand and numerous mica flakes. pH 7.0.

Grantsburg silt loam (301)

Grantsburg is a light-colored soil type developed under forest on slopes ranging from 2 to 18 percent. It occurs in eastern and northeastern Johnson county in association with Robbs silt loam (335) and Zanesville silt loam (340). Parent material of Grantsburg and Robbs is loess, not more than 80 inches thick, over sandstone residuum or sandstone bedrock. These soils have thus developed from thinner loess than Hosmer (214) and Stoy (164) in southwestern Johnson county and are more highly weathered.

Grantsburg silt loam, 1.5- to 4-percent slopes (301B or XB), representative profile



A_p (0-6″) Dark brown (10YR 4/3) friable silt loam with crumb structure. pH 5.2.

A_2 (6-12″) Yellowish-brown (10YR 5/4) friable silt loam with platy structure. pH 4.9.

B_1 (12-16″) Yellowish-brown (10YR 5/4) firm, heavy silt loam to silty clay loam with granular to subangular blocky structure. pH 4.8.

B_2 (16-23″) Yellowish-brown (10YR 5/4) firm silty clay loam to heavy silt loam with subangular blocky structure. pH 4.7.

A'_2 (23-27″) Brown (10YR 5/3) firm silty clay loam with light gray (10YR 7/1) coatings. Subangular blocky structure. Some dark brown (7.5YR 4/4) clay coatings. pH 4.6.

B'_2 (27-34″) Yellowish-brown (10YR 5/4) to brown (7.5YR 5/4), mottled with light gray (10YR 7/1), very firm silty clay loam with coarse prismatic breaking to coarse blocky structure. Thick dark brown (7.5YR 4/4) clay coatings present. pH 4.7.

B'_3 (34-48″+) Brown (10YR 5/3), mottled with light gray (10YR 7/1), firm, light silty clay loam to silt loam with large polygonal or many-sided aggregates bounded by white (10YR 8/1) streaks of clay and silt. Extremely hard and brittle when dry. pH 4.8.

Table 5. — GRANTSBURG SILT LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
301B or **XB** — Grantsburg silt loam, 1.5–4% slopes	Representative profile.	IIe-3	43	5	58
301$\overline{B}$ or **X$\overline{B}$** — Grantsburg silt loam, 1.5–4% slopes, moderately eroded	....	IIe-3	43	5	58
301C or **XC** — Grantsburg silt loam, 4–7% slopes	....	IIIe-2	46	5	58
301$\overline{C}$ or **X$\overline{C}$** — Grantsburg silt loam, 4–7% slopes, moderately eroded	....	IIIe-2	46	5	58
301$\underline{C}$ or **X$\underline{C}$** — Grantsburg silt loam, 4–7% slopes, severely eroded	Most of A horizon eroded away. Plow layer is heavy silt loam to light silty clay loam.	IVe-1	48	5	58
301D or **XD** — Grantsburg silt loam, 7–12% slopes	....	IIIe-2	46	5	58
301$\overline{D}$ or **X$\overline{D}$** — Grantsburg silt loam, 7–12% slopes, moderately eroded	....	IIIe-2	46	5	58
301$\underline{D}$ or **X$\underline{D}$** — Grantsburg silt loam, 7–12% slopes, severely eroded	Most of A horizon eroded away. Therefore, surface texture is heavy silt loam to light silty clay loam and depth to fragipan is less.	IVe-1	48	5	58
301$\overline{E}$ or **X$\overline{E}$** — Grantsburg silt loam, 12–18 % slopes, moderately eroded	Somewhat thinner solum than less sloping units. Used for pasture and woodland.	IVe-1	48	5	58
301$\underline{E}$ or **X$\underline{E}$** — Grantsburg silt loam, 12–18 % slopes, severely eroded	Surface texture is heavy silt loam or light silty clay loam. Somewhat thinner solum than less sloping units; gullies often present. Abandoned areas soon revert to briars and brush. Renovation for pastures or reforestation more difficult than on less sloping and less eroded units.	VIe-1	49	5	58

The fragipan in Grantsburg is more strongly developed and somewhat nearer the surface of the soil profile than the fragipan in Hosmer. As a result, the Grantsburg fragipan is probably more restrictive to plant roots. Like Hosmer, Grantsburg responds well to soil treatment (see Table 19), although it is generally a more weathered and leached soil.

Grantsburg is the second most extensive soil type in Johnson county, occupying 36,331 acres or about 16½ percent of the total area. Ten mapping units are shown on the soil map. They are listed and described in Table 5, page 19. Some physical and chemical properties of a Grantsburg profile sampled in Pope county are given in Table 17.

Hosmer silt loam (214)

Hosmer silt loam is a light-colored, moderately well-drained, upland soil type developed under forest on 2- to 30-percent slopes. The parent material is usually more than 80 inches of loess, but on the steeper areas, where Hosmer grades into Zanesville soils, the loess may be as thin as 40 to 45 inches. Hosmer occurs in western and southwestern Johnson county, where the loess may be underlain by bedrock residuum or sandstone bedrock and to some extent by limestone. It is associated with Stoy (164) and Zanesville (340) soils.

The upper part of the Hosmer profile has good physical properties; it has good moisture-storage capacity and is permeable to water and plant roots. However, the slightly to moderately well-developed fragipan in the lower part of the profile allows root penetration only in the gray streaks (see page 36). Since few roots penetrate the fragipan, little moisture is obtained in this zone.

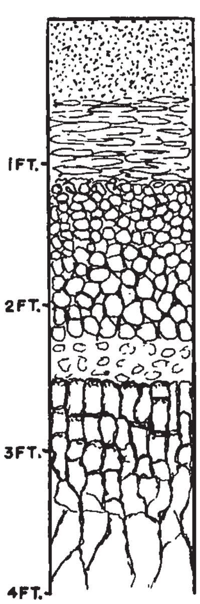
Hosmer is strongly acid, low in available phosphorus, and about medium in available potassium. It responds well to soil treatment and where not too steep is used for grain crops. Slopes over about 7 percent are best used for hay and pasture since erosion is severe if these slopes are cultivated (Fig. 10).

Hosmer is the most extensive soil type in Johnson county. There are thirteen mapping units shown on the soil map. They occupy a total of 67,253 acres or about 30½ percent of the area of the county. The mapping units are listed and described in Table 6.

Some chemical and physical properties of Hosmer silt loam are given in Table 17, as well as in Figure 20.

Rolling area of Hosmer in pasture with farmstead in background. (Fig. 10)

Hosmer silt loam, 1.5- to 4-percent slopes (214B or WB), representative profile



A_p (0-6″)	Dark grayish-brown (10YR 4/2) friable silt loam with weak crumb structure. pH 5.0.
A_2 (6-14″)	Brownish-yellow to yellowish-brown (10YR 6/6-5/4) friable silt loam with platy structure. pH 4.7.
B_1 (14-18″)	Yellowish-brown (10YR 5/4) firm, heavy silt loam to silty clay loam with granular to fine subangular blocky structure. pH 4.7.
B_2 (18-28″)	Yellowish-brown (10YR 5/4) to brown (7.5YR 5/4) firm silty clay loam to heavy silt loam with subangular blocky structure. Few dark brown (7.5YR 4/4) clay coatings present. pH 4.8.
A'_2 (28-31″)	Yellowish-brown (10YR 5/4) to brown (7.5YR 5/4) firm silty clay loam with subangular blocky structural aggregates which are coated with light gray (10YR 7/2). Some dark brown (7.5YR 4/4) clay coatings present. pH 4.7.
B'_2 (31-39″)	Brown (7.5YR 5/4) to yellowish-brown (10YR 5/4), mottled with gray (10YR 6/1) and yellowish-brown (10YR 5/8), very firm silty clay loam with coarse prismatic breaking to coarse blocky structure. Thick dark brown (7.5YR 4/4) clay coatings present. pH 4.8.
B'_3 (39-48″+)	Similar to B'_2 but having weaker, much coarser blocky structure and fewer clay coatings, and approaching silt loam in texture, especially in the lower part. Large polygonal blocks bounded by gray streaks of clay and silt are present. pH 4.9.

Table 6. — HOSMER SILT LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
214B or **WB** — Hosmer silt loam, 1.5–4% slopes	Representative profile.	IIe-3	43	5	58
214$\bar{B}$ or **W$\bar{B}$** — Hosmer silt loam, 1.5–4% slopes, moderately eroded	....	IIe-3	43	5	58
214C or **WC** — Hosmer silt loam, 4–7% slopes	....	IIIe-2	46	5	58
214$\bar{C}$ or **W$\bar{C}$** — Hosmer silt loam, 4–7% slopes, moderately eroded	....	IIIe-2	46	5	58
214$\underline{C}$ or **W$\underline{C}$** — Hosmer silt loam, 4–7% slopes, severely eroded	Very little A horizon. Plow layer approaching silty clay loam in most areas.	IVe-1	48	5	58
214D or **WD** — Hosmer silt loam, 7–12% slopes	....	IIIe-2	46	5	58
214$\bar{D}$ or **W$\bar{D}$** — Hosmer silt loam, 7–12% slopes, moderately eroded	....	IIIe-2	46	5	58
214$\underline{D}$ or **W$\underline{D}$** — Hosmer silt loam, 7–12% slopes, severely eroded	Similar to 214$\underline{C}$ in that most of A horizon eroded away. Plow layer is heavy silt loam to light silty clay loam.	IVe-1	48	5	58
214E or **WE** — Hosmer silt loam, 12–18% slopes	Total thickness of solum somewhat less than 214B. Used mainly for pasture and woodland.	IVe-1	48	5	58
214$\bar{E}$ or **W$\bar{E}$** — Hosmer silt loam, 12–18% slopes, moderately eroded	....	IVe-1	48	5	58
214$\underline{E}$ or **W$\underline{E}$** — Hosmer silt loam, 12–18% slopes, severely eroded	Used mainly for pasture or hay. Some areas abandoned and reverting to brush and trees.	VIe-1	49	5	58
214$\bar{F}$ or **W$\bar{F}$** — Hosmer silt loam, 18–30% slopes, moderately eroded	Solum somewhat thinner than 214B. Sequence of horizons similar, but fragipan is slightly thinner and somewhat nearer surface. Suitable only for permanent pasture or woodland.	VIe-1	49	5	58
214$\underline{F}$ or **W$\underline{F}$** — Hosmer silt loam, 18–30% slopes, severely eroded	Surface is heavy silt loam to light silty clay loam. Depth to fragipan somewhat less than other Hosmer units. Gullies often present. Establishment of permanent pasture or woodland difficult. Abandoned areas revert to scattered brush, including sassafras and persimmon, further complicating renovation.	VIIe-1	50	5	58

Karnak clay (426)

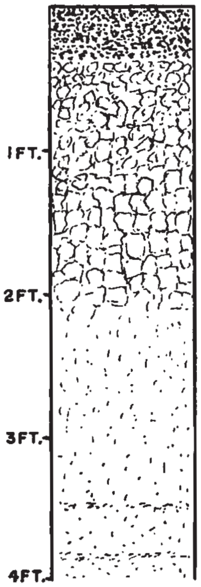
Karnak clay is a very poorly drained, fine-textured bottomland soil type that occurs in low-lying, originally wet areas along lower Cache river (Fig. 11). Some areas are still very wet and are devoted to woodland that includes such native species as tupelo gum and a few cypress. Areas that have been cleared and drained to some extent are used for pasture and some grain production. The very slow permeability of this soil makes tiling impractical. Even surface ditching is often inadequate because of poor outlets.

Karnak is lighter colored and usually more acid than Darwin clay (71) with which it is associated. One mapping unit — **Karnak clay (426A)** — is shown on the soil map. It is in management group IIIw-1 (page 46), woodland group 2 (page 57). Karnak occupies 3,877 acres in the county.

Some swampy areas of Karnak occur in Johnson county and are indicated on the soil map by a swamp symbol immediately preceding the soil type number. The swampy areas are similar to the other areas of Karnak except wetness and drainage problems are more intense.

Swampy area of Karnak clay. (Fig. 11)

Karnak clay (426A), representative profile



A_{11} (0-4″) Dark gray (10YR 4/1) firm clay to silty clay with thin platy to granular structure. pH 5.3. This horizon is absent in drained and cultivated areas.

A_{12} (4-16″) Grayish-brown (10YR 5/2) firm clay to silty clay with granular to weak, medium to fine blocky structure. pH 5.5.

BC (16-25″) Gray (10YR 5/1), mottled with very dark grayish-brown (10YR 3/2) and dark yellowish-brown (10YR 4/4), firm clay with weak, coarse blocky structure. pH 5.6. This horizon is very plastic when wet.

C (25″+) Dark gray (5Y 4/1) to light olive-gray (5Y 6/2) firm clay mottled with olive (5Y 5/6). pH 6.0.

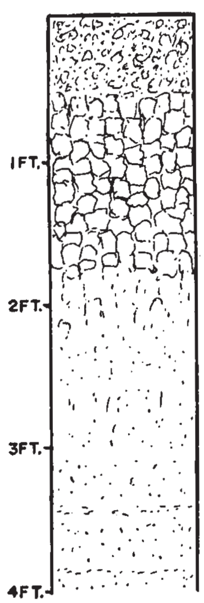
Piopolis silty clay loam (420)

Piopolis is a light-colored, acid, moderately fine-textured bottomland soil type found on the floodplains of lower Cache river in association with Darwin clay (71) and Karnak clay (426). Piopolis is poorly to very poorly drained, and because of its low-lying position, improving drainage is often a problem. Ditching is probably the best method of drainage if suitable outlets are available. Maintaining good physical condition is difficult because the surface is low in organic matter and the soil is often cultivated when too wet.

One mapping unit — **Piopolis silty clay loam (420A)** — occurs in Johnson county. It is in management group IIIw-1 (page 46), woodland group 2 (page 57). It occupies 1,150 acres in the county and is used for pasture, timber, and some grain production.

Some swampy areas of Piopolis occur in the county and are indicated on the soil map by a swamp symbol immediately preceding the soil type number. The swampy areas are similar to the other areas of Piopolis except wetness and drainage problems are more intense.

Piopolis silty clay loam (420A), representative profile



A_1 (0-6″) Grayish-brown (10YR 5/2), with some mottles and streaks of red (2.5YR 4/6), firm silty clay loam with granular to fine subangular blocky structure. pH 5.2.

BC (6-20″) Gray (10YR 5/1), with some mottles of dark brown (7.5YR 4/4) and dark grayish-brown (10YR 4/2), firm silty clay loam with weak to moderate, coarse blocky structure. pH 5.1.

C (20″+) Gray (10YR 5/1), mottled with yellowish-red (5YR 4/6) and light gray (10YR 7/1), firm silty clay loam with little if any structure. pH 5..3

Robbs silt loam (335)

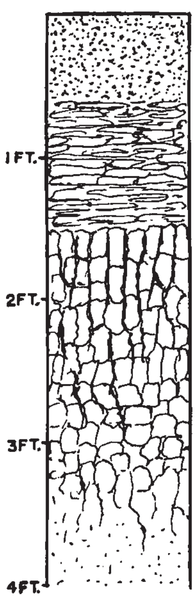
Robbs silt loam is an imperfectly drained upland soil type developed under forest from less than 80 inches of loess over bedrock or residuum. It occurs in northeastern Johnson county in association with Grantsburg silt loam (301). Robbs is similar in many ways to Stoy silt loam (164), but has developed from thinner loess and is more weathered. It occurs on slopes between 1 and 4 percent.

A few small, poorly drained areas are included with Robbs. Open ditches should be used where drainage is needed.

Erosion is ordinarily not a serious problem on Robbs. This soil is strongly acid, low in available phosphorus, and low to medium in available potassium. Response to soil treatment is generally good (see Table 19). Robbs is used for corn, soybean, wheat, hay, and pasture production.

Robbs is of minor extent in Johnson county, occupying 506 acres. Two mapping units are shown on the soil map. **Robbs silt loam, 0- to 1.5-percent slopes (335A)** is in management group IIw-2 (page 44), woodland group 4 (page 58). **Robbs silt loam, 1.5- to 4-percent slopes (335B)** is in management group IIe-4 (page 44), woodland group 4 (page 58).

Robbs silt loam, 0- to 1.5-percent slopes (335A), representative profile



A_p (0-6")	Dark grayish-brown (10YR 4/2) to brown (10YR 4/3) friable silt loam with weak crumb structure. pH 5.2.
A_2 (6-19")	Light yellowish-brown (10YR 6/4) friable silt loam with platy structure. pH 5.1.
B_2 (19-32")	Light brownish-gray (10YR 6/2) very firm silty clay loam mottled with light gray (10YR 7/1) and dark yellowish-brown (10YR 4/4). Prismatic breaking to blocky structure. pH 4.8.
B_3 (32-42")	Pale brown (10YR 6/3) very firm silty clay loam mottled with light gray (10YR 7/1) and yellowish-brown (10YR 5/8). Coarse blocky structure. pH 4.9.
C (42"+)	Pale brown (10YR 6/3) to brown (10YR 5/3), mottled with gray (10YR 6/1), friable to firm silt loam. Massive. pH 5.1.

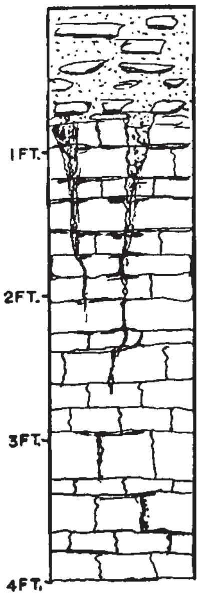
Rocky limestone land (94)

Rocky limestone land is of minor extent in Johnson county, occupying only 283 acres. It occurs on steep and very steep slopes scattered over the southern two-thirds of the county and is associated with Rocky sandstone land (9) and the Wellston-Muskingum, limestone variants complex (L339-425).

This land type tends to be drouthy because of the shallow depth to bedrock. It is a mixture of silt, some clay and sand, and numerous rocks, with bedrock outcrops common. This land type is suitable for forest and wildlife and should be managed for watershed protection. Tree growth, however, is somewhat limited.

Two mapping units, similar except for slope, are shown on the map. These are **Rocky limestone land, 18- to 30-percent slopes, moderately eroded ($94\overline{F}$)** and **Rocky limestone land, over 30-percent slopes, moderately eroded ($94\overline{G}$).** Both are in management group VIIs-1 (page 50), woodland group 8 (page 60).

Rocky limestone land, over 30-percent slopes, moderately eroded (94G̅), representative profile



A (0-9") Brown (10YR 5/3) with some intermixing of reddish-brown (5YR 4/4) and very dark grayish-brown (10YR 3/2) mixed silt, some clay and sand, and numerous rocks. pH 5.5 to 7.0.

R (9"+) Bedrock (limestone).

Rocky sandstone land (9)

Rocky sandstone land occurs on very strongly sloping to very steep areas throughout Johnson county. This land type is a mixture of sand, silt, and numerous rocks, and outcrops of sandstone bedrock are common (Fig. 12). Little soil development is evident in most areas. This type occupies 14,043 acres in the county.

In general, the moisture supply and plant-nutrient supply of this land type are very limited because of the shallow depth to bedrock. Most areas are in native forest and should be kept so for watershed protection. Timber management may be used to advantage in some areas, but at best, tree growth is slow.

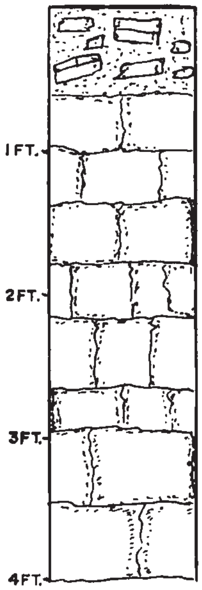
Rocky sandstone land is commonly associated with the Wellston-Muskingum complex. The three mapping units of Rocky sandstone land are very similar except for slope. All are moderately eroded. The mapping units are listed in Table 7 and a profile description is given for the most extensive unit.

Rocky sandstone land with outcrops of sandstone bedrock. (Fig. 12)

Table 7. — ROCKY SANDSTONE LAND: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
9E̅ — Rocky sandstone land, 12–18% slopes, moderately eroded	....	VIIs-1	50	8	60
9F̅ — Rocky sandstone land, 18–30% slopes, moderately eroded	....	VIIs-1	50	8	60
9G̅ — Rocky sandstone land, over 30 % slopes, moderately eroded	Representative profile. Most extensive unit of this land type, occupying slightly more than 9,500 acres.	VIIs-1	50	8	60

Rocky sandstone land, over 30-percent slopes, moderately eroded (9$\overline{G}$), representative profile



A (0-8") Grayish-brown (10YR 5/2) to brown (10YR 5/3) mixed silt, sand, and numerous rocks and rock ledges. pH 4.5 to 5.3.

R (8"+) Bedrock (sandstone).

Sciotoville silt loam (462)

Sciotoville silt loam is a light-colored, moderately well-drained soil type developed under forest vegetation from silty sediments overlying sandy material. Sciotoville occurs on nearly level to strongly sloping areas on the terraces in the Cache river lowlands. It is associated on these terraces with the poorly drained Ginat, the imperfectly drained Weinbach, and the well-drained Wheeling soils. All of these soils have formed in sediments deposited primarily by the Ohio river when it occupied this wide valley.

Sciotoville is used mainly for grain, hay, and pasture. A few tracts are in woodland. Some of the nearly level areas may need a few well-placed ditches to remove excess surface water. Erosion should be controlled on the more sloping areas, but slopes are usually short and practices such as contouring are seldom very practical.

Sciotoville is acid, relatively low in available phosphorus, and about medium in available potassium. It is a responsive soil.

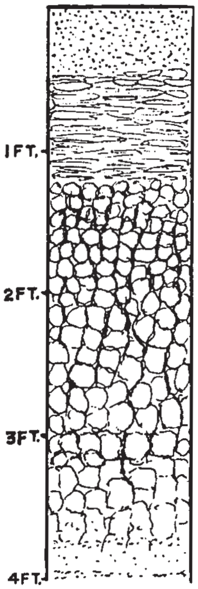
Four mapping units of Sciotoville are shown on the soil map and are described in Table 8. They occupy 941 acres in the county.

Some chemical and physical properties of Sciotoville silt loam from a profile sampled in Johnson county are given in Table 17, as well as in Figure 19.

Table 8. — SCIOTOVILLE SILT LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
462A — Sciotoville silt loam, 0–1.5% slopes	Representative profile.	IIw-2	44	6	59
462B — Sciotoville silt loam, 1.5–4% slopes	....	IIe-2	43	6	59
462$\overline{C}$ — Sciotoville silt loam, 4–7% slopes, moderately eroded	Generally somewhat shallower to underlying sandy material than 462A or 462B.	IIe-2	43	6	59
462$\overline{D}$ — Sciotoville silt loam, 7–12% slopes, moderately eroded	Somewhat more drouthy than other units because of thinner solum. Occupies only 35 acres.	IIIe-1	45	6	59

Sciotoville silt loam, 0- to 1.5-percent slopes (462A), representative profile



A_p (0-6″) Dark grayish-brown (10YR 4/2) friable silt loam with weak, fine crumb structure. pH 5.4.

A_2 (6-15″) Brown (7.5YR 5/4) friable silt loam with weak platy to fine granular structure. pH 5.0.

B_1 (15-19″) Brown (7.5YR 5/4) firm clay loam to silty clay loam with moderate, medium subangular blocky structure. pH 4.8.

B_{21} (19-24″) Dark brown (7.5YR 4/4) firm silty clay loam with some fine sand and with strong, medium subangular blocky structure. Much of sand is mica flakes. pH 4.6.

B_{22} (24-38″) Dark brown to brown (7.5YR 4/4 to 5/4) firm clay loam to silty clay loam with mottles of pinkish-gray (7.5YR 6/2) and very dark brown (7.5YR 2/2), and coatings of light yellowish-brown (10YR 6/4). Strong, medium to coarse subangular blocky structure. Mica flakes abundant. pH 4.6.

B_3 (38-44″) Pale brown (10YR 6/3), mottled with dark brown (7.5YR 4/4) and very dark brown (7.5YR 2/2), firm silty clay loam containing sand-size mica flakes and having weak, medium blocky structure. pH 4.7.

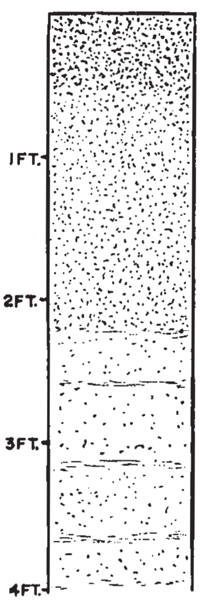
C (44″+) Light brownish-gray (10YR 6/2), mottled with strong brown (7.5YR 5/6), nearly massive sandy loam with abundant mica flakes present. pH 5.2.

Sharon silt loam (72)

Sharon silt loam is a light-colored soil type found in small bottomlands in association with Belknap silt loam (382) and Bonnie silt loam (108). It has a thicker surface soil than Belknap or Bonnie and has better drainage, being moderately well drained to well drained. Sharon has formed in recent alluvium and does not show much soil development.

Where untreated, Sharon is medium acid, low in available phosphorus, and medium to low in available potassium. After proper treatment, it is a productive

Sharon silt loam, 0- to 1.5-percent slopes (72A), representative profile



A_{1p} (0-7″) Dark grayish-brown (10YR 4/2) friable silt loam with weak crumb structure. pH 5.5.

A_1 (7-26″) Brown (10YR 4/3) to dark grayish-brown (10YR 4/2) friable silt loam with some fine crumb structure. pH 5.1.

C (26″+) Brown (10YR 5/3), mottled with very pale brown (10YR 7/3) and yellowish-brown (10YR 5/8), friable silt loam to loam with occasional sandy lenses. pH 5.4.

soil and is used largely for corn and soybean production. In very small bottoms Sharon is often used for pasture (Fig. 13).

Two mapping units, having a total area of 9,106 acres, are shown on the soil map. **Sharon silt loam, 0- to 1.5-percent slopes (72A)** is in management group I-1 (page 42), woodland group 1 (page 57). **Sharon silt loam, 1.5- to 4-percent slopes (72B)** is in management group IIe-1 (page 43), woodland group 1 (page 57). The 72B unit is of minor extent in Johnson county, occurring in small valleys or in gently sloping colluvial positions in larger stream valleys. Floods might not last as long on this unit as on the nearly level Sharon.

Pasture on Sharon silt loam in a small bottomland. (Fig. 13)

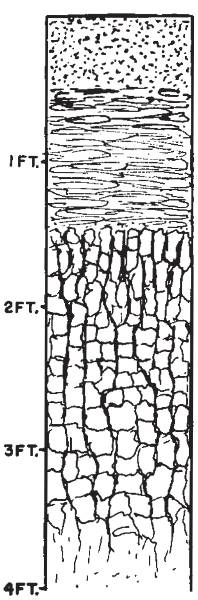
Stoy silt loam (164)

Stoy silt loam is a light-colored upland soil type found in association with Hosmer (214) in western and southwestern Johnson county. These soils have developed from thicker loess (more than 80 inches) than Robbs (335) and Grantsburg (301) in the northeastern part of the county, and are not as highly weathered. The loess from which Stoy has developed is underlain by bedrock residuum or sandstone bedrock.

Stoy has developed under forest on slopes ranging from 0 to 4 percent and is imperfectly drained. It is strongly acid, low in available phosphorus, and low to medium in available potassium. Organic matter and nitrogen are also low. This soil responds well to soil treatment, however, and is used for corn, soybean, wheat, and hay production.

Two mapping units, occupying only 128 acres in Johnson county, are shown on the soil map. **Stoy silt loam, 0- to 1.5-percent slopes (164A)** is in management group IIw-2 (page 44), woodland group 4 (page 58). **Stoy silt loam, 1.5- to 4-percent slopes (164B)** is in management group IIe-4 (page 44), woodland group 4 (page 58).

Stoy silt loam, 0- to 1.5-percent slopes (164A), representative profile



A_p (0-6″) Dark grayish-brown (10YR 4/2) to grayish-brown (10YR 5/2) friable silt loam with weak crumb structure. pH 5.0.

A_2 (6-18″) Pale brown (10YR 6/3) to light yellowish-brown (10YR 6/4) friable silt loam with platy structure. pH 4.9.

B_1 (18-22″) Brown to pale brown (10YR 5/3 to 6/3) firm silty clay loam with blocky to subangular blocky structure. Some light gray (10YR 7/1) mottles present. pH 4.6.

B_2 (22-32″) Brown (10YR 5/3) firm silty clay loam mottled with light brownish-gray (10YR 6/2). Blocky structure. pH 4.7.

B_3 (32-40″) Pale brown (10YR 6/3), mottled with light brownish-gray (10YR 6/2), firm silty clay loam. Coarse blocky structure. pH 4.8.

C (40″+) Pale brown (10YR 6/3), mottled with gray (10YR 6/1), friable silt loam. Nearly structureless. pH 4.9.

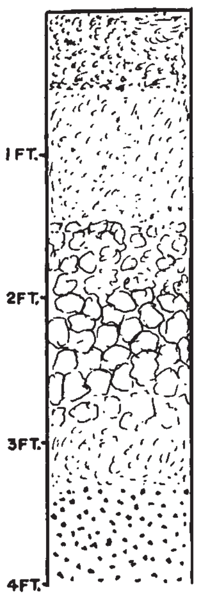
Unity sandy loam (175)

Unity sandy loam is a moderately well-drained to well-drained, light-colored soil type developed under forest vegetation. It occurs on nearly level to moderately sloping areas on the terraces along lower Cache river in association with Sciotoville silt loam (462) and Wheeling silt loam (463). It is of minor extent in the county, occupying only 59 acres.

Unity sandy loam is an acid soil and is generally low in available phosphorus and available potassium. It is apt to be somewhat drouthy because of its sandy nature. Unity is used mainly for general farm crops in Johnson county.

Three mapping units of Unity are shown on the soil map and are listed in Table 9.

Unity sandy loam, 0- to 1.5-percent slopes (175A), representative profile



A_1 (0-7") Dark grayish-brown (10YR 4/2) friable to loose sandy loam with very weak, fine crumb structure to single grain. pH 5.4.

A_2 (7-19") Light yellowish-brown (10YR 6/4) single grain sandy loam. pH 5.0.

B_1 (19-24") Yellowish-brown (10YR 5/4) friable loam to sandy clay loam with weak subangular blocky structure. pH 4.8.

B_2 (24-33") Yellowish-brown (10YR 5/4 and 5/6) friable sandy clay loam to loam with weak to moderate subangular blocky structure. pH 4.8.

B_3 (33-39") Brown (7.5YR 5/4) single grain sandy loam. pH 5.0.

C (39"+) Strong brown (7.5YR 5/6) single grain loamy sand to sand. pH 5.2.

Table 9. — UNITY SANDY LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
175A — Unity sandy loam, 0–1.5% slopes	Representative profile.	IIIs-1	47	6	59
175B — Unity sandy loam, 1.5–4% slopes	....	IIIs-1	47	6	59
175C̄ — Unity sandy loam, 4–7% slopes, moderately eroded	Somewhat shallower to sand than other units because of moderate erosion. Therefore slightly more drouthy.	IIIs-1	47	6	59

Wartrace silt loam (215)

Wartrace silt loam is a light-colored, well-drained upland soil type developed from loess under forest vegetation. It occurs in southwestern Johnson county in association with Hosmer silt loam (214).

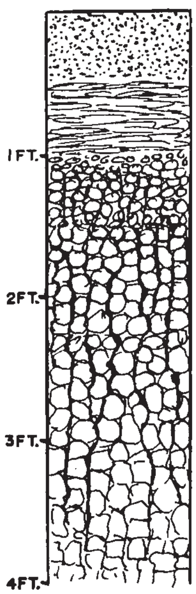
Wartrace is underlain by limestone bedrock and some sinkholes are present. It is a more permeable soil than Hosmer because it does not have a fragipan or siltpan development in the lower part of its profile.

The more permeable profile of Wartrace permits good rooting depth of such crops as corn (*5*) and makes Wartrace one of the most productive soils in Johnson county. Where not too steep or eroded, it is used for grain crops (Fig. 14). Steep areas as well as eroded areas are usually devoted to hay and pasture. Wartrace is acid, low in available phosphorus, and high to medium in available potassium.

Eight mapping units of Wartrace, occupying 704 acres, are shown on the map and listed in Table 10.

A field of Wartrace silt loam seeded to wheat. (Fig. 14)

Wartrace silt loam, 1.5- to 4-percent slopes (215B), representative profile



A_1 (0-5") Dark grayish-brown (10YR 4/2) friable silt loam with weak crumb to fine granular structure. pH 5.2.

A_2 (5-12") Brown (10YR 4/3) very friable silt loam with weak platy structure. pH 4.9.

B_1 (12-18") Dark brown (7.5YR 4/4) friable, heavy silt loam to light silty clay loam with fine to very fine subangular blocky structure. Thin clay films are present on peds. pH 4.9.

B_{21} (18-28") Yellowish-brown (10YR 5/4) to dark brown (7.5YR 4/4) firm to friable silty clay loam with strong, medium subangular blocky structure. Dark brown (7.5YR 4/4 and 4/3) clay films on peds. pH 4.8.

B_{22} (28-37") Dark brown (7.5YR 4/4) firm silty clay loam with some dark yellowish-brown (10YR 4/4) coatings. Medium to coarse subangular to angular blocky structure. pH 4.9.

B_3 (37-44") Yellowish-brown (10YR 5/4) to dark brown (7.5YR 4/4) friable to firm, light silty clay loam with weak, coarse blocky structure. Few clay films are present on ped surfaces. pH 5.0.

C (44"+) Brown (7.5YR 5/4) friable to firm silt loam with some light yellowish-brown (10YR 6/4) coatings. Very weak, coarse blocky structure. pH 5.1.

Table 10. — WARTRACE SILT LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
215B — Wartrace silt loam, 1.5–4% slopes	Representative profile.	IIe-2	43	6	59
215C — Wartrace silt loam, 4–7% slopes	....	IIe-2	43	6	59
215C̄ — Wartrace silt loam, 4–7% slopes, moderately eroded	....	IIe-2	43	6	59
215D̄ — Wartrace silt loam, 7–12% slopes, moderately eroded	....	IIIe-1	45	6	59
215D̲ — Wartrace silt loam, 7–12% slopes, severely eroded	Plow layer is heavy silt loam to light silty clay loam.	IVe-1	48	6	59
215Ē — Wartrace silt loam, 12–18% slopes, moderately eroded	Used mostly for permanent pasture.	IVe-1	48	6	59
215E̲ — Wartrace silt loam, 12–18 % slopes, severely eroded	Remaining solum thinner than that of 215B. Surface is sometimes silty clay loam because most of A horizon eroded away. Suitable only for permanent pasture or woodland.	VIe-1	49	6	59
215F̄ — Wartrace silt loam, 18–30% slopes, moderately eroded	Thinner solum than average. Surface is heavy silt loam to light silty clay loam. Suitable only for permanent pasture or woodland. Includes a few areas of severely eroded Wartrace, 18–30% slopes.	VIe-1	49	6	59

Weinbach silt loam (461)

Weinbach silt loam is an imperfectly drained forest soil type developed on the Ohio river terraces which border what are now the Cache river and Bay creek floodplains in southern Johnson county. After the Ohio abandoned its channel, Cache river and Bay creek occupied the valley. But the terrace sediments are largely those left by the Ohio. Weinbach is associated with Ginat, Sciotoville, and Wheeling.

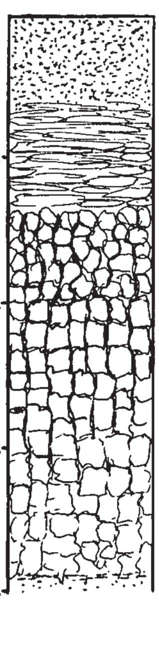
The more level areas of Weinbach sometimes need drainage for good crop growth. Surface ditches and furrows are commonly used to carry off excess water. The more sloping areas are subject to some erosion under clean-tilled crops. Weinbach responds well to soil treatment and good management. It is one of the more productive soils in the county and is used for general farm crops.

Three mapping units of Weinbach silt loam are shown on the soil map and are listed and described in Table 11. They occupy a total area of 1,166 acres in Johnson county.

Table 11. — WEINBACH SILT LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
461A — Weinbach silt loam, 0–1.5% slopes	Representative profile.	IIw-2	44	4	58
461B — Weinbach silt loam, 1.5–4% slopes	....	IIe-4	44	4	58
461$\bar{C}$ — Weinbach silt loam, 4–7% slopes, moderately eroded	Somewhat shallower to underlying sandy material than 461A or 461B; therefore has lower total water supply for plant growth. Slopes are generally short and not adapted to erosion control practices. Includes a few small areas of severely eroded Weinbach.	IIIe-3	46	4	58

Weinbach silt loam, 0- to 1.5-percent slopes (461A), representative profile



A_p (0-7″) Dark grayish-brown (10YR 4/2) friable silt loam with weak crumb to fine platy structure. pH 5.4.

A_2 (7-17″) Light yellowish-brown (10YR 6/4) to pale brown (10YR 6/3) friable silt loam with some yellowish-brown (10YR 5/6) mottles. Weak, medium platy structure. pH 4.6.

B_{21} (17-24″) Light brownish-gray (10YR 6/2), mottled with strong brown (7.5YR 5/6), firm silty clay loam with moderate, medium subangular blocky structure. pH 4.6.

B_{22} (24-34″) Grayish-brown (10YR 5/2), mottled with strong brown (7.5YR 5/6), firm silty clay loam with moderate, coarse blocky structure. Mica flakes are abundant in this horizon. pH 5.0.

B_3 (34-47″) Light brownish-gray (10YR 6/2) to pale brown (10YR 6/3), mottled with grayish-brown (10YR 5/2) and brownish-yellow (10YR 6/8), firm silty clay loam in upper part grading to clay loam and heavy loam in lower part. Weak, coarse blocky structure. Mica flakes are abundant. pH 6.4.

C (47″+) Light brownish-gray (10YR 6/2) and dark yellowish-brown (10YR 4/4) sandy loam with abundant mica flakes. pH 6.6.

Wellston-Muskingum complex (339-425)

The Wellston-Muskingum complex occurs in various areas throughout Johnson county on slopes greater than about 10 percent. Most areas, however, are on slopes ranging between 18 and 30 percent. These soils are light colored and well drained to excessively drained. Because sandstone occurs at shallow depths, they are somewhat drouthy for most economic plants, including pasture plants and trees. Besides drouthiness, erosion and stoniness are also major problems, especially on the few areas used for permanent pasture (Fig. 15). Most areas of this soil complex are in native hardwood forest. Tree growth is generally slow, but woodland appears to be the best land use for these soils in Johnson county.

Seven mapping units of this soil complex are shown on the soil map and are listed and described in Table 12. They occupy 27,189 acres or 12.3 percent of the total area of the county. The profiles of the two soil types in this complex are described separately. The proportion of the two soil types varies widely in different areas. No attempt was made to indicate the dominant member of the complex in any of the areas.

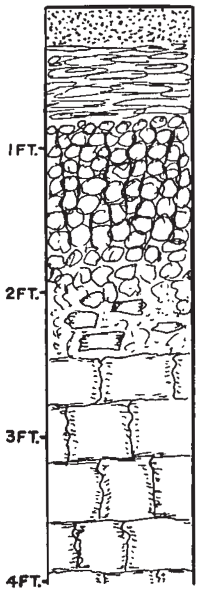
Wellston may have as much as 20 inches of loess parent material in its profile as shown in the following description.

Muskingum has developed mainly from sandstone, although in many places there has been some mixing of loess in the upper 6 to 10 inches of its profile.

Table 12. — WELLSTON-MUSKINGUM COMPLEX and WELLSTON-MUSKINGUM COMPLEX, LIMESTONE VARIANTS: Description of Mapping Units

Mapping unit		Other descriptive comments	Management group		Woodland group	
			Symbol	Page	No.	Page
339-425$\overline{\text{D}}$ or Z$\overline{\text{D}}$ —	Wellston-Muskingum complex, 7–12% slopes, moderately eroded	Of minor extent. Can be used for limited pasture and woodland.	VIIs-1	50	9	61
339-425$\underline{\text{D}}$ or Z$\underline{\text{D}}$ —	Wellston-Muskingum complex, 7–12% slopes, severely eroded	Little A horizon left. Surface soil is loam, silt loam, or light silty clay loam.	VIIs-1	50	9	61
339-425$\overline{\text{E}}$ or Z$\overline{\text{E}}$ —	Wellston-Muskingum complex, 12–18% slopes, moderately eroded	....	VIIs-1	50	9	61
339-425$\underline{\text{E}}$ or Z$\underline{\text{E}}$ —	Wellston-Muskingum complex, 12–18% slopes, severely eroded	Surface soil is loam, silt loam, or light silty clay loam.	VIIs-1	50	9	61
339-425$\overline{\text{F}}$ or Z$\overline{\text{F}}$ —	Wellston-Muskingum complex, 18–30% slopes, moderately eroded	Representative profiles. Most extensive unit, occupying over 17,000 acres out of about 27,000 acres. Most areas in native hardwoods and should remain so to prevent erosion and denudation of slopes.	VIIs-1	50	9	61
339-425$\underline{\text{F}}$ or Z$\underline{\text{F}}$ —	Wellston-Muskingum complex, 18–30% slopes, severely eroded	Similar to 339-425$\overline{\text{F}}$, but remaining A horizon is thinner. Occupies only 186 acres.	VIIs-1	50	9	61
339-425$\overline{\text{G}}$ or Z$\overline{\text{G}}$ —	Wellston-Muskingum complex, over 30% slopes, moderately eroded	Similar to 339-425$\overline{\text{F}}$ or Z$\overline{\text{F}}$, but slopes are over 30%. Rock outcrops common; many large dislodged sandstone blocks present. Includes a few severely eroded areas.	VIIs-1	50	9	61
L339-425$\overline{\text{E}}$ or LZ$\overline{\text{E}}$ —	Wellston-Muskingum complex, limestone variants, 12–18% slopes, moderately eroded	Limestone variants have some limestone fragments throughout profiles; underlying bedrock is also limestone. Thin red clay horizons present just above bedrock in some areas. Where present, thin clay layers have greater moisture-holding capacity than comparable sandy layers in regular Wellston-Muskingum complex. Limestone variants therefore somewhat more productive for forest or pasture.	VIIs-1	50	9	61
L339-425$\overline{\text{F}}$ or LZ$\overline{\text{F}}$ —	Wellston-Muskingum complex, limestone variants, 18–30% slopes, moderately eroded	Similar to L339-425$\overline{\text{E}}$ or LZ$\overline{\text{E}}$, but occurs on steeper slopes and is less productive.	VIIs-1	50	9	61
L339-425$\underline{\text{F}}$ or LZ$\underline{\text{F}}$ —	Wellston-Muskingum complex, limestone variants, 18–30% slopes, severely eroded	Surface soil is heavy silt loam to light silty clay loam because erosion removed most of silty A horizon, exposing subsoil B horizon. Depth of bedrock less than on other units. Because of thinner rooting zone, plants more subject to drouthiness.	VIIs-1	50	9	61

Wellston silt loam (339), representative profile



A_1 (0-3″) Dark gray (10YR 4/1) friable silt loam with crumb structure. pH 5.2.

A_2 (3-10″) Pale brown (10YR 6/3) to yellowish-brown (10YR 5/4) friable silt loam with crumb to platy structure. pH 5.1.

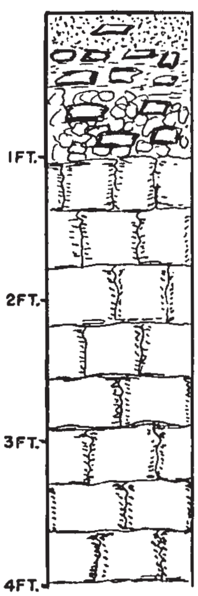
B_1 (10-14″) Strong brown (7.5YR 5/8) firm, coarse silty clay loam with subangular blocky structure. pH 5.0.

B_2 (14-20″) Strong brown (7.5YR 5/8) firm silty clay loam with subangular blocky structure. pH 4.9.

B_3 (20-30″) Dark brown (7.5YR 4/4) firm to friable clay loam to sandy loam with weak structure. Sandstone residuum. pH 4.9.

R (30″+) Sandstone bedrock.

Muskingum stony silt loam (425), representative profile



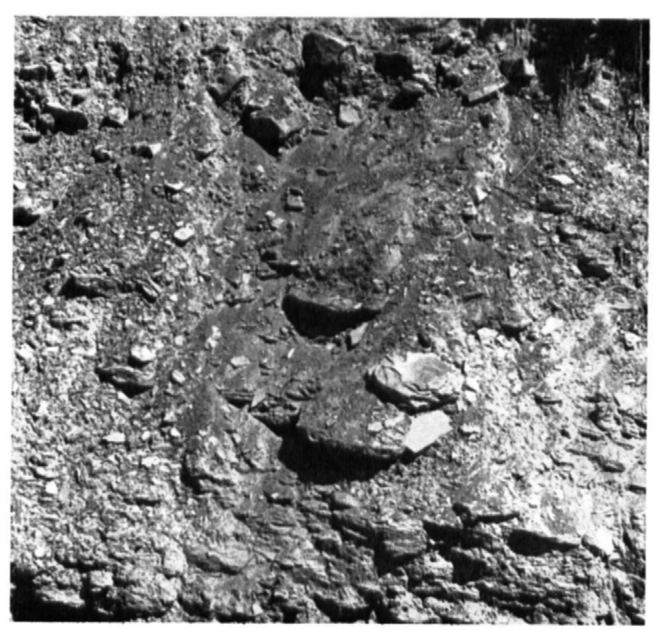
A_1 (0-3″) Grayish-brown (10YR 5/2) friable silt loam to loam with many sandstone boulders and broken fragments. pH 4.5.

A_2 (3-5″) Pale brown (10YR 6/3) to light yellowish-brown (10YR 6/4) friable silt loam to loam with many sandstone fragments. pH 4.5.

B_2 (5-7″) Brown (10YR 5/3) friable loam with weak, coarse granular to very fine subangular blocky structure. pH 4.6.

B_3 (7-12″) Pale brown (10YR 6/3) massive, firm stony loam with many rock fragments grading downward into sandstone that has some root penetration along fractures and joints. pH 4.6.

R (12″+) Sandstone bedrock.



Profile of Muskingum stony silt loam.
(Fig. 15)

Wellston-Muskingum complex, limestone variants (L339-425)

The Wellston-Muskingum complex, limestone variants includes light-colored soils similar to those described under the Wellston-Muskingum complex. The underlying bedrock and the rock fragments in these profiles, however, are limestone rather than sandstone.

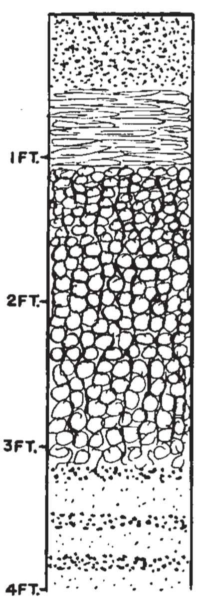
Erosion control, stoniness, and drouthiness are the major problems on these soils. A few areas are in permanent pasture, but most are best adapted to timber production. The limestone variants complex is of minor extent in Johnson county, occupying 115 acres. Three mapping units are shown on the soil map and are listed and described in Table 12, page 31.

Wheeling silt loam (463)

Wheeling silt loam is a light-colored, well-drained forest soil type occurring on the terraces along the present lower Cache river floodplain in association with Ginat, Weinbach, and Sciotoville soils. Wheeling is better drained than its associates and is also underlain by sandy material at shallower depths.

Wheeling is acid, low in available phosphorus, and about medium in available potassium. It responds well to proper soil treatment and good management and is used for grain, hay, pasture, and some timber production. Sloping cultivated areas are usually eroded to some extent. Because of the short slopes, practices such as contouring and terracing are not very practical. Erosion is best controlled by using sod crops in rather long rotations or permanent pasture or woodland on the steeper slopes.

Wheeling silt loam, 1.5- to 4-percent slopes (463B), representative profile



A_p (0-6″) Dark grayish-brown (10YR 4/2) to brown (10YR 4/3) friable silt loam with weak crumb structure. pH 5.2.

A_2 (6-14″) Dark brown (10YR 3/3) friable silt loam with weak, fine granular to weak, fine platy structure. pH 4.6.

B_1 (14-18″) Strong brown (7.5YR 4/5) firm, light silty clay loam with moderate, fine subangular blocky structure. pH 4.5.

B_2 (18-30″) Dark brown (7.5YR 4/4) firm silty clay loam to clay loam with mica flakes present and with moderate, medium subangular blocky structure. pH 4.5.

B_3 (30-38″) Dark brown (7.5YR 3/4) to strong brown (7.5YR 5/6) firm, heavy loam to clay loam with weak, medium subangular blocky structure. pH 4.5.

C (38″+) Dark brown (10YR 4/3), mottled with dark reddish-brown (5YR 3/4), sandy loam to loamy sand with iron banding prominent. Single grain. pH 5.0 in upper part becoming calcareous at about 7 feet.

Table 13. — WHEELING SILT LOAM: Decription of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
463B — Wheeling silt loam, 1.5–4% slopes	Representative profile.	IIe-2	43	6	59
463C̄ — Wheeling silt loam, 4–7% slopes, moderately eroded	Somewhat thinner solum than 463B.	IIe-2	43	6	59
463D̲ — Wheeling silt loam, 7–12% slopes, severely eroded	Surface texture varies from heavy silt loam to light silty clay loam. More drouthy than 463B and 463C̄ because of thinner solum.	IVe-1	48	6	59
463Ē — Wheeling silt loam, 12–18% slopes, moderately eroded	Usually used for pasture or woodland.	IVe-1	48	6	59

Four mapping units of Wheeling are shown on the soil map and are listed in Table 13, page 33. They occupy a total of 230 acres in the county.

Some chemical and physical properties of Wheeling silt loam from a profile sampled in Massac county are given in Table 17.

Zanesville silt loam (340)

Zanesville silt loam is a well-drained to moderately well-drained, light-colored soil type developed under forest from about 20 to 40 or 50 inches of loess over sandstone residuum or sandstone bedrock. It occurs on 10- to 30-percent slopes throughout Johnson county in association with Grantsburg (301) and Hosmer (214). It is also commonly associated with the Wellston-Muskingum complex (339-425) and with Rocky sandstone land (9).

Zanesville is used primarily for pasture or hay production, with some areas in forest. Few areas in Johnson county are adapted to cultivated crops.

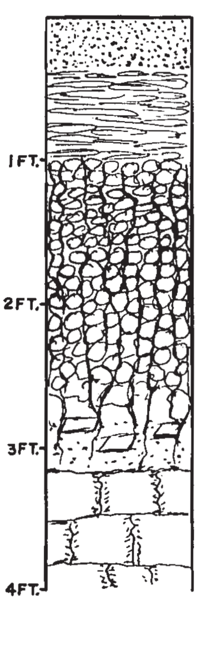
Zanesville is strongly acid, low in available phosphorus, and medium to high in available potassium. Pastures respond well to soil treatment and to good management in general. Erosion is a serious problem but can be controlled reasonably well by growing vigorous pastures and preventing overgrazing (Fig. 16).

There is some fragipan development in the lower part of the profile in Zanesville, but it is not as strongly expressed nor as thick as the fragipans in Hosmer and Grantsburg.

Seven mapping units of Zanesville, occupying 26,432 acres or almost 12 percent of the county, are shown on the soil map. They are listed and described in Table 14.

Rolling area of Zanesville in pasture. (Fig. 16)

Zanesville silt loam, 7- to 12-percent slopes (340D or YD), representative profile



A_1 (0-4″)	Brown to dark brown (10YR 4/3) friable silt loam with weak crumb structure. pH 6.0.
A_2 (4-12″)	Yellowish-brown (10YR 5/4) friable silt loam with weak platy structure. pH 5.0.
B_1 (12-18″)	Brown (7.5YR 4/4 to 5/4) firm, fine silt loam with granular to subangular blocky structure. pH 4.9.
B_2 (18-26″)	Brown to dark brown (7.5YR 4/4) firm silty clay loam with subangular blocky structure. Some dark brown (7.5YR 4/3) clay coatings present. pH 4.8.
B_{31} (26-34″)	Brown (7.5YR 5/4), with few gray (10YR 6/1) mottles, firm to very firm fine silt loam with subangular blocky structure and some fragipan development. pH 4.9.
B_{32} (34-40″)	Brown (7.5YR 5/4), mottled with some gray (10YR 6/1), firm to friable sandy clay loam to loam residuum. Some fragipan development is often evident in the sandy residuum.
R (40″+)	Sandstone bedrock.

Table 14. — ZANESVILLE SILT LOAM: Description of Mapping Units

Mapping unit	Other descriptive comments	Management group		Woodland group	
		Symbol	Page	No.	Page
340D or **YD** — Zanesville silt loam, 7–12% slopes	Representative profile.	IIIe-1	45	7	60
340$\overline{\text{D}}$ or **Y$\overline{\text{D}}$** — Zanesville silt loam, 7–12% slopes, moderately eroded	....	IIIe-1	45	7	60
340$\underline{\text{D}}$ or **Y$\underline{\text{D}}$** — Zanesville silt loam, 7–12% slopes, severely eroded	Surface or plow layer is heavy silt loam.	VIe-1	49	7	60
340$\overline{\text{E}}$ or **Y$\overline{\text{E}}$** — Zanesville silt loam, 12–18% slopes, moderately eroded	....	VIe-1	49	7	60
340$\underline{\text{E}}$ or **Y$\underline{\text{E}}$** — Zanesville silt loam, 12–18% slopes, severely eroded	Because of erosion, depth to bedrock somewhat shallower than on less sloping and less eroded units. Surface is fine silt loam.	VIe-1	49	7	60
340$\overline{\text{F}}$ or **Y$\overline{\text{F}}$** — Zanesville silt loam, 18–30% slopes, moderately eroded	Soil similar to 340$\overline{\text{E}}$ or Y$\overline{\text{E}}$, but solum is somewhat thinner.	VIe-1	49	7	60
340$\underline{\text{F}}$ or **Y$\underline{\text{F}}$** — Zanesville silt loam, 18–30% slopes, severely eroded	Thin solum and shallow depth to bedrock because of erosion and steep slopes. Therefore is somewhat drouthy and used mostly for woodland and some pasture.	VIIe-1	50	7	60

GENESIS AND CLASSIFICATION OF JOHNSON COUNTY SOILS

Factors of Soil Formation in Various General Soil Areas

Soils are developed primarily by the action of climate and living plants and animals upon parent materials. Relief or topography indirectly affects soil formation by influencing drainage conditions. The time during which parent materials have been subjected to these forces partly determines the degree to which the present soils have weathered and developed.

How these five major factors of soil development — parent material, climate, biological activity or living organisms, relief, and time — have influenced the soils of Johnson county and their distribution is discussed in the following paragraphs. (See also general soil areas of Johnson county, pages 9-12, and soil key, Table 15, page 37.)

Parent materials. Parent materials of soils result mainly from the weathering of rock. Glaciers, wind, and water may move these materials from place to place. Johnson county soils developed mainly from loess, deposited by wind, or from alluvium, deposited by water. Of lesser importance is residuum or parent material formed in place by the weathering of sandstone and limestone on the steep slopes.

The loess, when first deposited in Johnson county, was calcareous or relatively high in limestone and also contained various minerals. Soils that developed from it were probably high in plant nutrients at first. But, as will be discussed later, the action of climate and living organisms over long periods of time has leached plant nutrients in varying degrees from the parent materials. The result has been soils which, in general, require large applications of lime and fertilizer for good crop growth.

As was mentioned earlier (page 6), total loess thickness on nearly level, uneroded, upland areas varies from about 200 inches in the southwestern part of the county to about 70 inches in the northeastern part. The thickness of the loess deposits has an important bearing on the degree of leaching and profile development that has taken place in the soils. Upland soils in general soil area X, developed from less than 70 to 80 inches of loess, are more highly leached of plant nutrients and more strongly developed than those in soil area Q (developed from more than about 80 inches).

In the thinner loess area, where annual deposits were small, considerable leaching probably occurred during each year of loess deposition. Many of the readily soluble minerals were removed as fast as they were deposited. In the soils formed from thicker deposits, annual leaching may not have kept up with the deposition of lime carbonates and other minerals. This means simply that in the same period of time soils formed from thick loess deposits will not be developed as much as soils from thinner loess.

When deposited, the loess was predominantly of silt size and this is reflected in the silt loam texture of the A horizon. Weathering and the downward movement of fine materials in soils have increased the clay content of the B horizon in comparison with the parent loess.

Most areas of alluvial soils in Johnson county (soil area Z) are derived from sediment washed from weathered, upland soils. They are therefore acid and rather low in plant nutrients. The main soils of this character are Sharon, Belknap, Bonnie, and Burnside silt loams.

The Karnak, Darwin, Piopolis, and Dupo soils (soil area Y), which are the main alluvial soils along the lower Cache river in the southwestern part of the county, are strongly influenced by sediments from the Ohio river when it flowed through this lowland area. These soils, except Piopolis and Karnak, are less acid and not as strongly leached as Sharon, Belknap, Bonnie, and Burnside.

The parent materials of area N are of Wisconsinan age. The material is mainly silt loam to sandy loam, originally calcareous, covered by some thin loess. Deposition of most of these sediments, like those of area Y, took place during glacial times when the Ohio river flowed through this lowland area and carried melt waters and sediments of the Wisconsinan glacial stage.

Sandstone bedrock is an important parent material on the steep, rocky slopes in soil areas Q and X. These slopes received loess deposits, but are so steep that practically all the loess has been removed by erosion. On many of the slopes part of the weathered sandstone has also been washed away, leaving thin soils and many rock outcrops. Although the soils on these sloping areas are predominantly sandy, they contain some silt washed down from loess deposits higher up on the slopes.

Most sandstone of this area (*1*) is 95 percent or more SiO_2 (silica), 1 to 2 percent Al_2O_3, and less than 1 percent Fe_2O_3 by weight. MgO and CaO content is less than 0.1 percent and K_2O is less than 0.4 percent. The sandstone of this area, therefore, does not form particularly good parent materials for soils.

Limestone is the parent material on some steep slopes in Johnson county. Soils developed from limestone generally are more productive than those formed from sandstone.

Climate and vegetation. Climate is important in soil development because it influences the type of vegetation growing on soils and also largely determines the type of weathering that takes place. The humid, temperate climate of Johnson county is conducive to the growth of trees and, at the time of settlement, the entire county was covered with forest.

These two factors, the humid, temperate climate and the forest vegetation, account for the predominant type of weathering in the county. In such a climate the decay of forest litter forms carbonic and other acids that increase the rate of leaching by downward-percolating water. Eventually the soils become highly acid and leached of most of the bases.

Clay and some iron and aluminum are removed from the A horizon and carried down into the B horizon, resulting in a well-developed soil. This translocation of materials is particularly pronounced on the more level-lying areas, and with time, the result is a very fine-textured B horizon or "claypan."

While the poorly drained soils of Johnson county are either "claypan" soils or are developing in this direction, some other soils are developing fragipans or siltpans in the lower part of their profiles. These are moderately well-drained soils, formed under forest vegetation, that are undergoing a somewhat secondary stage of weathering. The Grantsburg and Hosmer soils have fragipans of varying degrees of development. Some recent work on fragipan soils in Illinois (*6*) gives general characteristics, field relationships, mineralogy, and micromorphology of the Hosmer.

The genesis of the fragipan in these soils is believed to be related to the stage of weathering, perhaps the texture of the parent material, and the depth to a temporary or perched water table. The fragipans of southern Illinois restrict root growth. They are very slowly permeable to water and when dry are hard and brittle, appearing to be cemented. Upon wetting, however, the fragipans lose this hard, brittle consistency and if thoroughly wet slake down to a nonsticky or only slightly sticky mass. Whether the hardness and brittleness are due to cementation by some chemical agent or merely dehydration of small amounts of clay between closely packed silt particles is not definitely known. The fragipans have very coarse prismatic structural blocks bounded by gray silty and clayey streaks or channels 1 to 2 inches wide. On a horizontal plane cut through the fragipan the large blocks bounded by the gray streaks form a polygonal pattern (Fig. 17).

Relief. Under given climatic conditions and in uniform parent materials, relief largely controls the amount of moisture in the soil. It influences the amount of runoff, infiltration, drainage water, and the degree of erosion. The direction of slopes is of some importance. Because south-facing slopes receive direct rays from the sun, they have more evaporation and are generally drier than north-facing slopes.

In Johnson county the flat areas have received runoff from higher slopes. This, coupled with the normal

Gray streaks along the faces of large polygonal structure blocks in a fragipan. (Fig. 17)

rainfall, has brought about a rather high degree of soil development, causing much of the clay originally in the A horizons to move into the B horizons and form the "claypans" already mentioned. Flat areas and claypan soils, however, are very minor in the county. On the more sloping areas, part of the rainfall runs off, and with less water passing through the profile, soil development has not proceeded quite as far. Soil horizons are not so strongly differentiated and chemical weathering has not been as severe. On quite steep slopes, where runoff is very rapid, geologic erosion or the removal of soil under natural conditions may almost keep pace with soil development. Soils on these slopes usually are thin and weakly developed.

Time. Time as a factor in soil formation cannot be measured strictly in years. The length of time necessary for a certain soil to develop depends upon the other factors involved. An acid soil, for example, will develop much faster from parent materials low in lime than from materials very high in lime. Fine-textured parent materials which impede downward movement of water are leached free of lime much more slowly than are coarse-textured materials, other things being equal.

In general, soil development is faster in humid climates that support good vegetative growth than in dry climates supporting little vegetation. On slopes where geologic erosion is great, soils may be in the early stages of development even though the slopes have been exposed to weathering for thousands of years.

Grouping of soils according to soil-forming factors. Various combinations of the five soil-forming factors just discussed have been operative in the different areas of the county. In Table 15 Johnson county soils are grouped according to parent materials and physiography, degree of development or degree of weathering, and natural soil drainage class. The general climate over the entire county is essentially the same, and all of the soils have developed under the influence of forest vegetation.

The six broad soil areas shown in Table 15 are described on pages 9 to 12.

Table 15. — JOHNSON COUNTY SOILS:[a] Grouped According to Parent Materials, Degree of Development, and Natural Soil Drainage

General soil area and physiography	Parent material	Degree of development	Natural soil drainage class: Poor to very poor	Imperfect	Moderately well	Well
N (Terrace)	Silty sediments	Moderate........	Ginat (460)	Weinbach (461)	Sciotoville (462)	Wheeling (463)
	Sandy sediments	Moderate.......	....	....	....	Unity (175)
Q (Upland)	Loess (80–200″) on sandstone	Moderately strong	....	Stoy (164)	Hosmer (214)	....
	Loess (40–20″) on sandstone	Moderate........	....	....	Zanesville (340)	Zanesville (340)
	Loess (20–10″) on sandstone	Moderate to weak	....	....	....	Wellston-Muskingum complex (339-425)
	Sandstone	Weak...........	....	....	....	Rocky sandstone land (9)
U (Upland)	Loess (80–200″) on limestone	Moderately strong	....	....	Hosmer (214)	....
		Moderate........	....	....	....	Wartrace (215)
	Loess (20–10″) on limestone	Moderate to weak	....	....	....	Wellston-Muskingum complex, limestone variants (L339–425)
	Limestone	Weak...........	....	....	....	Rocky limestone land (94)
X (Upland)	Loess (40–80″) on sandstone	Strong..........	....	Robbs (335)	Grantsburg (301)	....
	Loess (40–20″) on sandstone	Moderate........	....	....	Zanesville (340)	Zanesville (340)
	Loess (20–10″) on sandstone	Moderate to weak	....	....	....	Wellston-Muskingum complex (339-425)
	Sandstone	Weak...........	....	....	....	Rocky sandstone land (9)
Y (Bottomland)	Acid, light-colored silty clay loam	Weak...........	Piopolis (420)	....	....	....
	Acid, light-colored silty clay	Weak...........	Karnak (426)	....	....	....
	Slightly acid, moderately dark clay	Weak...........	Darwin (71)	....	....	....
	Slightly acid, light-colored silt loam on moderately dark silty clay loam to silty clay	Weak...........	Dupo (180)	Dupo (180)	....	....
Z (Bottomland)	Acid, light-colored silt loam	Weak...........	Bonnie (108)	Belknap (382)	Sharon (72)	Sharon (72)
	Acid, light-colored silt loam with sandstone rubble or bedrock at 12–36 inches	Weak...........	....	Burnside (427)	Burnside (427)	....

[a] All of the soils of Johnson county have developed under the influence of forest vegetation and similar climate.

Taxonomic Classification of Johnson County Soils

In Table 16 the soils of Johnson county are classified into six categories: series, family, subgroup, great group, suborder, and order. Category I, the soil type, is not included in Table 16. The soil types of Johnson county are described on pages 13 to 35.

Classification is based on profile characteristics and genesis without reference to geographic occurrence (*11*). Soils from several different soil areas may be classified the same in the higher categories (groups above soil type and soil series).

At the present time the soil classification system is being re-examined (*20*), and the system presented here is designed to fit into the new over-all scheme in so far as our present knowledge will permit. Soil type and the six categories in Table 16 are explained below. It will be noted that while soil characteristics or soil properties are the chief basis of classification, the soil characteristics having genetic significance tend to be emphasized more and more from Category V to Category VII inclusive.

Soil type (Category I). This unit of classification has the least variation of the categories discussed. It is based on a consideration of more detailed characteristics or soil properties than the other categories.

Series (Category II). The soil series differs from the soil type only in that texture of the surface soil is not considered. In other words, a soil series is divided into soil types on the basis of surface soil texture. A soil series is a group of soils that have developed from a particular kind of parent material and that have genetic horizons similar in differentiating characteristics and arrangement in the profile. These differentiating characteristics include such morphological features as kind, thickness, and arrangement of horizons, as well as their color, structure, reaction, consistence, mineralogical and chemical composition, and texture below the A horizon.

Any criteria for differentiating classes in any category above the series are also criteria for separating series.

The soil series is the lowest category in the taxonomic key, Table 16.

Family (Category III). Soil series are grouped into families which are nearly uniform in properties that affect plant growth. Families approach uniformity in properties which influence the capacity of the soil to supply air, water, and major nutrients (except nitrogen) to plants roots. Many of the properties used for groupings in Category III are the same as those used in Category II, but they have a wider range in Category III. The main properties considered in Category III are texture, permeability, consistence, bulk density, reaction and chemical composition of the soil below 6 inches; and soil depth class or thickness of the plant rooting zone.

Subgroup (Category IV). Families are combined into subgroups on the basis of kind and sequence of all horizons considered significant genetically.

Many of the subgroups represent the central concept of the great groups. Other subgroups are somewhat intermediate between the central concept of various great groups, suborders, or orders, and therefore are called intergrades between the groups of Category V or intergrades to other suborders or orders.

Great group (Category V). Great groups approach uniformity in the kind and arrangement of all significant horizons and their degree of development. The presence or absence of diagnostic horizons is important in the placing of soils in the great groups.

Although of less importance than in Category VI, genetic differences in the horizons themselves are considered in the great groups. Differences such as the presence or absence of fragipans and major differences in kinds of horizon boundaries are also considered. Where differences in horizons cannot be used, other diagnostic features such as wide differences in base saturation are used.

Suborder (Category VI). Suborders are uniform in characteristics which are most important genetically. Soils within a suborder have similarities in genesis and morphology of the main horizons; that is, they are similar in chemical and physical properties that reflect either the presence or absence of waterlogging, or the genetic processes due to climate and vegetation. This means they are similar in mineralogy and chemistry, degree of gleying and soil moisture regimes, texture, and presence or absence of prominent accumulations of soluble material.

Order (Category VII). The orders are based on several critical horizons whose presence provides a key to the main soil-forming processes that have been active or whose absence indicates a lack of development. Thus soils that are similar in the kinds and relative degree of processes tending to develop horizons are grouped in the orders. Because of the importance of climate to soil formation, the orders are to some extent climatic zonal groups, and tend to have definite geographic ranges.

Table 16. — TAXONOMIC KEY OF JOHNSON COUNTY SOILS[a]

Series (II)	Family (III)	Subgroup (IV)	Great group (V)	Suborder (VI)	Order (VII)
Bonnie	Light silty soils, slow permeability. pH <5.8.	Soils which have, below any A_1 or A_p and to a depth of 30", chromas of less than 1 (moist) or hues bluer than 5Y if unmottled. If mottled, they have chromas of 2 or less (moist) in 80% of the mass.	Soils having textures finer than loamy very fine sand within some part or all of upper 20", mean annual temperatures greater than 47°F., and evidence of wetness as shown by the characteristics listed in Category VI.	Soils which, if undrained, are saturated with water at some season, and have within upper 20" wetness characteristics of hues between 10YR and 10Y, chromas of 3 or less (moist) if distinctly mottled, and 1 or less (moist) if unmottled.	Mineral soils with weak or no horizon development. Youthful soils which may have a weak A_1 or an A_p horizon but no B horizon.
Piopolis	Heavy silty soils, slow permeability. pH <5.8.				
Karnak	Fine-textured soils, very slow permeability, nearly neutral to acid.				
Sharon	Light silty soils, moderate permeability. pH <5.8.	Soils having color values greater than 3.5 (moist) within upper 20". The underlying C material has chromas of 3 to 4 or more (moist), with no mottles of chroma less than 2 (moist).	Soils with as fine or finer textures than loamy very fine sand and mean annual temperatures greater than 47°F. Lack evidence of wetness with chromas usually of 3 or 4 in the upper 20".	Soils usually moist in some horizon or layer within the soil but lacking characteristics of wetness. If mottles are present within 20", the dominant chromas are more than 2 (moist) in hues as red or redder than 10YR.	
Belknap	Light silty soils, moderately slow permeability. pH <5.8.	Similar to the subgroup for Sharon but having within 20" mottles with chromas of 2 or less (moist) and also having either seasonal ground water within 20" or artificial drainage.			
Burnside	Light silty soils, moderate to moderately slow permeability, pH <5.8. Sandstone within 36 to 40".				
Dupo	Heavy silty soils (15–40" thick) over fine-textured material, nearly neutral. pH > 5.8.	Light-colored, silty material similar to the subgroup for Belknap but with buried soil which is greater than 8" thick and has values less than 3.5 (moist).			
Muskingum	Light silty to fragmental soils, acid, shallow to sandstone, siltstone, or shale.	Soils which have base saturation of less than 30% in structure B and that have no mottles with chromas of 2 or less (moist) within the upper 30".	Soils with a B texture finer than loamy fine sand in at least some part and with base saturation usually much less than 80% in B horizon.	Soils with thin A_1 or A_p resting on a structure B horizon. Usually moist except for short periods, and occur in humid to subhumid regions from the Arctic to the Tropics.	Mineral soils with weakly developed or no textural B horizon but with structure B horizon. Not much evidence of alteration other than structure B.
Darwin	Fine-textured soils, very slowly permeable, nearly neutral.	Soils with dark-colored surface layers between 6 and 24" thick and with a gradual boundary between the surface and underlying layers.	Same as in Category VI; without textural B horizon, but may have structure B.	Soils saturated with water at some season unless artificially drained, without an eluvial horizon, and with chromas of 3 (moist) or less if highly mottled, or 1 or less if not mottled.	Dark-colored mineral soils with or without B horizons. Surface color has values less than 3.5 (moist) and base saturation is more than 50%.
Ginat	Heavy silty soils, acid, slow to very slow permeability.	Soils which, if plowed, have an A_p color value of 4 or more (moist). If uncultivated, the A_1 is less than 6" thick and has a color value of less than 3.5 when moist.	Same as in Category VI; without an abrupt textural change from A to B, and no tonguing of A into B, and without fragipan.	Soils saturated with water at some season unless artificially drained, with wetness characteristics of mottles, iron-manganese concretions, or chromas of 2 or less (moist) immediately below A_1 or A_p, and with chromas of 1 to 3 (moist) in the B horizon accompanied by mottles of stronger chroma.	Mineral soils lacking dark-colored surface horizons but having textural B with base saturation above 35%.
Stoy **Robbs**	Heavy silty soils, acid, slow to very slow permeability.	Intergrades between soils having characteristics listed in Category V and having an abrupt textural change from A to B; without fragipan.	Same as in Category VI; without an abrupt textural change from A to B, and no tonguing of A into B, and with fragipan.		
Unity	Sandy soils with textural B horizon within 40", moderate to moderately rapid permeability.	Same as in Category V.	Soils having no mottles with chromas of 2 or less (moist) in upper 10". No abrupt textural change if mottles are present in upper 10" of textural B. Chroma of B is less than 6 (moist) if hue is 7.5YR or redder, or if base saturation is less than 50%. A_p has moist value of more than 3, or the A_1 is less than 6" thick if moist value is lower than 3.5. There is no tonguing of A into B; the B is continuous and finer textured than loamy sand. The textural B is less than 10% sodium saturated, and there is no fragipan.	Soils usually or always moist in some part of the solum but lacking characteristics associated with wetness, and having mean annual temperatures greater than 47°F.	
Wartrace **Sciotoville** **Wheeling**	Heavy silty soils, sola thicker than 42", moderate permeability.				
Wellston	Heavy silty soils, hard bedrock within 30", moderate permeability above bedrock.				
Weinbach	Heavy silty soils, sola thicker than 42", moderately slow permeability.	Similar to soils above except that mottles with chromas of 2 (moist) or less are present in the upper 10" of B horizon.			
Hosmer **Grantsburg**	Heavy silty soils, sola thicker than 42", very slow permeability.	Soils with fragipans. No tonguing of upper A_2 into upper B, but lower A_2 or A'_2 may tongue downward into lower B or B'_2.	Similar to above except fragipans are present in lower part of solum.		
Zanesville	Heavy silty soils, bedrock within 42", moderately slow permeability above bedrock.				

[a] The land types, Rocky sandstone land (9) and Rocky limestone land (94), are not classified.

Some Chemical and Physical Characteristics of Soils Representing Three Subgroups

Selected chemical and physical properties of soils representing three subgroups (Category IV, Table 16) are given in Table 17 and in Figures 18, 19, and 20.

In Darwin, the percentage of clay (less than 2 microns) changes very little to a depth of 50 inches (Fig. 18). Besides lacking a textural B horizon, Darwin has a high cation-exchange capacity and high percent base saturation.

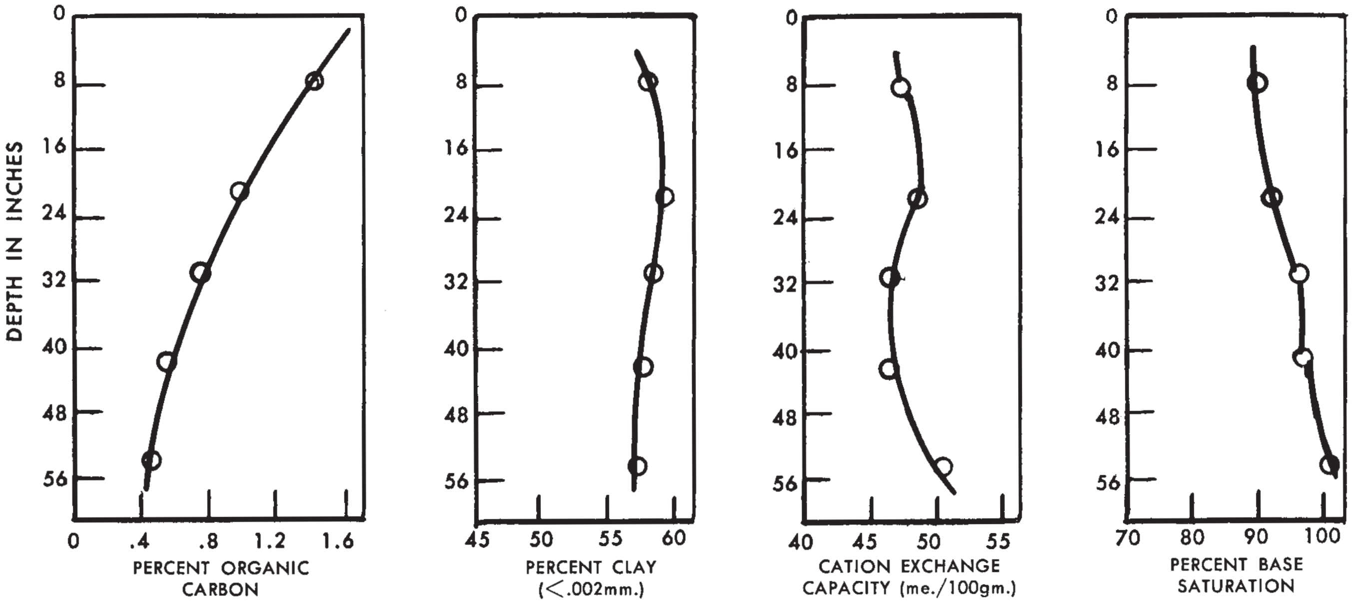
Sciotoville (Fig. 19) and Wheeling are included in the light-colored, moderately well-drained and well-drained soils without fragipans developed under forest vegetation. These two soils occur on the terrace or benchlands along the lower Cache river and contain more sand (see Table 17) throughout their profiles than the loess-derived upland soils.

Hosmer (Fig. 20) is a light-colored, moderately well-drained soil developed from loess on the upland under forest vegetation. It has a fragipan in the lower part of its profile (below 36 inches), but this is not evident in the data in Table 17. The fragipan is very slowly permeable to water and restricts root penetration to a few structure faces. Grantsburg (Table 17) has a more strongly developed fragipan than Hosmer.

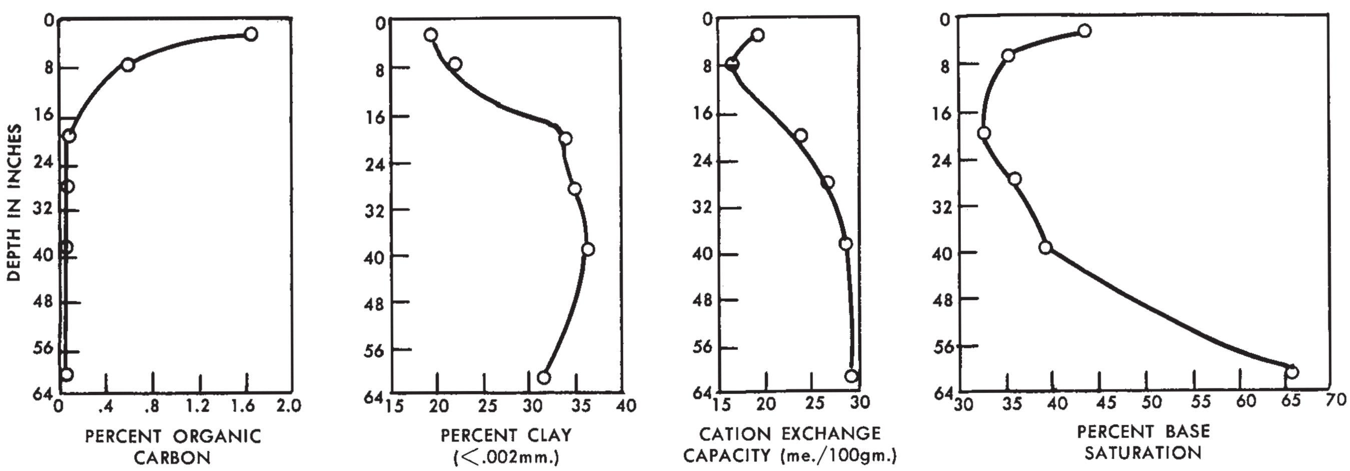
Table 17. — CHEMICAL ANALYSES AND PARTICLE SIZE DISTRIBUTION OF FIVE SOILS

Horizon	Depth, in.	pH	Pct. organic carbon[b]	Exchangeable cations,[a] me./100 gm.			Cation exchange capacity, me./100 gm.	Pct. base saturation	Pct. of particle size		
				Ca	Mg	K			Sand 2-.05 mm.	Silt .05-.002 mm.	Clay <.002 mm.
				DARWIN CLAY[c]							
A_1	0–15	6.5	1.30	29.5	10.1	.6	47.0	88	.8	42.1	57.1
BC	15–25	7.0	.92	30.2	11.6	.4	48.0	90	.6	41.4	58.0
BC	25–32	7.4	.67	30.0	12.2	.4	46.5	94	.6	42.1	57.3
BC	32–44	7.5	.52	29.7	12.5	.4	46.1	95	.6	42.6	56.8
C	44–55	7.8	.41	34.3	12.4	.4	49.6	98	.5	43.3	56.2
				GRANTSBURG SILT LOAM[d]							
A_2	1–6.5[e]	4.2	.72	.5	.3	.3	10.2	14	2.4	84.6	13.0
B_1	12–17	4.7	.24	1.2	3.0	.3	16.7	28	2.5	71.1	26.4
B_2	20–24	4.6	.14	1.0	3.2	.3	16.4	28	3.7	75.1	21.2
A'_1	24–27	4.6	.17	2.6	6.6	.4	23.7	41	1.7	66.2	31.3
B'_2	27–33	4.5	.10	3.5	7.8	.3	23.1	47	2.1	65.8	32.1
B'_3	38–45	4.6	.05	4.1	7.4	.3	21.5	57	1.7	68.3	25.0
C	52–61	5.2	.03	4.2	5.5	.2	15.2	70	3.4	78.6	18.0
				HOSMER SILT LOAM[f]							
A_p	0–8	6.5	.71	6.8	1.6	.1	13.2	66	4.5	80.7	14.8
A_2	8–15	5.0	.31	...	...	..	....	..	2.0	79.9	18.1
B_2	15–25	4.7	.05	2.6	1.7	.2	14.9	32	1.8	75.8	22.4
A'_2	25–28	4.6	.04	...	...	..	....	..	1.4	68.2	30.4
B'_2	28–36	4.6	.04	3.7	4.5	.3	24.0	38	1.3	67.0	31.4
B'_3	36–48	4.6	.01	...	...	..	....	..	1.0	72.5	26.5
C	48–56	4.7	.01	5.8	5.3	.3	20.3	59	1.0	76.0	23.0
				SCIOTOVILLE SILT LOAM[g]							
A_1	0–5[e]	5.4	1.63	5.1	2.5	.5	18.2	44	13.4	67.0	19.6
A_2	5–9.5	5.0	.62	3.0	2.0	.5	15.4	36	11.8	66.6	21.6
B_{21}	16–23	4.6	.17	2.6	4.3	.7	23.4	32	24.9	40.6	34.5
B_{22}	23–34	4.6	.10	3.4	5.4	.7	26.2	37	9.9	55.3	34.8
B_{23}	34–45	4.6	.11	3.8	6.6	.6	28.3	40	21.8	41.9	36.3
C	51–72	4.6	.12	7.7	6.8	.5	28.8	66	10.8	57.8	31.4
				WHEELING SILT LOAM[h]							
A_2	7–11.5[e]	5.6	.26	4.2	2.8	.2	11.8	61	20.4	59.9	19.7
B_{21}	14.5–20	4.8	.10	3.0	4.6	.4	19.5	41	25.7	42.4	31.9
B_{22}	20–31	4.6	.08	2.0	3.4	.4	17.9	32	35.2	36.8	28.0
C_1	36–45	4.7	.08	1.3	2.7	.3	16.2	27	42.8	33.8	23.4
C_2	45–52	4.7	.08	1.6	3.3	.4	18.9	28	34.3	39.4	26.3

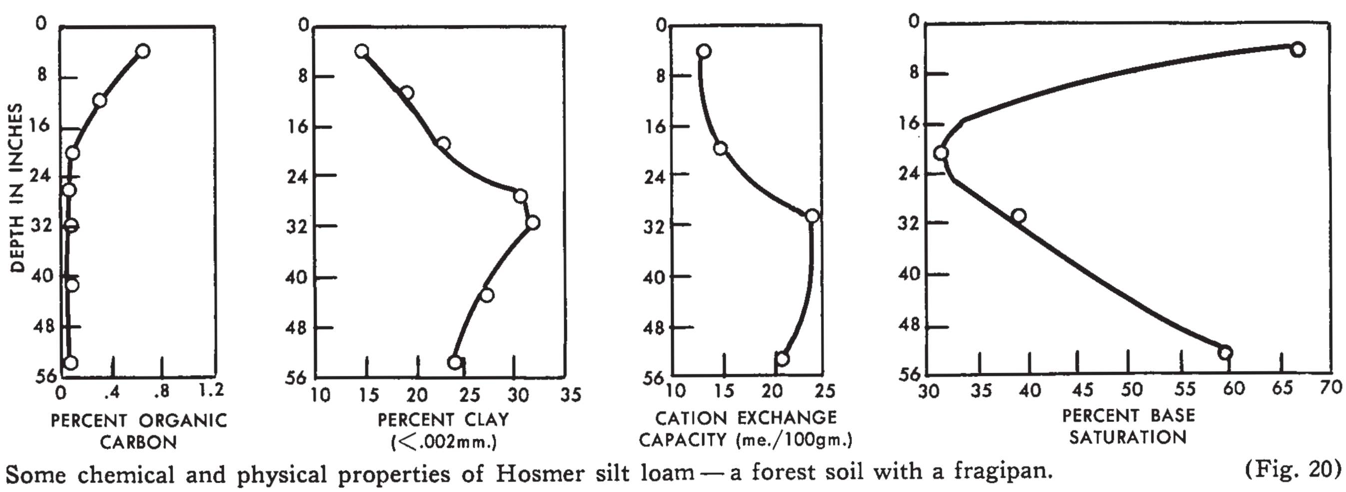
[a] One me. Ca (calcium) per 100 gm. soil = 400 pounds per acre or per 2 million pounds soil. One me. Mg (magnesium) per 100 gm. soil = 240 pounds per acre or per 2 million pounds of soil. One me. K (potassium) per 100 gm. soil = 780 pounds per acre or per 2 million pounds of soil.
[b] Percent organic carbon times 1.724 = percent organic matter.
[c] Profile sampled in Lawrence county. Township 2 north, Range 12 west, Section 8, southwest ¼, northeast 40 acres, northeast 10 acres.
[d] Profile sampled in Pope county. Township 13 south, Range 5 east, Section 4, northwest ¼, northeast 40 acres, northeast 10 acres.
[e] Analyses were not run on all depths sampled.
[f] Profile sampled in Williamson county. Township 9 south, Range 2 east, Section 19, northwest ¼, northeast 40 acres, northwest 10 acres.
[g] Profile sampled in Johnson county. Township 14 south, Range 2 east, Section 9, northeast ¼, northeast 40 acres, northeast 10 acres.
[h] Profile sampled in Massac county. Township 14 south, Range 4 east, Section 22, northwest ¼, southeast 40 acres, northeast 10 acres.



Some chemical and physical properties of Darwin clay — a fine-textured soil without a textural B horizon. (Fig. 18)



Some chemical and physical properties of Sciotoville silt loam — a forest soil without a fragipan. (Fig. 19)



Some chemical and physical properties of Hosmer silt loam — a forest soil with a fragipan. (Fig. 20)

INTERPRETATION OF SOIL CHARACTERISTICS FOR SPECIFIC PURPOSES

Use and Management of Soils for Field Crop Production

A capability classification is a grouping of soils that shows, in a general way, their suitability for most kinds of farming. It is a practical grouping based on limitations of the soils, the risk of damage when used, and the way they respond to treatment.

In this system all the kinds of soil are grouped at three levels: the capability class, subclass, and unit. The eight capability classes in the broadest grouping are designated by Roman numerals I through VIII. In class I are the soils that have the fewest limitations, the widest range of use, and the least risk of damage when used. The soils in the other classes have progressively greater natural limitations. In class VIII are soils and landforms so rough, shallow, or otherwise limited that they do not produce worthwhile yields of crops, forage, or wood products. All classes are found in Johnson county except class VIII.

The subclasses indicate major kinds of limitations within the classes. Within most classes there can be as many as three subclasses. There are no subclasses in class I, however, because the soils of this class have few or no limitations. The subclass is indicated by adding a small letter e, w, or s, to the class numeral (for example IIe). The letter e shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; w means that water in or on the soil will interfere with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); s shows that the soil is limited mainly because it is shallow, drouthy, or stony.

Within the subclasses are the capability units. These are groups of soils enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus the capability unit is a convenient grouping of soils for many statements about their management. These units are generally identified by numbers (for example, IIe-1 or IIIe-2) and are called management groups in the following section.

Soils are classified in capability classes, subclasses, and units according to the degree and kind of their permanent limitations. Consideration is not given to major and generally expensive landforming that would change the slope, depth, or other characteristics of the soil, or to possible but unlikely major reclamation projects.

The seven classes in the capability system and the subclasses occurring in Johnson county are defined and the management groups discussed in the following paragraphs. As mentioned earlier (page 3), specific management information, including recommended crop rotations, is available in the Johnson county soil management guide (*4*).

Class I. — Soils having few or no limitations or hazards that restrict their use

Management group I-1. This management group consists of light-colored, imperfectly drained and moderately well-drained bottomland soils, occupying 0- to 1.5-percent slopes. They are formed by the deposition of silty materials washed from upland soils. When protected from overflow, the following soils are in this management group:

Dupo silt loam, 0- to 1.5-percent slopes (180A)
Sharon silt loam, 0- to 1.5-percent slopes (72A)

Where these soils are unprotected from overflow, they are in management group IIw-1.

The imperfectly drained Dupo soil has 15 to 40 inches of silty wash deposited on a moderately dark-colored silty clay loam or silty clay soil. The Sharon is silty throughout. These soils are moderately permeable to air and water and can be cultivated intensively to the common crops of the area (Fig. 21). Water-supplying capacity is high and natural fertility is low to medium.

Bottomland occupied by Sharon and Dupo silt loams — two intensively cultivated soils. (Fig. 21)

The Sharon soil is medium to strongly acid and low in available phosphorus and available potassium. Dupo is slightly acid to neutral and low to medium in available phosphorus and potassium. Soil tests should be made and lime and fertilizer applied according to recommendations based on the tests. Organic matter and nitrogen content are low to medium. For high crop yields, nitrogen must be applied regularly by plowing down leguminous crops or by adding commercial fertilizers, or both.

Class II. — Soils having some limitations that reduce the choice of plants or require moderate conservation practices

Subclass IIe. — Soils having a moderate hazard of erosion if not protected

Management group IIe-1. This management group consists of only one soil: Sharon silt loam, 1.5- to 4-percent slopes (72B). Sharon is a light-colored, deep, moderately permeable, and moderately well- to well-drained soil. It is a silty soil that has high water-supplying capacity and low to medium natural fertility. If protected against erosion, this soil is suited for intensive cultivation to the common crops of the area.

Erosion on this soil can be controlled by the use of suitable cropping systems and such conservation practices as contouring.

This soil is usually medium to strongly acid and low in available phosphorus and available potassium. Soil tests should be made and fertilizer and lime added according to recommendations based on the tests.

Organic matter and nitrogen are low to medium and should be maintained through the use of grass and legume crops and commercial fertilizers.

Management group IIe-2. This management group consists of light-colored, deep, moderately well- to well-drained soils on upland and terraces or benchlands on 1.5- to 7-percent slopes. Permeability is moderate to moderately slow, water-supplying capacity is high, and natural fertility is medium.

The following soils are in this management group:

Sciotoville silt loam, 1.5- to 4-percent slopes (462B)
Sciotoville silt loam, 4- to 7-percent slopes, moderately eroded (462$\overline{C}$)
Wartrace silt loam, 1.5- to 4-percent slopes (215B)
Wartrace silt loam, 4- to 7-percent slopes (215C)
Wartrace silt loam, 4- to 7-percent slopes, moderately eroded (215$\overline{C}$)
Wheeling silt loam, 1.5- to 4-percent slopes (463B)
Wheeling silt loam, 4- to 7-percent slopes, moderately eroded (463$\overline{C}$)

If protected against erosion, these soils are suitable for intensive cultivation. To control erosion grasses and legumes should be grown at least half the time where no conservation practices are used. When contouring is used grasses and legumes should be grown at least 1 year in 4. When these soils are terraced erosion can be controlled by using grasses and legumes as a standover crop, plowed down for green manure 1 year in 5.

Where these soils have not been treated, they are medium to strongly acid, low in available phosphorus, and medium to high in available potassium. Lime and fertilizer should be applied according to recommendations based on soil tests.

Because organic matter and nitrogen are low, grasses and legumes should be included in the crop rotation and all crop residues should be returned to the soil. Higher yields can often be obtained by also using commercial nitrogen.

Management group IIe-3. This management group consists of light-colored, moderately deep, moderately well-drained, loess-derived, upland soils occurring on 1.5- to 4-percent slopes. The following soils are in this management group:

Grantsburg silt loam, 1.5- to 4-percent slopes (301B or XB)
Grantsburg silt loam, 1.5- to 4-percent slopes, moderately eroded (301$\overline{B}$ or X$\overline{B}$)
Hosmer silt loam, 1.5- to 4-percent slopes (214B or WB)
Hosmer silt loam, 1.5- to 4-percent slopes, moderately eroded (214$\overline{B}$ or W$\overline{B}$)

These soils are very slowly permeable because of a dense, compact layer (fragipan) in the lower part of the subsoil, usually found 25 to 35 inches below the soil surface. Because of this dense layer, root penetration is restricted and water-supplying capacity is only moderate. The dense, compacted layer in Grantsburg is somewhat more fragile than that in Hosmer.

The soils in this group are suitable for the common crops of the area. Natural fertility of these soils is low to medium. Where they have not been treated, they are acid, low in available phosphorus, and low to medium in available potassium. Soil tests should be made and lime and fertilizer added according to recommendations based on the tests.

Organic matter and nitrogen are usually low. Grasses and legumes should be used regularly in the crop rotation to help replenish organic mater and to add some nitrogen. Nitrogen may also be applied in commercial fertilizer.

Erosion is a major problem on these soils. When they are not contoured or terraced, a suitable cropping system should provide for grasses and legumes

1 year in 3 to control soil loss. When the soils are contoured or terraced, grasses and legumes should be included 1 year in 4. All crop residues should be returned to the soil. Grass waterways should be kept well sodded.

Management group IIe-4. This management group consists of light-colored, imperfectly drained, upland and terrace soils occurring on 1.5- to 4-percent slopes.

They have silt loam surfaces and silty clay loam subsoils. The subsoils are slowly permeable to air and water. For roots to penetrate the subsoils, the fertility, naturally low to medium, must be raised to a high level. Water-supplying capacity is high.

The following soils are in this management group:

Robbs silt loam, 1.5- to 4-percent slopes (335B)
Stoy silt loam, 1.5- to 4-percent slopes (164B)
Weinbach silt loam, 1.5- to 4-percent slopes (461B)

These soils are suitable for the common crops adapted to the area. Where no soil treatment has been used, these soils are acid, usually low in available phosphorus, and low to medium in available potassium. Lime and fertilizer should be applied according to soil-test recommendations.

Since organic matter and nitrogen are low, grasses and legumes should be grown at regular intervals. Organic matter will supply some nitrogen and will also help maintain a loose, well-granulated structure essential for good movement of air and water.

Erosion is a major problem on these soils. When the soils are not contoured or terraced, a suitable cropping system should provide for grasses and legumes 2 years in 4 to control soil loss. Where the soils are contoured, grasses and legumes should be included 2 years in 5. With terraces, meadow should be grown 1 year in 4. All grass waterways should be kept well sodded and all crop residues returned to the soil.

Diversion terraces may be required in a few places to protect the Weinbach soil from water that runs off adjacent slopes. During rainy seasons some of the flatter areas of these soils are occasionally wet for longer periods than desirable. If they are tilled when too wet the surface soil is apt to be puddled and compacted.

Subclass IIw. — Soils having moderate limitations because of excess water

Management group IIw-1. This management group consists of light-colored, deep, imperfectly drained bottomland soils occurring on 0- to 4-percent slopes. They are formed from silty deposits eroded from silt loam upland soils. These soils are slowly permeable to air and water and their natural fertility is low. Water-supplying capacity is high.

The following soils are in this management group:

Belknap silt loam, 0- to 1.5-percent slopes (382A)
Belknap silt loam, 1.5- to 4-percent slopes (382B)

The light-colored, imperfectly drained and moderately well-drained, moderately permeable Dupo and Sharon bottomland soils are also in this management group when they are unprotected from overflow.

Dupo silt loam, 0- to 1.5-percent slopes (180A)
Sharon silt loam, 0- to 1.5-percent slopes (72A)

When protected from overflow, however, Sharon and Dupo are in management group I-1.

Because of overflow, drainage, and fertility hazards, the soils in management group IIw-1 are suitable only for moderately intensive cultivation. Where the overflow hazard is serious, small grain and leguminous crops are risky. Diversion ditches help intercept water from nearby hills. Keeping drainage ditches free of brush also helps speed the removal of excess water.

Drainage is a problem because the subsurfaces of these soils will not allow water to pass through as fast as desirable. Also, the watertable is often high. Surface ditches are usually recommended to carry off excess water. Tile will function satisfactorily under good management but usually are not needed if good surface ditches are provided.

A few swampy areas of Belknap silt loam, 0- to 1.5-percent slopes, occur in Johnson county and are shown on the soil map by a swamp symbol immediately preceding the soil type number. These swampy areas are class V land. For a discussion of their use and management see management group Vw-1, page 49.

These soils are usually low in available phosphorus and available potassium. They are medium to strongly acid. Soil tests should be made and lime and fertilizer applied according to recommendations.

When overflow and drainage hazards have been corrected and fertilizer applied, these soils are suitable for the common crops of the area.

Management group IIw-2. This management group consists of light-colored, deep, imperfectly drained to moderately well-drained upland and terrace soils on 0- to 1.5-percent slopes. The surface soils are silty and the subsoils are silty clay loams that are somewhat slowly permeable to air and water. For roots to penetrate the subsoils, the fertility, naturally low to medium, must be raised to a high level. Water-supplying capacity is high.

The following soils are in this management group:

Robbs silt loam, 0- to 1.5-percent slopes (335A)
Sciotoville silt loam, 0- to 1.5-percent slopes (462A)

Stoy silt loam, 0- to 1.5-percent slopes (164A)
Weinbach silt loam, 0- to 1.5-percent slopes (461A)

These soils are suitable for the common crops of the area. Where soil treatment has not been applied, these soils are acid, usually low in available phosphorus, and low to medium in available potassium. Lime and fertilizer should be applied according to soil-test recommendations.

Water normally moves slowly through these soils and they stay wet longer than desirable. An adequate system of surface drainage is needed.

Since organic matter and nitrogen are low to medium, grass and legumes should be grown regularly at least 1 year in 4 as a standover crop (Fig. 22).

Subclass IIs. — Soils having moderate limitations because of low moisture capacity or stones

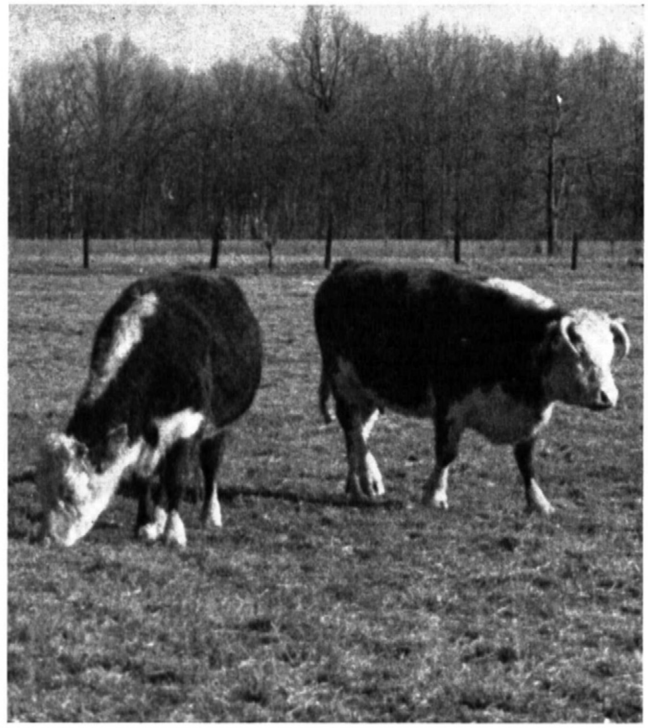
Management group IIs-1. This management group consists of light-colored, shallow to moderately deep, imperfectly drained to moderately well-drained, silty bottomland soils with numerous flagstones or sandstone bedrock at depths of 15 to 40 inches. The silty soil above the bedrock is moderately permeable and moderately high in water-supplying capacity.

These soils commonly occur on 0- to 4-percent slopes in narrow, gorge-like areas along streams of high gradient.

The following soils are in this management group:

Burnside silt loam, 0- to 1.5-percent slopes (427A)
Burnside silt loam, 1.5- to 4-percent slopes (427B)

Where these soils are shallow and occur in narrow, rather inaccessible bottoms, they are best suited to pasture or woodland. However, a few larger areas have 30 to 40 inches of silty soil material over rock and are suited to the common crops of the region.



Improved fescue pasture in January on Sciotoville silt loam. (Fig. 22)

These soils are acid and variable in need for phosphorus and potassium. After soil tests have been made and soil treatments applied accordingly, fresh supplies of organic matter should be added regularly by including grasses and legumes in the cropping system.

Stream-bank cutting may be a problem. Straightening the stream, sloping the sides, and planting adapted grasses and shrubs helps control this cutting.

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

Subclass IIIe. — Soils subject to severe erosion if cultivated and not protected

Management group IIIe-1. This management group consists of light-colored, moderately deep to deep, moderately well-drained to well-drained silty upland and terrace soils occurring on 7- to 12-percent slopes. The following soils are in this management group:

Sciotoville silt loam, 7- to 12-percent slopes, moderately eroded (462D̄)
Wartrace silt loam, 7- to 12-percent slopes, moderately eroded (215D̄)
Zanesville silt loam, 7- to 12-percent slopes (340D or YD)
Zanesville silt loam, 7- to 12-percent slopes, moderately eroded (340D̄ or YD̄)

These soils are moderately permeable to air and water and have a moderately high to high water-supplying capacity. Natural fertility is low to medium. The subsoils (silty clay loams) are very favorable to root development. In Zanesville, however, the root-development zone might be limited because of bedrock found between about 20 and 40 inches below the surface.

Erosion is a serious problem on these soils, limiting crop selection. Good cropping systems containing grasses and legumes at least three-fifths of the time are needed where these soils are cultivated without conservation practices. If practices such as contouring and terracing can be established, less grasses and legumes are needed to control erosion.

Where they have not been treated, these soils are acid, low to medium in available phosphorus, and usually high in available potassium. Lime and fertilizer should be applied according to soil-test recommendations.

Organic matter and nitrogen are low. Grasses and legumes should be used to maintain and, if possible, increase organic matter and nitrogen. Nitrogen may also be supplied by commercial fertilizers.

Management group IIIe-2. This management group consists of light-colored, moderately deep, moderately well-drained, silty upland soils occurring on 4- to 12-percent slopes. The following soils are in this management group:

Grantsburg silt loam, 4- to 7-percent slopes (301C or XC)
Grantsburg silt loam, 4- to 7-percent slopes, moderately eroded (301$\overline{C}$ or X$\overline{C}$)
Grantsburg silt loam, 7- to 12-percent slopes (301D or XD)
Grantsburg silt loam, 7- to 12-percent slopes, moderately eroded (301$\overline{D}$ or X$\overline{D}$)
Hosmer silt loam, 4- to 7-percent slopes (214C or WC)
Hosmer silt loam, 4- to 7-percent slopes, moderately eroded (214$\overline{C}$ or W$\overline{C}$)
Hosmer silt loam, 7- to 12-percent slopes (214D or WD)
Hosmer silt loam, 7- to 12-percent slopes, moderately eroded (214$\overline{D}$ or W$\overline{D}$)

Because of a dense, compact layer (fragipan) in the lower part of the subsoil — usually beginning at depths between 25 and 35 inches — these soils are very slowly permeable and water-supplying capacity is only moderate. Root penetration is also restricted. The fragipan in Grantsburg is somewhat more compact and brittle than that in Hosmer.

Erosion is a severe hazard on these soils, limiting crop selection. Controlling erosion is a major problem. Conservation practices such as contouring, terracing, and establishing grass waterways are very effective in helping to control soil loss. Without conservation practices, a cropping system including grasses and legumes 3 years in 5 is needed to control soil loss. When contouring is used, grasses and legumes should be included 2 years in 5. With terracing, grasses and legumes should be grown 1 year in 4.

Natural fertility of these soils is low to medium. If not treated, the soils are acid, low in available phosphorus, and low to medium in available potassium. Soil tests should be made to determine the amounts of lime and fertilizer to apply. These soils respond well to fertilizer treatment.

Organic matter and nitrogen are usually low. The best sources of these materials are grasses and legumes. Nitrogen may also be applied in commercial fertilizer.

Management group IIIe-3. Weinbach silt loam, 4- to 7-percent slopes, moderately eroded (461$\overline{C}$), is the only soil in this management group. It is a light-colored, deep, imperfectly drained terrace soil. The surface soil is silty and the subsoil is a silty clay loam that is slowly permeable. For roots to penetrate the subsoil, the fertility, naturally low, must be raised to a high level. Water-supplying capacity is high.

Erosion is a severe hazard on this soil, limiting crop selection. Controlling erosion is a major problem because of the slope. Without conservation practices, a cropping system including grasses and legumes 3 years in 5 is needed to control soil loss. If this soil is cultivated on the contour, grasses and legumes should be included 2 years in 5. If terraces are established and the soil is cultivated on the contour, a cropping system including grasses and legumes 1 year in 4 will control soil loss provided a good cover of grasses and legumes is plowed under.

Unless treated, this soil is strongly acid, low in available phosphorus, and low to medium in available potassium. Soil tests should be made to determine the amounts of lime and fertilizer to apply.

Organic matter and nitrogen are low. Grasses and legumes should be grown regularly to help maintain these materials. For high crop yields, commercial nitrogen fertilizers must be added.

Subclass IIIw. — Soils having severe limitations because of excess water

Management group IIIw-1. This management group consists of light- to moderately dark-colored, very poorly drained, fine- to very fine-textured (silty clay loam to clay) lowland soils. These soils are very slowly permeable and very plastic when wet. They occur in low-lying or depressional bottomland areas on 0- to 1.5-percent slopes. Water-holding capacity is high.

The following soils are in this management group:

Darwin clay (71A)
Karnak clay (462A)
Piopolis silty clay loam (420A)

When adequately drained, these soils are suited to the common crops of the area. Because of their low-lying position, however, providing suitable outlets for drainage is often a problem. These soils have a high clay content and water passes through them very slowly. Tile drainage is impractical and surface ditches are recommended. In some places, diversion ditches can be used to divert water from nearby slopes. Keeping drainage ditches and channels free of brush helps remove excess water.

The acidity varies considerably in the light-colored Karnak and Piopolis soils, and in some places large amounts of limestone are needed. The Darwin soil is usually slightly acid to neutral and seldom needs limestone. Soil tests should be made and lime and fertilizer applied according to recommendations based on the tests.

Organic matter is usually low to medium. Grasses and legumes should be grown when possible to furnish fresh organic matter and nitrogen and to help keep the surface soil open and porous. Grasses and legumes which are tolerant to wet conditions, such as reed canarygrass, tall fescue, redtop, alsike clover, and Ladino clover, should be used.

Fall plowing of these soils is recommended for seedbed preparation. Plowing when too wet should be avoided.

Some swampy areas of Piopolis silty clay loam and Karnak clay occur in Johnson county. They are indicated on the soil map by a swamp symbol immediately preceding the soil type number. These swampy areas are in management group Vw-1, page 49.

Management group IIIw-2. Bonnie silt loam (108A) is the only soil in this management group. It is a light-colored, poorly drained, silty bottomland soil occurring on 0- to 1.5-percent slopes. It is very slowly permeable but has a high water-supplying capacity and is often subject to damaging overflow. Natural fertility is low.

This soil is suitable for most of the common crops of the area, but growing small grain and leguminous crops may be severely limited because of wetness. Diversion ditches sometimes help intercept water from nearby hills. Keeping drainage ditches and channels free of brush helps speed the removal of excess water.

Drainage is also a serious problem because a high water table often exists, causing the surface soil to remain wet and waterlogged for long periods of time. Surface ditches are recommended to carry off excess water because tile function poorly in this soil.

Some swampy areas of Bonnie silt loam occur in Johnson county and are indicated on the soil map by a swamp symbol immediately preceding the soil type number. These swampy areas are in management group Vw-1, page 49.

Bonnie silt loam is strongly acid, low in available phosphorus, and low to medium in available potassium. Lime and fertilizer should be applied according to soil-test recommendations.

This soil is low in organic matter and nitrogen. Growing grasses and legumes and turning them under will provide both materials. Nitrogen may also be added in commercial fertilizer. Regular additions of these materials, as well as returning all crop residues, will help keep the surface soil in good working condition. Every effort should be made to avoid cultivating this soil when it is too wet.

Management group IIIw-3. Ginat silt loam (460A) is the only soil in this management group. It is a light-colored, poorly drained soil developed from silty material over water-laid silts, clays, and some sand. It occupies slopes ranging from 0 to 1.5 percent. Because of a slowly permeable subsoil, water movement is slow. Water-supplying capacity is moderate and depth of root penetration is shallow if adequate soil treatment has not been applied. When this soil is raised to a high level of fertility, however, corn roots will penetrate the subsoil, enabling them to draw upon a greater supply of nutrients and water.

With proper drainage, Ginat is suited to the common crops of the area. Drainage is a major problem on this soil, however, and since water moves through the subsoil slowly, tile will not function satisfactorily. Surface ditches and dead furrows are practical means of drainage.

Fertility is also a major problem. Where this soil has not been treated, it is strongly acid, low in available phosphorus, and medium in available potassium. These nutrients should be added according to needs indicated by soil tests.

Organic matter is low and should be applied regularly to improve the physical condition of the surface soil and to increase crop yields. Nitrogen is also low. Grasses and legumes used in the cropping system and turned under as green manure are good sources of these materials. Nitrogen may also be added in commercial fertilizers. All crop residues should be returned to the soil.

Subclass IIIs. — Soils having severe limitations of moisture capacity or tilth

Management group IIIs-1. This management group consists of light-colored, deep, sandy soils formed on terraces from water- or wind-deposited sands, or both. They occur on 0- to 7-percent slopes. These soils are moderately rapidly to rapidly permeable to air and water and have rather low water-supplying capacity.

The following soils are in this management group:

Unity sandy loam, 0- to 1.5-percent slopes (175A)
Unity sandy loam, 1.5- to 4-percent slopes (175B)
Unity sandy loam, 4- to 7-percent slopes, moderately eroded (175C)

These soils are suited to the common crops of the area, but because moisture is severely limited, deep-rooted crops should be favored.

When these soils are untreated, they are acid and low in available phosphorus and potassium. Apply lime and fertilizer in amounts indicated by soil tests and according to the needs of the particular crop. Add small amounts of lime at frequent intervals because lime and soluble plant nutrients may leach rather rapidly from the root zones of these soils. Replenish the supply of organic matter.

Tillage should be kept to a minimum. These soils should be plowed only when they contain plenty of moisture.

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

Subclass IVe. — Soils subject to very severe erosion if cultivated and not protected

Management group IVe-1. This management group consists of light-colored, moderately well- to well-drained soils of the upland and stream terraces occurring on slopes ranging from 4 to 18 percent. The following soils are in this management group:

Grantsburg silt loam, 4- to 7-percent slopes, severely eroded (301C or XC)
Grantsburg silt loam, 7- to 12-percent slopes, severely eroded (301D or XD)
Grantsburg silt loam, 12- to 18-percent slopes, moderately eroded (301E or XE)
Hosmer silt loam, 4- to 7-percent slopes, severely eroded (214C or WC)
Hosmer silt loam, 7- to 12-percent slopes, severely eroded (214D or WD)
Hosmer silt loam, 12- to 18-percent slopes (214E or WE)
Hosmer silt loam, 12- to 18-percent slopes, moderately eroded (214E or WE)
Wartrace silt loam, 7- to 12-percent slopes, severely eroded (215D)
Wartrace silt loam, 12- to 18-percent slopes, moderately eroded (215E)
Wheeling silt loam, 7- to 12-percent slopes, severely eroded (463D)
Wheeling silt loam, 12- to 18-percent slopes, moderately eroded (463E)

Permeability ranges from very slow (Hosmer and Grantsburg) to moderate (Wartrace and Wheeling). Water-supplying capacity is moderately high to high. On slopes of less than 12 percent, these soils are severely eroded, but on 12- to 18-percent slopes they are slightly to moderately eroded.

A very slowly permeable layer (fragipan) often begins at depths of less than 30 inches in Hosmer and Grantsburg soils. The original silt loam surface is often absent on the severely eroded areas and the heavy silt loam to silty clay loam subsoil usually constitutes the plow layer. On the moderately eroded areas the surface is a silt loam which may be mixed with some of the subsoil.

Because of the severe erosion hazard, these soils should receive little or no cultivation. With no conservation practices, meadow crops should be grown three-fourths of the time and small grains the other fourth. With contouring or strip cropping an occasional row crop can be grown. If suitable terrace outlets can be developed, slopes of less than 12 percent can be terraced, thus permitting the growth of more row crops. Even if terraces are established, however, meadow crops should constitute two-thirds of the rotation.

Deep-rooting grasses and legumes that are adapted to these soils should be selected for meadow and pasture seeding (Fig. 23).

Lime and fertilizer need to be applied in amounts indicated by soil tests. All crop residues should be returned to the soil.

Improved pasture on Grantsburg silt loam. (Fig. 23)

Class V. — Soils having severe limitations that restrict use to pasture, woodland, or wildlife food and cover

Subclass Vw. — Soils too wet for cultivation

Management group Vw-1. This management group consists of light-colored, poorly to very poorly drained, silt loam to clay soils occurring on low-lying bottomland. They are, for the most part, so wet that it is impractical to drain them without major reclamation.

The following soils are in this management group. They are indicated on the soil map by a swamp symbol immediately preceding the soil type number.

Belknap silt loam, 0- to 1.5-percent slopes (382A)
Bonnie silt loam (108A)
Karnak clay (426A)
Piopolis silty clay loam (420A)

Because these swampy areas are very difficult or impractical to drain, existing stands of timber should be maintained and improved. Encourage growth of more valuable species such as cypress, sweet gum, ash, and maple by harvesting mature and defective trees of these species and removing less desirable species such as willow and honey locust.

Where these soils have been cleared of timber and are being used for pasture, choose grasses and legumes such as reed canarygrass, tall fescue, redtop, timothy, alsike clover, and Ladino clover that are adapted to wet conditions (Fig. 24). Even though these areas are wet, fertilizer treatment according to needs indicated by soil tests will increase forage yields.

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

Subclass VIe. — Soils severely limited, chiefly by risk of erosion if protective cover is not maintained

Management group VIe-1. This management group consists of light-colored, moderately well- to well-drained, silty upland soils occurring on 7- to 30-percent slopes. On slopes of less than 18 percent most of the soils are severely eroded; on steeper slopes erosion is moderate.

The following soils are in this management group:

Grantsburg silt loam, 12- to 18-percent slopes, severely eroded (301E or XE)
Hosmer silt loam, 12- to 18-percent slopes, severely eroded (214E or WE)
Hosmer silt loam, 18- to 30-percent slopes, moderately eroded (214F or WF)
Wartrace silt loam, 12- to 18-percent slopes, severely eroded (215E)
Wartrace silt loam, 18- to 30-percent slopes, moderately eroded (215F)
Zanesville silt loam, 7- to 12-percent slopes, severely eroded (340D or YD)
Zanesville silt loam, 12- to 18-percent slopes, moderately eroded (340E or YE)
Zanesville silt loam, 12- to 18-percent slopes, severely eroded (340E or YE)
Zanesville silt loam, 18- to 30-percent slopes, moderately eroded (340F or YF)

Hosmer and Grantsburg soils have a very slowly permeable and highly compacted layer which often begins less than 30 inches from the surface. Zanesville has large chunks of rock or solid bedrock at depths of less than 40 inches. Wartrace soils are moderately permeable. All of these soils have a moderately high to high water-supplying capacity.

Unless protected, these soils have severe erosion hazards and are best suited to permanent vegetation such as hay, pasture, or woodland.

When used for hay or pasture, apply lime and fertilizer as indicated by soil tests. Tear up old sod by shallow plowing, field cultivating, or disking, and reseed with adapted grasses and legumes. Prevent overgrazing and clip to control weeds and to promote uniform grazing.

For woodland, manage existing stands to favor oaks, tulip poplar, and ash. Cut mature, defective, and less desirable trees, and protect from grazing. For plantations, favor shortleaf and loblolly pine.

Pasture on a wet area of Bonnie silt loam. (Fig. 24)

Class VII. — Soils having very severe limitations that make them unsuitable for cultivation without major reclamation and restrict use largely to grazing, woodland, or wildlife

Subclass VIIe. — Soils very severely limited, chiefly by risk of erosion if protective cover is not maintained

Management group VIIe-1. This management group consists of light-colored, moderately deep, silty upland soils. They occur on 18- to 30-percent slopes and are severely eroded. The following soils are in this management group:

- Hosmer silt loam, 18- to 30-percent slopes, severely eroded (214F or WF)
- Zanesville silt loam, 18- to 30-percent slopes, severely eroded (340F or YF)

The Hosmer soil has an impermeable, compacted layer (fragipan) beginning at depths of 25 to 35 inches. The Zanesville has less of a fragipan but may have large chunks of rocks or bedrock above a depth of 40 inches. Water-supplying capacity is low to moderate.

Because of steep slopes and severe erosion, these soils are best suited for woodland. Since stands of timber are practically nonexistent, plantations of loblolly and shortleaf pine are recommended.

Subclass VIIs. — Soils very severely limited by low moisture capacity, stones, or other soil features

Management group VIIs-1. This management group consists of shallow, silty, and rocky upland soils occurring on 7- to over 30-percent slopes. They are drouthy and in some areas severely eroded.

The following soils are in this management group:

- Rocky limestone land, 18- to 30-percent slopes, moderately eroded (94F)
- Rocky limestone land, over 30-percent slopes, moderately eroded (94G)
- Rocky sandstone land, 12- to 18-percent slopes, moderately eroded (9E)
- Rocky sandstone land, 18- to 30-percent slopes, moderately eroded (9F)
- Rocky sandstone land, over 30-percent slopes, moderately eroded (9G)
- Wellston-Muskingum complex, 7- to 12-percent slopes, moderately eroded (339-425D or ZD)
- Wellston-Muskingum complex, 7- to 12-percent slopes, severely eroded (339-425D or ZD)
- Wellston-Muskingum complex, 12- to 18-percent slopes, moderately eroded (339-425E or ZE)
- Wellston-Muskingum complex, 12- to 18-percent slopes, severely eroded (339-425E or ZE)
- Wellston-Muskingum complex, 18- to 30-percent slopes, moderately eroded (339-425F or ZF)
- Wellston-Muskingum complex, 18- to 30-percent slopes, severely eroded (339-425F or ZF)
- Wellston-Muskingum complex, over 30-percent slopes, moderately eroded (339-425G or ZG)
- Wellston-Muskingum complex, limestone variants, 12- to 18-percent slopes, moderately eroded (L339-425E or LZE)
- Wellston-Muskingum complex, limestone variants, 18- to 30-percent slopes, moderately eroded (L339-425F or LZF)
- Wellston-Muskingum complex, limestone variants, 18- to 30-percent slopes, severely eroded (L339-425F or LZF)

When not severely eroded, the Wellston-Muskingum complex has from 3 to 7 inches of silt loam surface soil and a silty clay loam subsoil ranging from 5 to 15 inches thick. The other soils in this group consist of a thin mantle of silt loam over large chunks of rock or bedrock with stones scattered on the surface. Bedrock outcrops are fairly common.

Since these soils are shallow and rocky and slopes are generally steep, they are drouthy and best suited for woodland. In managing existing stands of trees, favor white oak, red oak, black oak, and red cedar. Harvest mature and defective trees of these species and remove the less desirable species such as hickory, elm, and blackjack oak. Protect from fire and grazing. Favor shortleaf and loblolly pine for plantations. Scotch pine may be planted for Christmas trees.

Crop Yields and Productivity

Average crop yields under two levels of management are given in Table 18 for each mapping unit. The two levels of management, moderately high (column A under each crop) and high (column B), are defined in the following paragraphs.

A moderately high level of management includes the following management practices: adequate drainage; timely use of adapted cultural practices; careful handling of manure; a cropping system which minimizes erosion and helps maintain good soil tilth and the nitrogen supply; and application of limestone, phosphate, and potash as soil tests indicate. Corn should have 40 pounds each of phosphate (P_2O_5) and potash (K_2O) per acre, either applied or estimated as residual from previous applications. The nitrogen requirement for corn is a total of 100 pounds per acre in the current and previous year (from legumes or nonlegumes, or both). For soybeans, wheat, and oats, the nitrogen, phosphate, and potash requirements are about 70 percent of those for corn.

A high level of management includes more intensive and near optimum application of all the practices

Table 18. — ESTIMATED AVERAGE YIELDS OF CROPS ON JOHNSON COUNTY SOILS UNDER MODERATELY HIGH (Column A) AND HIGH (Column B) LEVELS OF MANAGEMENT[a]

Soil map symbol	Corn		Soybeans		Wheat		Winter oats[b]		Alfalfa hay		Mixed pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	bu.	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*tons*	*tons*	*days*[c]	*days*[c]
9E̅	N	N	N	N	N	N	N	N	N	N	20	...
9F̅	N	N	N	N	N	N	N	N	N	N	15	...
9G̅	N	N	N	N	N	N	N	N	N	N	10	...
71A	61	72	25	29	22	26	43	50	2.4	2.5	120	125
72A	81	90	32	35	31	34	54	60	2.6	3.2	130	160
72B	79	88	30	34	30	33	52	58	2.6	3.2	130	160
94F̅	N	N	N	N	N	N	N	N	N	N	20	...
94G̅	N	N	N	N	N	N	N	N	N	N	15	...
108A	61	68	24	27	23	26	41	48	2.0	2.5	100	125
164A	68	80	26	31	30	35	58	64	2.5	2.7	125	135
164B	58	70	22	26	25	30	54	60	2.4	2.6	120	130
175A	57	63	20	22	23	26	43	48	2.1	2.4	105	120
175B	49	55	19	21	22	25	40	45	2.0	2.3	100	115
175C̅	40	46	16	18	19	21	35	39	1.8	2.1	90	105
180A	85	95	32	36	31	34	57	63	2.9	3.3	145	165
214B or WB	58	68	21	25	25	29	50	50	2.0	2.7	100	135
214B̅ or WB̅	45	55	18	21	20	23	46	52	1.7	2.6	85	130
214C or WC	56	66	20	24	24	28	48	54	1.8	2.7	90	135
214C̅ or WC̅	45	53	17	20	19	22	42	48	1.6	2.5	80	125
214C̲ or WC̲	31	37	13	14	15	16	38	44	1.2	2.0	60	100
214D or WD	54	62	19	23	20	24	44	50	1.6	2.5	80	125
214D̅ or WD̅	38	49	15	18	18	21	40	45	1.4	2.4	70	120
214D̲ or WD̲	27	32	10	12	12	14	35	40	.9	1.8	45	90
214E or WE	49	58	19	22	19	23	42	48	1.5	2.3	75	115
214E̅ or WE̅	30	35	14	17	16	19	35	40	1.4	2.0	70	100
214E̲ or WE̲	N	N	N	N	N	N	N	N	.8	1.6	40	80
214F̅ or WF̅	N	N	N	N	N	N	N	N	.9	1.8	45	90
214F̲ or WF̲	N	N	N	N	N	N	N	N	N	N	30	...
215B	75	85	28	32	33	36	54	60	3.1	3.4	155	170
215C	72	82	26	30	30	35	52	56	2.8	3.1	140	155
215C̅	65	75	22	26	26	30	44	50	2.7	3.0	135	150
215D̅	52	62	18	22	22	26	42	48	2.6	2.9	130	145
215D̲	35	40	15	18	17	20	38	42	2.4	2.7	120	135
215E̅	40	45	19	21	19	23	42	48	1.8	2.5	90	125
215E̲	N	N	N	N	N	N	N	N	2.2	2.5	110	125
215F̅	N	N	N	N	N	N	N	N	2.5	2.8	125	140
301B or XB	52	62	20	24	23	27	48	54	1.9	2.6	95	130
301B̅ or XB̅	42	49	16	19	17	20	42	48	1.6	2.5	80	125
301C or XC	52	62	19	23	21	26	46	52	1.7	2.6	85	130
301C̅ or XC̅	41	48	15	18	16	19	40	45	1.5	2.4	75	120
301C̲ or XC̲	30	36	12	15	13	15	35	41	1.1	1.9	55	95
301D or XD	50	60	18	22	19	23	42	48	1.5	2.4	75	120
301D̅ or XD̅	37	43	14	16	15	18	37	42	1.3	2.3	65	115
301D̲ or XD̲	25	29	9	11	11	13	30	35	.8	1.7	40	85
301E̅ or XE̅	28	33	13	15	15	18	33	38	1.3	1.9	65	95
301E̲ or XE̲	N	N	N	N	N	N	N	N	.8	1.6	40	80
335A	60	70	23	28	27	32	52	58	2.5	2.7	125	135
335B	50	62	21	24	22	27	47	52	2.4	2.6	120	130
339-425D̅ or ZD̅	N	N	N	N	N	N	N	N	N	N	35	...
339-425D̲ or ZD̲	N	N	N	N	N	N	N	N	N	N	30	...
339-425E̅ or ZE̅	N	N	N	N	N	N	N	N	N	N	30	...
339-425E̲ or ZE̲	N	N	N	N	N	N	N	N	N	N	25	...
339-425F̅ or ZF̅	N	N	N	N	N	N	N	N	N	N	25	...
339-425F̲ or ZF̲	N	N	N	N	N	N	N	N	N	N	20	...
339-425G̅ or ZG̅	N	N	N	N	N	N	N	N	N	N	20	...
L339-425E̅ or LZE̅	N	N	N	N	N	N	N	N	N	N	35	...
L339-425F̅ or LZF̅	N	N	N	N	N	N	N	N	N	N	25	...
L339-425F̲ or LZF̲	N	N	N	N	N	N	N	N	N	N	20	...

(For footnotes see page 52, where table is concluded.)

Table 18. — Concluded

Soil map symbol	Corn		Soybeans		Wheat		Winter oats[b]		Alfalfa hay		Mixed pasture	
	A	B	A	B	A	B	A	B	A	B	A	B
	bu.	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*bu.*	*tons*	*tons*	*days*[c]	*days*[c]
340D or YD	48	56	16	20	18	22	38	44	1.3	2.0	65	100
340D̄ or YD̄	35	40	13	15	14	17	35	40	1.0	1.6	50	80
340D̲ or YD̲	N	N	N	N	N	N	N	N	.7	1.4	35	70
340Ē or YĒ	N	N	N	N	N	N	N	N	.9	1.5	45	75
340E̲ or YE̲	N	N	N	N	N	N	N	N	.6	1.2	25	60
340F̄ or YF̄	N	N	N	N	N	N	N	N	.7	1.4	35	70
340F̲ or YF̲	N	N	N	N	N	N	N	N	N	N	25	...
382A	67	75	30	33	28	31	50	54	2.4	2.8	120	140
382B	66	73	28	31	26	29	48	52	2.3	2.7	115	135
420A	61	72	24	28	22	26	38	45	2.0	2.5	100	125
426A	51	60	20	24	18	21	34	40	2.0	2.5	100	125
427A	61	68	24	27	27	30	46	52	2.5	3.0	125	150
427B	56	62	22	25	24	27	42	48	2.5	3.0	125	150
460A	58	68	26	31	24	28	46	52	2.2	2.5	110	125
461A	69	81	28	33	28	33	58	64	2.4	2.6	120	130
461B	59	70	24	28	24	29	54	60	2.3	2.5	115	125
461C̄	46	54	19	22	18	21	46	52	1.9	2.2	95	110
462A	70	85	28	33	30	34	56	62	3.1	3.4	155	170
462B	60	72	24	28	26	30	52	58	3.1	3.4	155	170
462C̄	48	56	20	22	20	23	46	52	2.6	2.9	130	145
462D̄	40	48	17	20	19	22	42	48	2.5	2.8	125	140
463B	55	66	22	26	25	29	50	56	3.0	3.2	150	160
463C̄	46	54	18	20	19	22	44	50	2.5	2.8	125	140
463D̲	35	43	15	18	18	21	38	44	2.3	2.6	115	130
463Ē	30	35	14	17	16	19	30	36	2.0	2.3	100	115

[a] For definitions of moderately high and high levels of management see page 50. Yields for bottomlands assume no damage from flooding. N means crop not adapted.
[b] Although winter oats occasionally fail because of winter freezing, they produce higher yields than spring oats over a period of years in Johnson county.
[c] Estimated number of days that one acre will carry one cow. On those soil mapping units where alfalfa is not adapted, the pasture days given in column A are for unimproved bluegrass pasture.

considered in the moderately high level of management, plus an increase (30 to 40 percent) in the application of nitrogen, phosphate, and potash fertilizers.

The yields in Table 18 are based on current information and can be expected to change with improvements in farming techniques, crop varieties, and soil management. Yields from experiments by the Illinois Agricultural Experiment Station and from long-time records kept by farmers in cooperation with the University of Illinois, Department of Agricultural Economics, were used as a basis for estimating yields in Table 18 wherever data were available and applicable.

Yields obtained on Grantsburg and Robbs silt loams at the Dixon Springs Experiment Station are given in Table 19. These results generally show good response to complete soil treatment.

Use and Management of Soils for Woodland[1]

Practically all of the land in Johnson county was in forest at the time of settlement. Excellent stands of mixed oaks, hickory, soft maple, and other hardwoods grew on the upland and terrace soils, and sycamore, cottonwood, and mixed bottomland hardwoods grew on the bottomlands. Cypress, once an important species on poorly drained bottomlands, can still be found in some areas.

The timber cover on most of the better upland sites was removed when land was cleared for agriculture. Thus present forests are on land that was unsuited for agriculture because of steep slopes, stoniness, inaccessibility, and other features. The average timber stand in southern Illinois (16 counties) contained about 2,500 board feet per acre of saw timber in 1948. Three-fourths of this volume was low-quality material (*12*). These understocked stands of poor-quality trees (typical of those found in Johnson

[1] The authors are indebted to William R. Boggess, Professor of Forestry, University of Illinois, for his assistance in the preparation of this section of the report. Credit is also due to W. D. Parks, Soil Scientist, SCS, Anna, Illinois, and to P. Lamendola, District Forester, Illinois State Department of Conservation, Murphysboro, Illinois, for suggestions and some of the data.

county) have resulted from overcutting, fire, and grazing.

Besides the many farm and home and industrial uses for wood materials, forests are invaluable for watershed protection, wildlife cover, and recreation. One of the greatest values of the forest resource is that it provides profitable employment opportunities for local residents. This is particularly true where local industries (Figure 25) are developed to utilize the kinds and amounts of timber which can best be produced. Eighty acres of well-managed forest, including all activities associated with growing and harvesting the crop, will provide continuous profitable employment for one man (*19*).

According to a 1958 study of conservation needs in Johnson county, the total privately owned timber land was 95,567 acres (Table 21). By 1975, it is estimated that 4,280 acres of this land will be cleared for other uses and that 6,263 acres not now in forest will be planted to trees. Thus by 1975, about 97,500 acres of privately owned land in the county may be used for woodland.

The U.S. Forest Service now has under its supervision 8,377 acres in Johnson county. Eighty percent of this land is in timber, 30 percent of which is in plantations.

Interest in woodland conservation is increasing and there is a greater need than ever for reforestation, especially on badly eroded land which is now being cultivated or is lying idle. Recognizing the need for reforestation, the Illinois Department of Conservation, Division of Forestry, has developed two large tree nurseries capable of producing 15 million trees annually for reforestation and erosion control (Fig. 26). These trees are available to farmers and landowners and can be secured from the state. They must be used only for reforestation and erosion control — not for landscape or ornamental plantings (*7*).

Table 19. — ANNUAL ACRE YIELDS — DIXON SPRINGS PLOTS, CHIEFLY GRANTSBURG SILT LOAM (301) WITH SOME ROBBS SILT LOAM (335)[a]

12-year Average for Corn, 11-year Average for Wheat and Hay, 1950-1961, Series 500-800

Treatment[b]	Corn	Wheat	Alfalfa-brome hay
	bu.	*bu.*	*tons*
O	16±3.9[c]	7±1.6[c]	.6±.19[c]
L	35±4.6	10±1.6	.8±.36
LsP	46±6.8	20±2.5	1.5±.34
LK	38±5.7	12±1.7	1.0±.25
LKrP	52±6.1	18±2.7	1.6±.33
LKsP	55±7.4	21±2.9	1.7±.31
LKP (fused)	57±7.8	22±2.8	2.0±.39
LKP (meta)	52±7.5	18±3.0	1.8±.41

[a] The authors are indebted to the Agronomy staff members in charge of soil experimental fields for the data in this table. The cropping system used on these plots was corn, wheat, and two years of hay.

[b] O = no treatment; L = limestone — average of 800 lb. per acre per year; rP = rock phosphate — average of 187 lb. per acre per year; sP = superphosphate (20 percent) — 100 lb. per acre per year; P (fused) = fused rock phosphate — 66 lb. per acre per year; P (meta) = metaphosphate — 26 lb. per acre per year; K = muriate of potash — 100 lb. per acre per year. Above amounts were applied from 1950 through 1956. From 1957 through 1961, the same amounts of L, rP, and K were applied each year as above, but average rate per acre per year of sP (45 percent) was increased to 178 lb., P (fused) to 320 lb., and P (meta) to 127 lb.

[c] Standard error of mean, $SEm = \frac{SEx}{\sqrt{n}}$. The standard error of a mean indicates the variability of sample means around the true mean, and hence the reliability of the observed mean. On the basis of 11 and 12 annual crop yields included in each mean, the true mean would be expected to fall within ± 2.2 SEm approximately 95 percent of the time. The standard error of the mean is also useful in judging the significance of differences between two means. If the actual difference between two means is greater than 3 times the larger SEm of the means being compared, the difference is probably significant.

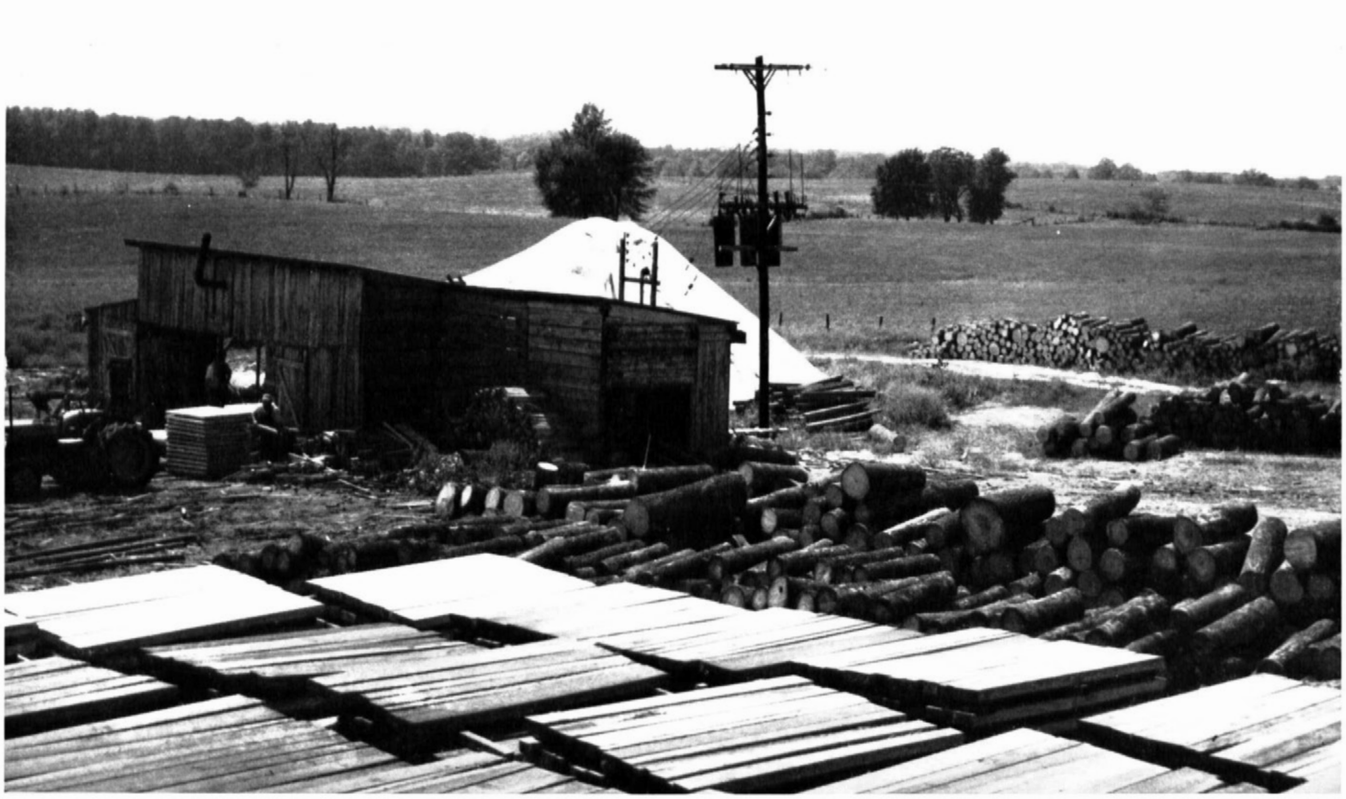
Species of trees vary in their site requirements. Black oak, for example, will grow well on sites where yellow poplar would fail. The pines and red cedar will usually grow on drier, shallower, more compact soils and on more exposed sites than will the hardwoods. But even the conifers will not grow as well on these poorer sites as they will on better sites.

The most important factors affecting the productive capacity of a soil for growing trees are those which affect the availability of moisture and permit the development of an adequate root system. These are related to some of the major soil characteristics such as natural supply of plant nutrients, consistence, aeration, drainage, depth to water table, and thickness of permeable soil.

Source of Soil-Woodland Interpretations

Information in this section was obtained from many sources, including technicians working in the area of soil-tree growth relationships. Two publications by the Illinois Technical Forestry Association have been used freely (*8*, *9*). Volume yield and other information on tree growth was available from 96 forest stands studied throughout the state by foresters of the University of Illinois Cooperative Extension Service. Soils on which these stands occurred were identified by the Soil Conservation Service and the data were analyzed to determine the relationships between groups of similar soils and tree growth (*21*). An additional 30 forest sites, occurring on 14 soil series in Johnson county, were measured to supplement the information.

Site-index measurements for different woodcrops on some soils in the county are summarized in Table 20. Site index is the average total height of the tallest trees (those that have been consistently in a dominant or co-dominant crown position) found growing



A sawmill in Johnson county which uses local timber. (Fig. 25)

Modern tree nursery producing trees for reforestation. (Fig. 26) in naturally occurring, well-stocked stands when they are 50 years of age. A set of site-index curves has been established to determine site index from total height and age measurements of trees in any particular qualifying stand regardless of the age.

Foresters have found that site index is closely related to volume yield from well-stocked, unmanaged stands, and they have developed yield tables giving approximate information that can be used as a measure of potential soil productivity. However, site-index information is not yet available for all the soils in the county. For that reason, the woodland suitability groups (Table 21) presented in the following section show estimates of average annual per acre growth of Illinois hardwood timber as supplied by the Illinois Technical Forestry Association.

Woodland Suitability Groupings of Soils

The soils of Johnson county have been placed into nine woodland suitability groups based on detailed knowledge of their physical characteristics and on less thorough information about their responses to woodland use and management. Each group is made up of soils requiring similar conservation treatment and having about the same potential soil productivity for woodcrops. Estimated potential productivity for hardwood timber is given in terms of average annual acre growth for each group of soils.

Tree species to favor in management of existing stands and species suited for reforestation, stream-

Table 20. — SITE-INDEX MEASUREMENTS FOR DIFFERENT WOODCROPS ON SOME JOHNSON COUNTY SOILS

Soil type name and No.[a]	Woodland group No.	Species or woodcrop	No. of measurements	Average site index
Belknap silt loam (382)	1	Sweet gum	1	76
		Tulip poplar	1	102
		Pin oak, cherry bark red oak, southern red oak	1	87
		Ash	1	102
Bonnie silt loam (108)	2	Soft maple	1	82
		Sycamore	1	87
Ginat silt loam (460)	3	Pin oak	1	98
Grantsburg silt loam (301)	5	Mixed upland hardwoods (white oak, red oak, hickory)	13[b]	60 ± 11.8[c]
Hosmer silt loam (214)	5	Mixed upland hardwoods (white oak, red oak, hickory)	6	67 ± 11.9[c]
Karnak clay (426)	2	Mixed bottomland hardwoods (ash, pin oak, red oak)	3	84
Muskingum silt loam (425)	9	Mixed upland hardwoods (white oak, red oak, hickory)	2	58
Piopolis silty clay loam (420)	2	Mixed bottomland hardwoods (pin oak, red oak, white oak)	2	87
Rocky limestone land (94)	8	Mixed upland hardwoods (white oak, red oak, hickory)	1	54
Rocky sandstone land (9)	8	Mixed upland hardwoods (white oak, red oak, hickory)	1	48
Sciotoville silt loam (462)	6	White oak	1	58
		White oak, red oak	1	80
		Mixed upland hardwoods (white oak, red oak, hickory)	17[b]	60 ± 7.1[c]
Stoy silt loam (164)	4	White oak	1	62
		Mixed upland hardwoods (white oak, red oak, hickory)	11[b]	66 ± 8.6[c]
Wartrace silt loam (215)	6	Tulip poplar	1	89
Wellston silt loam (339)	9	Mixed upland hardwoods (white oak, red oak, hickory)	1	57
Wheeling silt loam (463)	6	Northern red oak	1	93
Zanesville silt loam (340)	7	Mixed upland hardwoods (white oak, red oak, hickory)	6	55 ± 8.5[c]

[a] Slope and erosion classes and aspect and position phases not distinguished.
[b] Data from similar soils which do not occur in Johnson county.
[c] Standard deviation of individual observations about the mean.

Table 21. — WOODLAND SUITABILITY GROUPS OF JOHNSON COUNTY SOILS

Group No. and soil type No.[a]	Estimated annual growth rate[b] (board ft. per acre)	Suitable species: To favor in managing existing stands	Suitable species: To plant	Plant competition	Seedling mortality	Equipment limitation	Erosion hazard	Estimated acres in woodland use[c]: 1958	Estimated acres in woodland use[c]: 1975
Group 1: 72, 180, 382	400 to 800	Pin oak, Water oak, Cherry bark red oak, Swamp white oak, Southern red oak, Ash, Yellow poplar, Sycamore, Cottonwood, Sweet gum, Cypress, Bur oak	Cottonwood, Sweet gum, Sycamore, Ash, Yellow poplar, Pin oak, Cypress, Black walnut	Moderate to severe	Slight	Slight to moderate	Slight	9,259	8,465
Group 2: 71, 108, 420, 426	150 to 500	Water oak, Cherry bark red oak, Swamp white oak, Bur oak, Ash, Sycamore, Cottonwood, Sweet gum, Cypress, Pin oak	Cottonwood, Sweet gum, Sycamore, Pin oak, Cypress	Moderate to severe	Slight	Severe	Slight	9,289	7,279
Group 3: 460	150 to 500	Black oak, White oak, Swamp oak, Post oak, Red oak, Southern red oak, Pin oak	Shortleaf pine, Loblolly pine, Red cedar, Scotch pine[d]	Moderate	Slight	Moderate	Slight	2,109	1,609
Group 4: 164, 335, 461	100 to 500	Black oak, Bur oak, Black cherry, Basswood, White oak, Southern red oak, Ash, Scarlet oak	Loblolly pine, Shortleaf pine, Red oak, Black walnut, White oak, Scotch pine[d], Ash	Slight to moderate	Slight	Slight	Slight to moderate	2,559	2,597
Group 5: 214, 301	175 to 500	Black oak, White oak, Red oak, Black walnut	Loblolly pine, Shortleaf pine, Black walnut, Southern red oak, White oak, Black locust, White pine, Scotch pine[d]	Moderate	Slight	Slight	Moderate	14,053	18,161
Group 6: 175, 215, 462, 463	225 to 550	Yellow poplar, White oak, Southern red oak, Black oak, Black walnut, White ash, Sweet gum	Black walnut, Yellow poplar, Southern red oak, Black locust, Scotch pine[d], Loblolly pine, Shortleaf pine, White pine, Willow	Moderate to severe	Slight (moderate on soil No. 175)	Slight	Moderate	844	844
Group 7: 340, 427	125 to 350	Black oak, White oak, Southern red oak	Loblolly pine, Shortleaf pine, Black walnut, Southern red oak, White oak, Black locust, White pine, Scotch pine[d], Red cedar	Moderate	Moderate	Moderate	Moderate to severe	12,220	13,935
Group 8: 9, 94	75 to 150	White oak, Red oak, Red cedar	Red cedar, Loblolly pine	Moderate	Moderate to severe	Moderate to severe	Moderate to severe	19,189	18,989
Group 9: 339–425, L339–425	100 to 300	White oak, Red oak, Hickory	Shortleaf pine, Loblolly pine, Red cedar	Moderate	Slight to moderate	Slight to moderate	Moderate to severe	27,866	27,646

[a] Each soil type number includes all mapping units for its type.
[b] Information furnished by Illinois Technical Forestry Association. Ranges in yield are from poorest sites to best sites.
[c] From 1958 study of conservation needs made by Soil Conservation Service.
[d] For Christmas trees only.

bank protection, and erosion-control cover are also listed for each group.

Important limitations and hazards involved in woodland uses of each group of soils include plant competition, equipment limitations, seedling mortality, and erosion hazard. These limitations have been rated "slight," "moderate," or "severe" to direct attention to the kinds and intensities of treatments that should be considered in woodland conservation.

Plant competition refers to the degree of competition from undesirable species and the rate at which they invade or develop on different soils (brush encroachment) when openings are made in the canopy for regenerating the stand or similar purposes. It is assumed that stands are well stocked with species which normally grow on the soils in question.

Seedling mortality (an indication of regeneration potential) refers to the expected mortality of naturally occurring or planted tree seedlings as influenced by soil or topographic condition. Plant competition is assumed not to be a limiting factor. Adequate seed supply for naturally occurring seedlings, good stock and proper planting for plantations, and normal environmental factors are assumed.

Equipment limitations (trafficability) include those soil characteristics and topographic features that restrict or prohibit the use of equipment commonly used in crop tending or tree harvesting. Differences may be due to soil characteristics, stones, drainage, slope, wetness, or other factors. Problems may be seasonal or year long.

Erosion hazard refers to the potential risk of erosion when the area is managed according to acceptable standards for woodland use. Factors influencing these risks are slope and profile characteristics.

Information on the woodland suitability groups of the various soils is summarized in Table 21 and discussed below.

Woodland group 1. The soils in this group are deep, silty, and friable. They occur on floodplains and have formed from local alluvium eroded from uplands. Their natural supply of plant nutrients for tree growth is medium to high and organic-matter content is medium. Permeability is moderate to slow.

The soils in this group are:

Belknap silt loam, 0- to 1.5-percent slopes (382A)
Belknap silt loam, 1.5- to 4-percent slopes (382B)
Dupo silt loam (180A)
Sharon silt loam, 0- to 1.5-percent slopes (72A)
Sharon silt loam, 1.5- to 4-percent slopes (72B)

The Sharon soils are naturally moderately well to well drained and the Belknap and Dupo soils are imperfectly drained.

Plant competition ranges from moderate where overflow is occasional to severe where overflow is frequent and the soils remain wet for long periods. Moderate plant competition delays natural regeneration and slows the initial growth of trees but will not usually prevent an adequate stand of desirable species from becoming established. Where plant competition is severe, the desirable species such as those listed in Table 21 need encouragement. Clearing, disking, spraying with chemicals, and other prescribed methods of preparing seedbeds are helpful. Less desirable species, such as elm, box elder, willow, hickory, soft maple, and black gum, should be eliminated whenever possible.

Seedling mortality is slight on these soils for most adapted forest species.

Machinery can generally be used 9 months of the year on Sharon soils without serious damage to tree roots, soil structure, and stability. On Belknap and Dupo soils, equipment should not be used during wet periods. These periods sometimes last more than 3 months.

These soils have no erosion hazard in woodland use and are the most productive soils for woodcrops in the county. Sharon, the most productive soil in this group, should grow up to 700 or 800 board feet of mixed bottomland hardwoods per acre per year under good management.

Cottonwood, frequently found in pure stands on soils such as Sharon, grows more rapidly than any of the bottomland hardwood species and may exceed 800 board feet per acre per year.

Woodland group 2. The soils in this group are deep and slowly to very slowly permeable. They are light-colored to moderately dark-colored, medium- to fine-textured alluvial soils that are poorly to very poorly drained. Plant-nutrient supply is medium to high and water-holding capacity is high to very high.

The soils in this group are:

Bonnie silt loam (108A)
Darwin clay (71A)
Karnak clay (426A)
Piopolis silty clay loam (420A)

Bonnie is the only medium-textured soil in the group. Darwin, Piopolis, and Karnak are commonly found in low-lying, large bottomland areas.

Plant competition ranges from moderate on Bonnie silt loam to severe on the other soils. In some areas, especially where finer textured soils are found, a very high water table allows many undesirable plants to grow and develop rapidly. The severe competition that results prevents the more desirable tree species from becoming established. Special management and site-preparation treatments are needed to assure adequate regeneration and growth of desirable trees. Less desirable species, such as elm, willow, hickory, and soft maple, should be eliminated whenever possible.

Seedling mortality is slight on this group of soils. It is very difficult, however, for cottonwood and sycamore to compete unless the site is clean of other naturally occurring species.

Equipment limitations on these soils are severe (Fig. 27). Because the soils are naturally wet, there are usually periods of more than 3 months each year when equipment should not be used. Damage to crop and soil can be expected if equipment is used on these soils when they are wet.

Erosion is not a hazard when these soils are in woodland use. These soils are moderately productive of woodcrops. The growth rate of pin oak, which often occurs in nearly pure stands on these soils, is quite favorable. On such sites, pin oak frequently attains heights of 70 to 90 feet and diameters up to 24 inches.

Woodland group 3. The only soil in this group is Ginat silt loam (460A). It is slowly to very slowly permeable. This soil is light colored and has a medium-textured A horizon and moderately fine- to fine-textured B horizon. It is a poorly drained, wet soil in which root penetration is apt to be rather shallow. Water-holding capacity is high but available moisture may be limited where the root zone is restricted.

This soil is found on nearly level terrace positions where erosion is not a hazard.

Although plant competition is moderate, an adequate stand of desirable species can be established. Seedling mortality is usually slight and natural regeneration is ordinarily adequate.

Equipment limitation is moderate, but in times of unusually high rainfall, there may be periods of 3 months or more when equipment should not be used.

Woodland group 4. The soils in this group are imperfectly drained and slowly permeable. They are light colored and have medium-textured A horizons and moderately fine-textured B horizons. They have a high water-holding capacity and permit deep root penetration.

Soils in this group are:

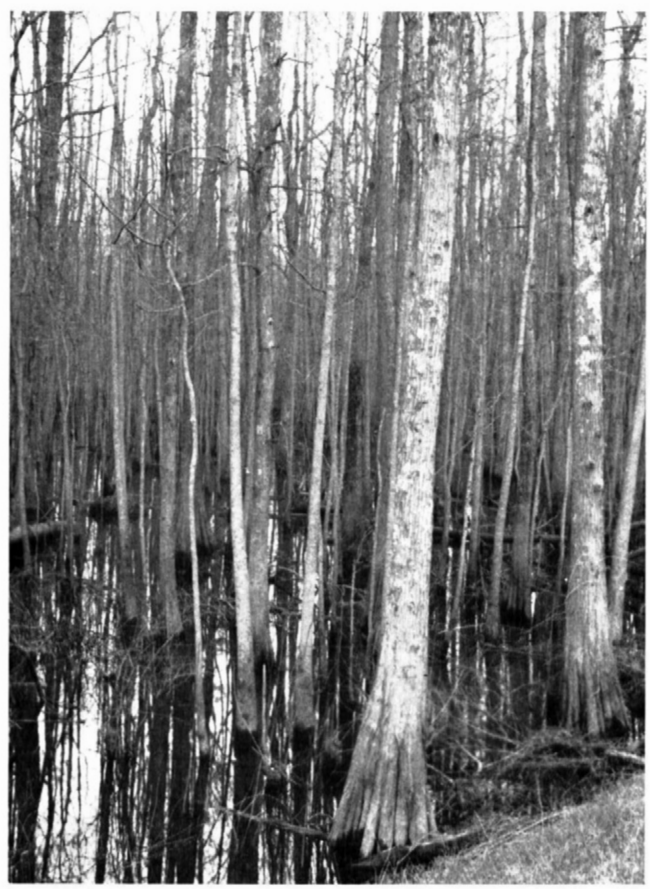
Robbs silt loam, 0- to 1.5-percent slopes (335A)
Robbs silt loam, 1.5- to 4-percent slopes (335B)
Stoy silt loam, 0- to 1.5-percent slopes (164A)
Stoy silt loam, 1.5- to 4-percent slopes (164B)
Weinbach silt loam, 0- to 1.5-percent slopes (461A)
Weinbach silt loam, 1.5- to 4-percent slopes (461B)
Weinbach silt loam, 4- to 7-percent slopes, moderately eroded (461C̄)

Plant competition usually does not prevent desirable species from becoming established on these soils, but it may delay natural regeneration of desirable trees and slow initial growth. Seedling mortality is slight and natural regeneration is ordinarily adequate. Less desirable species, such as hickory, maple, black gum, blackjack, scarlet oak, sassafras, and persimmon, should be eliminated whenever possible.

Equipment limitation is slight, and except for relatively short periods after rains, woods work can be done any time of the year.

Erosion hazard is slight on these soils.

Woodland group 5. These soils are moderately well drained and have a very slowly permeable fragipan beginning at depths ranging between 25 and 35 inches. They are light colored and have medium-textured A horizons and moderately fine-textured B horizons. Water-holding capacity is high but available moisture may be somewhat limited because the fragipan limits root penetration and slows the downward movement of water.



A stand of Tupelo gum and cypress on a swampy area of Piopolis silty clay loam. Equipment limitations on soils like these are severe. (Fig. 27)

The following soils are in this group:

Grantsburg silt loam, 1.5- to 4-percent slopes (301B or XB)
Grantsburg silt loam, 1.5- to 4-percent slopes, moderately eroded (301$\overline{B}$ or X$\overline{B}$)
Grantsburg silt loam, 4- to 7-percent slopes (301C or XC)
Grantsburg silt loam, 4- to 7-percent slopes, moderately eroded (301$\overline{C}$ or X$\overline{C}$)
Grantsburg silt loam, 4- to 7-percent slopes, severely eroded (301$\underline{C}$ or X$\underline{C}$)
Grantsburg silt loam, 7- to 12-percent slopes (301 D or XD)
Grantsburg silt loam, 7- to 12-percent slopes, moderately eroded (301$\overline{D}$ or X$\overline{D}$)
Grantsburg silt loam, 7- to 12-percent slopes, severely eroded (301$\underline{D}$ or X$\underline{D}$)
Grantsburg silt loam, 12- to 18-percent slopes, moderately eroded (301$\overline{E}$ or X$\overline{E}$)
Grantsburg silt loam, 12- to 18-percent slopes, severely eroded (301$\underline{E}$ or X$\underline{E}$)
Hosmer silt loam, 1.5- to 4-percent slopes (214B or WB)
Hosmer silt loam, 1.5- to 4-percent slopes, moderately eroded (214$\overline{B}$ or W$\overline{B}$)
Hosmer silt loam, 4- to 7-percent slopes (214C or WC)
Hosmer silt loam, 4- to 7-percent slopes, moderately eroded (214$\overline{C}$ or W$\overline{C}$)
Hosmer silt loam, 4- to 7-percent slopes, severely eroded (214$\underline{C}$ or W$\underline{C}$)
Hosmer silt loam, 7- to 12-percent slopes (214D or WD)
Hosmer silt loam, 7- to 12-percent slopes, moderately eroded (214$\overline{D}$ or W$\overline{D}$)
Hosmer silt loam, 7- to 12-percent slopes, severely eroded (214$\underline{D}$ or W$\underline{D}$)
Hosmer silt loam, 12- to 18-percent slopes (214E or WE)
Hosmer silt loam, 12- to 18-percent slopes, moderately eroded (214$\overline{E}$ or W$\overline{E}$)
Hosmer silt loam, 12- to 18-percent slopes, severely eroded (214$\underline{E}$ or W$\underline{E}$)
Hosmer silt loam, 18- to 30-percent slopes, moderately eroded (214$\overline{F}$ or W$\overline{F}$)
Hosmer silt loam, 18- to 30-percent slopes, severely eroded (214$\underline{F}$ or W$\underline{F}$)

Plant competition is moderate, sometimes retarding the initial growth of desirable species (Fig. 28). The competition is not enough, however, to keep an adequate stand from being established. Seedling mortality is slight and natural regeneration is ordinarily adequate on areas not badly eroded.

On severely eroded, sloping areas, seedbeds must be carefully prepared. Avoid building roads on the downslope, clearing for firebreaks, and other activities that remove natural cover. On severely eroded areas, use pine seedlings for first plantings because they are better adapted and survive better than hardwoods.

Using equipment on these soils generally presents no problem. Any of the common machinery can be used the year round except for short periods after heavy rains or during thawing.

Woodland group 6. Except for Unity, these soils are deep silty upland and terrace soils which are moderately permeable. They are light colored and have medium-textured A horizons and moderately fine-textured B horizons. They are moderately well drained or well drained and allow deep root penetration. Water-holding capacity is high. Unity is a light-colored, well-drained sandy soil that is somewhat drouthy.

The following soils are in this group:

Sciotoville silt loam, 0- to 1.5-percent slopes (462A)
Sciotoville silt loam, 1.5- to 4-percent slopes (462B)
Sciotoville silt loam, 4- to 7-percent slopes, moderately eroded (462$\overline{C}$)
Sciotoville silt loam, 7- to 12-percent slopes, moderately eroded (462$\overline{D}$)
Unity sandy loam, 0- to 1.5 percent slopes (175A)
Unity sandy loam, 1.5- to 4-percent slopes (175B)
Unity sandy loam, 4- to 7-percent slopes, moderately eroded (175$\overline{C}$)
Wartrace silt loam, 1.5- to 4-percent slopes (215B)
Wartrace silt loam, 4- to 7-percent slopes (215C)
Wartrace silt loam, 4- to 7-percent slopes, moderately eroded (215$\overline{C}$)
Wartrace silt loam, 7- to 12-percent slopes, moderately eroded (215$\overline{D}$)
Wartrace silt loam, 7- to 12-percent slopes, severely eroded (215$\underline{D}$)
Wartrace silt loam, 12- to 18-percent slopes, moderately eroded (215$\overline{E}$)
Wartrace silt loam, 12- to 18-percent slopes, severely eroded (215$\underline{E}$)
Wartrace silt loam, 18- to 30-percent slopes, moderately eroded (215$\overline{F}$)
Wheeling silt loam, 1.5- to 4-percent slopes (463B)
Wheeling silt loam, 4- to 7-percent slopes, moderately eroded (463$\overline{C}$)
Wheeling silt loam, 7- to 12-percent slopes, severely eroded (463$\underline{D}$)
Wheeling silt loam, 12- to 18-percent slopes, moderately eroded (463$\overline{E}$)

Undesirable species such as these often compete with the better trees. (Fig. 28)

The moderately well-drained Sciotoville and the well-drained Wheeling and Unity soils are found on alluvial terraces. Wartrace is a well-drained upland loessial soil.

Although plant competition is moderate to severe, an adequate stand can usually be established. However, competition from less desirable species such as hickory, sassafras, and persimmon may be severe on heavily cut areas. These soils can generally be restocked satisfactorily. Loss of seedlings is slight, except possibly on Unity sandy loam, where it is moderate. Pine rather than hardwood seedlings should be used for first plantings on abandoned eroded areas (Fig. 29).

Use of equipment is not restricted on these soils. During abnormally wet seasons, however, short periods may occur when machinery should not be used on Sciotoville and Wheeling soils.

Erosion is not a serious hazard on gentle slopes. As the slope increases, however, the hazard of erosion also increases. Care should be taken in logging operations and road construction on steep slopes.

Under optimum stocking and good management, mixed hardwood stands on these soils should yield about 500 board feet per acre annually.

Woodland group 7. These moderately deep, friable, silty soils are underlain by sandstone at depths ranging from 20 to 40 inches. They are moderately well drained to well drained and allow moderately deep root penetration. Water-holding capacity is moderately high to low depending on soil depth.

The following soils are in this group:

Burnside silt loam, 0- to 1.5-percent slopes (427A)
Burnside silt loam, 1.5- to 4-percent slopes (427B)
Zanesville silt loam, 7- to 12-percent slopes (340D or YD)
Zanesville silt loam, 7- to 12-percent slopes, moderately eroded (340$\overline{D}$ or Y$\overline{D}$)
Zanesville silt loam, 7- to 12-percent slopes, severely eroded (340$\underline{D}$ or Y$\underline{D}$)
Zanesville silt loam, 12- to 18-percent slopes, moderately eroded (340$\overline{E}$ or Y$\overline{E}$)
Zanesville silt loam, 12- to 18-percent slopes, severely eroded (340$\underline{E}$ or Y$\underline{E}$)
Zanesville silt loam, 18- to 30-percent slopes, moderately eroded (340$\overline{F}$ or Y$\overline{F}$)
Zanesville silt loam, 18- to 30-percent slopes, severely eroded (340$\underline{F}$ or Y$\underline{F}$)

Although plant competition on these soils is moderate to severe, restocking generally is not a problem. The loss of seedlings is slight. If adequate sources of seed are available, a satisfactory stand of trees may be obtained through natural regeneration. Less desirable species such as post oak, blackjack oak, and sassafras should be eliminated whenever possible.

Pine plantation on Unity sandy loam. (Fig. 29)

Machinery can ordinarily be used on these soils any time of the year. Logging operations might be restricted for short periods on the Burnside soils, however, especially during heavy rainfall.

Erosion is not a problem on gentle slopes but becomes more of a hazard as the slope increases. On steep slopes, be careful in logging operations and road construction. On severely eroded areas, use pine rather than hardwood seedlings for first plantings.

Woodland group 8. These soils are shallow (usually less than 10 inches deep), rocky, and drouthy. Root penetration is very shallow and water-holding capacity is low to very low.

The following soils are in this group:

Rocky limestone land, 18- to 30-percent slopes, moderately eroded (94$\overline{F}$)
Rocky limestone land, over 30-percent slopes, moderately eroded (94$\overline{G}$)
Rocky sandstone land, 12- to 18-percent slopes, moderately eroded (9$\overline{E}$)
Rocky sandstone land, 18- to 30-percent slopes, moderately eroded (9$\overline{F}$)
Rocky sandstone land, over 30-percent slopes, moderately eroded (9$\overline{G}$)

Plant competition is moderate. Good stands are difficult to establish because of drouthiness rather than plant competition. Because the soil is shallow and water-holding capacity is low, seedling mortality is moderate to severe. When rainfall is adequate, good stands of seedlings can be established. Initial growth, however, is usually retarded by lack of moisture.

Equipment limitation is moderate to severe because of steep slopes and rock outcrops.

Erosion can be a severe problem on these soils. Because of the very shallow, loose, loamy soil and the steep slopes, these soils are subject to severe erosion when adequate cover is lacking. Use pine seedlings in new plantings because they are better adapted and survive better than hardwoods.

Woodland group 9. The soils in this group are moderately to rapidly permeable. They are light colored and have medium-textured A horizons, often with stones present. Soil depth, root penetration, and water-holding capacity depend upon the underlying rock strata (whether consolidated or unconsolidated) and the degree of erosion.

The following soils are in this group:

- Wellston-Muskingum complex, 7- to 12-percent slopes, moderately eroded (339-425$\overline{D}$ or Z$\overline{D}$)
- Wellston-Muskingum complex, 7- to 12-percent slopes, severely eroded (339-425$\underline{D}$ or Z$\underline{D}$)
- Wellston-Muskingum complex, 12- to 18-percent slopes, moderately eroded (339-425$\overline{E}$ or Z$\overline{E}$)
- Wellston-Muskingum complex, 12- to 18-percent slopes, severely eroded (339-425$\underline{E}$ or Z$\underline{E}$)
- Wellston-Muskingum complex, 18- to 30-percent slopes, moderately eroded (339-425$\overline{F}$ or Z$\overline{F}$)
- Wellston-Muskingum complex, 18- to 30-percent slopes, severely eroded (339-425$\underline{F}$ or Z$\underline{F}$)
- Wellston-Muskingum complex, over 30-percent slopes, moderately eroded (339-425$\overline{G}$ or Z$\overline{G}$)
- Wellston-Muskingum complex, limestone variants, 12- to 18-percent slopes, moderately eroded (L339-425$\overline{E}$ or LZ$\overline{E}$)
- Wellston-Muskingum complex, limestone variants, 18- to 30-percent slopes, moderately eroded (L339-425$\overline{F}$ or LZ$\overline{F}$)
- Wellston-Muskingum complex, limestone variants, 18- to 30-percent slopes, severely eroded (L339-425$\underline{F}$ or LZ$\underline{F}$)

Competition from undesirable species such as post oak and sassafras may be a problem on eroded areas. Generally, however, plant competition is moderate and does not prevent an adequate stand from becoming established. Seedling mortality is slight to moderate. Regenerating desirable species may be somewhat restricted, especially on steep slopes.

Equipment limitation is slight to moderate. There is no restriction on the kind of equipment or on the time of year it can be used.

The erosion hazard is severe on steeper slopes. When logging and hauling, avoid making wheel ruts that run up and down hill. Such ruts can increase the erosion hazard when they are filled with water. Pine seedlings survive better than hardwood seedlings and should be planted on severely eroded areas.

Pine Plantations

Poor agricultural practices have reduced many acres in southern Illinois to the point where they are no longer suitable for field crops and should be returned to some type of forest cover. Hardwood species do poorly on many of these degraded sites, making it necessary to find more tolerant coniferous species.

Two species — shortleaf pine and loblolly pine — have been widely planted and seem to be well adapted to southern Illinois, although they are growing near the northern limit of their natural range. Growth and yield data (Table 22) from plantations of these species in southern Illinois are encouraging, and pine will probably play an important part in the future forest economy of the area.

An example of yields that can be expected from shortleaf pine is found in results of a 1958 thinning study (*2*) of a plantation established in 1937. The soil was slightly eroded Grantsburg silt loam (woodland group 5). Total yield for both thinned and unthinned stands was 2,775 cubic feet or 30.9 cords per acre. This represents an average annual growth of nearly 2.5 cords per acre per year for the period 1950 to 1958 or about 1.5 cords per acre per year for the 21-year life of the plantation. While thinning has had little effect on total yield, trees on the thinned plots are larger and of better quality than those on the unthinned checks.

Comparable yields were obtained on another 21-year-old shortleaf pine plantation growing on Robbs silt loam (woodland group 4). On a severely eroded phase of Grantsburg silt loam, however, yields were about one-third less for a plantation of the same species and age. But even on the poorer site, yields

Table 22. — GROWTH DATA FOR PINE PLANTATIONS IN SOUTHERN ILLINOIS

Soil map symbol	Woodland group	Species of pine	Age	Height of dominant trees	Average diameter	Basal area	Cords
			yrs.	*ft.*	*in.*	*sq. ft./acre*	
164B	4	Loblolly	32	67	10.9	130	42
214$\overline{C}$	5	Loblolly	28	70	8.9	100[a]	32
214$\overline{D}$	5	Shortleaf	19	34	4.9	155	19
214$\underline{D}$	5	Loblolly	15	35	5.0	122	14
214$\underline{E}$	5	Loblolly	23	38	6.8	127	20
215$\underline{D}$	6	Loblolly	28	55	8.3	120	28
301C	5	Shortleaf	21	40	6.4	175	28
301$\overline{C}$	5	Shortleaf	11	30	3.9	93	14
301$\overline{C}$	5	Loblolly	11	35	4.5	127	20
301$\overline{C}$	5	Loblolly	19	45	6.4	154	26
301$\overline{D}$	5	Shortleaf	19	35	5.1	148	23
301$\underline{D}$	5	Shortleaf	22	30	5.3	136	19
335B	4	Shortleaf	24	45	6.0	200	24

[a] Plantation had been thinned.

were favorable from the standpoint of pulpwood production.

Pine plantations in Johnson county are subject to a number of hazards. Loblolly pine is particularly susceptible to damage from severe ice storms such as those which occurred in 1950 and 1952. This risk is fairly common throughout the range of loblolly pine. Shortleaf pine is also subject to glaze damage but not to the same extent as loblolly.

Shortleaf pine is extremely susceptible to attacks by the Nantucket pine-tip moth. Such attacks seldom kill trees but may retard growth in height and cause stem deformities. In particularly bad years, trees have been observed that made no net growth in height because terminal shoots were continually killed back.

Although outbreaks of defoliators such as the pine sawfly have occurred, they have not represented a serious threat to pine plantations in Johnson county.

Engineering Properties of Johnson County Soils[1]

The following section summarizes the engineering characteristics of Johnson county soils and points out principal soil features affecting engineering practices. It is provided to help engineers interpret the soil survey information for engineering purposes.

The information in this report provides a guide for engineers — not a complete manual. Its main value is for preliminary studies of land use and soil properties important to construction and engineering uses. For example, preliminary estimates can be made of the soils' engineering properties for flood prevention, agricultural drainage systems, farm ponds, irrigation systems, diversion terraces, and waterways. Another use of the information is in selecting possible sites for highways, airports, industry, business, residences, and recreation. Suitability of soils for cross-country movements of vehicles and construction equipment can be determined. And probable sources of gravel, sand, limestone, and other construction materials can be located.

To be most helpful, the soil survey information should be supplemented by information from other maps, reports, and aerial photographs. Results of the soil survey do not eliminate the need for soil testing and sampling. This must still be done before specific engineering works can be designed and constructed.

Engineering classification systems. Two systems for classifying soils are in general use among engineers. Both will be used in this report. These classification systems are explained in the PCA Soil Primer (*16*) and in the Michigan State Highway soil engineering manual (*14*).

Most highway engineers classify soil materials according to the system approved by the American Association of State Highway Officials (AASHO). All soil materials are classified in seven principal groups based on mechanical analysis and plasticity test data. These groups range from A-1 (gravelly soils of high bearing-capacity — the best soils for subgrades) to A-7 (clay soils having low strength when wet — the poorest soils for subgrades). Within each of the principal groups the relative engineering value of the soil material is indicated by a group index number, ranging from 0 for the best materials to 20 for the poorest. The group index number is in parentheses after the soil group symbol.

Some engineers prefer to use the Unified Soil Classification System, established by the Waterways Experimental Station, Corps of Engineers. In this system soils are identified according to texture, plasticity, and performance as engineering construction materials.

Soil data related to engineering. Test data were available for ten soil types in Johnson county (Table 23). Samples were tested by standard procedures in the laboratories of the Illinois State Division of Highways or the Bureau of Public Roads. These samples do not represent the entire range of soil characteristics in the county or even within the ten soil types sampled. The test results, however, can be used as a general guide in estimating the physical properties of the soils in the county.

Soil properties significant to engineering are listed in Table 24 by major soil layers for each soil type. Wherever possible the information in the table is based on test data. Field observations were also made and the figures in Table 24 represent average site conditions. The brief descriptions in the table summarize important soil profile features for engineering purposes. In many cases, however, the engineer will find it advantageous to read the detailed soil profile descriptions beginning on page 13 of this report.

The soils of Johnson county are evaluated in Table 25 as to their suitability for specific engineering practices. These soil features, based on test data and observations of field performance, affect the selection, design, and application of engineering practices.

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[1] The authors are indebted to H. L. Davenport, Area Engineer, SCS, Anna, Illinois, and to W. D. Parks, Soil Scientist, SCS, Anna, Illinois, for their assistance in the preparation of this section of the report. Credit is also due to T. H. Thornburn, Civil Engineering Dept., University of Illinois, for reviewing this section.

Table 23. — ENGINEERING TEST DATA FOR TEN SOIL TYPES IN JOHNSON COUNTY

Soil type name and number	Location	Horizon and depth in inches from surface	Classification		Particle size distribution, percent[a]				Maximum dry density (lb./cu. ft.)	Optimum moisture (percent)	Liquid limit	Plasticity index
			AASHO	Unified	Passing #40 sieve, 0.42 mm.	Passing #200 sieve, 0.074 mm.	<.02 mm.	Clay <.002 mm.				
Belknap silt loam (382)	Johnson Co., T13S, R3E, Sec. 21, SW160, NW40, NE10.	12–24	A-4(8)[b]	ML	99	89	...	26	106	17	30.1	7.5
		48–72	A-4(8)	CL or ML	100	96	...	15	107	16	23.8	....
	Wabash Co., T2N, R12W, Sec. 33, NE160, SW40, NE10.	0–6	A-4(8)	ML	100	92	63	17	104	17	25.0	2.0
		6–23	A-4(8)	ML	100	89	57	20	108	15	24.0	3.0
		27–59	A-4(8)	ML	99	86	53	17	111	15	22.0	1.0
Bonnie silt loam (108)	Johnson Co., T11S, R4E, Sec. 2, NE160, NW40, NE10.	12–72	A-4(8)	CL	...	91	...	24	106	17	27.3	8.2
		72–120	A-4(8)	CL	...	89	...	26	106	17	29.4	10.6
Ginat silt loam (460)	Johnson Co., T14S, R2E, Sec. 7, NW160, NW40, SW10.	A 6–18	A-4(8)	CL	89	84	...	...	108	16	28.1	10.1
		A+B 12–24	A-6(11)	CL	100	93	...	...	105	19	36.4	17.1
		B+C 24–54	A-6(11)	CL	100	87	...	...	105	18	35.2	17.6
		C 54–72	A-6(11)	CL	98	83	...	...	106	17	32.0	14.6
Grantsburg silt loam (301)	Johnson Co., T11S, R4E, Sec. 10, NW160, NW40, SW10.	B 0–18	A-6(10)	CL	100	97	...	...	105	18	37.2	15.0
		B 18–36	A-6(9)	CL	100	97	...	...	105	18	37.6	13.9
		B′ 36–72	A-6(9)	CL	100	96	...	...	105	18	33.5	12.8
		C 72–84	A-4(8)	CL–ML	96	81	...	...	107	16	23.0	5.6
		D 84–114	A-6(4)	CL	...	56	...	...	111	15	26.9	10.7
Hosmer silt loam (214)	Johnson Co., T11S, R2E, Sec. 19, NW160, NW40, NE10.	A+B 0–24	A-4(8)	ML	100	97	...	...	106	17	29.8	6.3
		B 24–36	A-6(10)	CL	100	98	...	...	105	18	36.9	15.2
		C 36–72	A-4(8)	CL	100	95	...	...	106	17	29.8	8.6
		C 72–84	A-6(10)	CL	100	89	...	...	105	18	31.6	14.8
	Wabash Co., T1N, R12W, Sec. 9, NW160, NE40, NE10, NE1.	A_p 0–6	A-4(8)	ML–CL	99	96	62	9	105	16	26.0	4.0
		B_2 14–27	A-7-6(13)	ML–CL	...	99	70	31	103	20	45.0	19.0
		B'_3 38–60	A-6(9)	ML–CL	...	99	64	21	109	17	34.0	12.0
Karnak clay (426)	Johnson Co., T14S, R2E, Sec. 7, NW160, NW40, SE10.	4–18	A-7-6(16)	CL	100	93	...	...	99	22	45.9	28.0
		18–42	A-7-6(20)	CH	100	100	...	...	95	25	54.7	34.6
Piopolis silty clay loam (420)	Pulaski Co., T14S, R2E, Sec. 15, NE160, NE40, SE10.	0–30	A-6(11)	CL	92	76	...	...	105	18	34.9	17.3
		30–54	A-6(10)	CL	92	73	...	...	107	17	32.3	16.5
		54–72	A-6(11)	CL	95	70	...	...	106	18	35.0	19.1
Sciotoville silt loam (462)	Johnson Co., T14S, R2E, Sec. 11, SW160, SW40, NE10.	B 12–54	A-6(12)	CL	100	94	...	...	105	19	39.5	19.5
		C 54–72	A-6(12)	CL	100	94	...	...	105	19	37.0	19.6
Wartrace silt loam (215)	Johnson Co., T13S, R2E, Sec. 31, NE160, SE40, NE10.	A 0–7	A-4(8)	ML–CL	100	98	...	...	106	17	28.0	5.0
		B 7–14	A-7-6(14)	CL	100	97	...	...	101	20	47.1	22.0
		C 12–126	A-4(8)	ML	100	96	...	...	106	17	33.5	8.5
		D 126–144	A-7-6(20)	CH	100	98	...	...	93	25	62.0	42.0
Wheeling silt loam (463)	Johnson Co., T14S, R2E, Sec. 7, NE160, SE40, NE10.	B 12–42	A-6(13)	CL	98	78	...	...	106	16	39.1	23.5
		C 42–60	A-2-4	SM or SC	...	27	...	...	114	12	17.9	...
		C 60–72	A-4(4)	ML	...	53	...	...	112	15	21.2	0.6

[a] Particle size distribution was run by sieve and hydrometer analysis. One hundred percent of all soils tested passed the No. 10 (2.0 mm.) sieve.
[b] Numbers in parenthesis refer to group indexes which range from 0 for the best material to 20 for the poorest material for engineering purposes.

Table 24. — SOIL PROPERTIES SIGNIFICANT TO ENGINEERING[a]

Soil type name, number, and description	Depth to seasonal high water table (ft.)	Depth to bedrock (ft.)	Depth from surface (in.)	Probable classification: AASHO	Probable classification: Unified	Range in permeability (in./hr.)	Available water (in./in. of depth)	Reaction (pH)	Shrink-swell potential
Belknap silt loam (382) Silt loam to depth of at least 5 ft. In some narrow bottoms rock may be present below 40″.	0–3	10 (average) 3½ (minimum)	0–60	A-4(6-8)[b]	ML	.2–.8	.30	4.8–5.8	Moderate to low
Bonnie silt loam (108) Silt loam to depth of at least 5 ft. In some narrow bottoms rock may be present below 40″.	0–3	10 (average) 3½ (minimum)	0–20	A-4(8)	ML or CL	.2–.8	.30	4.6–5.8	Moderate to low
			20–35	A-4(8)	CL	.05–.2	.30	4.5–5.8	Moderate to low
			35–60	A-4(8)	CL	.2–.8	.30	4.5–5.8	Moderate to low
Burnside silt loam (427) Silt loam to depths of 1 to 3½ ft. over stones or bedrock.	......	1–3½	0–30	A-4(6-8)	ML	.2–.8	.24	4.5–5.8	Moderate to low
			30–40	Variable	Variable	......	...	....	....
Darwin clay (71) Silty clay to clay to depth of at least 5 ft.	0–3	10+	0–36	A-7-6(20)	CH	.05–.2	.19	5.8–6.5	Very high
			36–60	A-7-6(20)	CH	.00–.05	.19	5.8–7.5	Very high
Dupo silt loam (180) Silt loam 1½ to 3½ ft. over silty clay loam to clay to depth of at least 5 ft.	0–3	10+	0–24	A-4(6-8)	ML	.2–.8	.28	5.8–6.5	Moderate to low
			24–60	A-7-6(20)	CH	.05–.2	.19	5.8–7.5	Very high
Ginat silt loam (460) Silt loam 1½ ft. thick over 2 ft. of silty clay loam, underlain by several feet of mixed sediments.	0–3	10+	0–18	A-4(8)	CL	.05–.2	.24	5.1–6.2	Moderate to low
			18–42	A-6(11)	CL	.05–.2	.22	4.5–5.8	Moderate to high
			42–60	A-6(10-11)	CL	.2–.8	.23	5.0–7.0	Moderate to high
Grantsburg silt loam (301) 1 ft. of silt loam over 1½ ft. of silty clay loam, over 3 to 4 ft. of compacted silt loam to silty clay loam (fragipan) underlain by silt loam over sandstone or occasionally shale bedrock.	10+	3½–8	0–12	A-4(8)	CL	.8–2.5	.24	5.0–6.0	Moderate to high
			12–30	A-6(8-12)	CL	.2–.8	.27	4.6–5.5	Moderate to high
			30–60	A-6(8-11)	CL	.05–.2	.28	4.8–5.8	Moderate to high
Hosmer silt loam (214) 1 ft. of silt loam over 2 ft. of silty clay loam, over 2 to 3 ft. of compacted heavy silt loam (fragipan) underlain by silt loam over sandstone or occasionally shale.	10+	6–12 (average) 3½ (minimum)	0–12	A-4(8)	ML–CL	.8–2.5	.24	5.0–6.0	Moderate to high
			12–30	A-6(10)	ML–CL	.2–.8	.27	4.6–5.5	Moderate to high
			30–60	A-6(9-11)	ML–CL	.05–.2	.28	4.6–5.5	Moderate to high
			60+	A-4(7-8)	CL	.2–.8	...	4.6–6.0	Moderate
Karnak clay (426) Clay to a depth of at least 5 ft.	0–3	10+	0–20	A-7-6(16-20)	CL	.05–.2	.18	5.0–7.0	Very high
			20–60	A-7-6(20)	CH	.00–.05	.18	5.5–7.0	Very high
Piopolis silty clay loam (420) Silty clay loam to a depth of at least 5 ft.	0–3	10+	0–42	A-6(10-11)	CL	.05–.2	.21	4.8–5.8	High
			42–60	A-6(11)	CL	.00–.05	.20	5.0–5.8	High
Robbs silt loam (335) 1½ ft. of silt loam over 2 ft. of silty clay loam, over silt loam underlain by bedrock.	5–10+	5–8	0–12	A-4(8)	ML	.2–.8	.26	5.0–6.0	Moderate to low
			12–36	A-6(10-11)	CL	.05–.2	.28	4.6–5.5	Moderate to high
			36–60	A-6(8-11)	ML or CL	.2–.8	.30	4.8–5.8	Moderate to high
Rocky limestone land (94) Less than 1 ft. of stony silt over limestone bedrock with rock outcrops common.	......	0–1	0–6	......	......	.8–2.5	...	5.1–6.0	Low

Table 24. — Concluded

Soil type name, number, and description	Depth to seasonal high water table (ft.)	Depth to bedrock (ft.)	Depth from surface (in.)	Probable classification		Range in permeability (in./hr.)	Available water (in./in. of depth)	Reaction (pH)	Shrink-swell potential
				AASHO	Unified				
Rocky sandstone land (9) Less then 1 ft. of stony silt loam over sandstone bedrock with rock outcrops common.	....	0-1	0-6	......	......	.8-2.5	...	4.5-5.8	Low
Sciotoville silt loam (462) 1 to 1½ ft. of silt loam over 2½ ft. of silty clay loam, underlain by mixed silty clay loam, clay loam, and silt loam sediments.	10+	10+	0-12	A-4(8)	ML	.8-2.5	.24	4.5-5.5	Moderate to low
			12-42	A-6(12)	CL	.2-.8	.23	4.5-5.5	High
			42-60	A-6(12)	CL	.2-2.5	.19	5.0-6.0	High
Sharon silt loam (72) Silt loam to depth of at least 5 ft. In some narrow bottoms rock may be present below 40".	5-10	10 (average) 3½ (minimum)	0-60	A-4(8)	ML	.8-2.5	.27	5.0-5.8	Moderate to low
Stoy silt loam (164) 1½ ft. of silt loam over 2 ft. of silty clay loam over silt loam, underlain by silt loam on sandstone bedrock.	5-10	8-10	0-12	A-4(8)	ML	.2-.8	.26	5.0-6.0	Moderate to low
			12-36	A-6(10-11)	CL	.05-.2	.28	4.6-6.0	Moderate to high
			36-60	A-6(8-11)	CL	.2-.8	.30	4.8-6.0	Moderate to high
Unity sandy loam (175) 1½ ft. of sandy loam over 1 to 1½ ft. of loam to sandy clay loam over several feet of loamy sand to sand.	10+	10+	0-18	A-4(2-4)	ML	.8-2.5	.09	5.0-6.0	Low
			18-36	A-4(2-4)	CL-ML	.8-2.5	.10	4.8-5.5	Low
			36-60	A-2-4	SP-SM	2.5-5.0	.03	5.0-6.5	Low
Wartrace silt loam (215) 1 ft. of silt loam over 2 ft. of silty clay loam, over silt loam underlain by limestone bedrock.	10+	5-15	0-12	A-4(8)	ML-CL	.8-2.5	.23	5.1-6.0	Moderate to low
			12-36	A-6(10-13)	CL	.2-.8	.23	4.9-5.5	High
			36-60	A-6(9-10)	CL	.8-2.5	.30	5.1-5.5	Moderate to high
Weinbach silt loam (461) 1½ ft. of silt loam over 2 ft. of silty clay loam, underlain by clay loam to loam sediments.	5-10	10+	0-12	A-4(8)	ML	.2-.8	.26	5.1-6.0	Moderate to low
			12-36	A-6(10-11)	CL	.05-.2	.26	4.5-5.5	Moderate to high
			36-60	A-6(10-12)	CL	.2-2.5	.22	5.1-6.5	Moderate to high
Wellston-Muskingum complex (339-425) ½ to 1 ft. of silt loam over ½ to 1 ft. of light silty clay loam, underlain by sandstone bedrock with stones present in upper layers and on surface.	....	½-1½	0-12	......	......	.8-2.5	...	4.8-5.5	Low
Wellston-Muskingum complex, limestone variants (L339-425) Same as 339-425 except stones and bedrock are limestone rather than sandstone.	....	½-1½	0-12	......	......	.8-2.5	...	5.0-5.5	Low
Wheeling silt loam (463) 1 to 1½ ft. of silt loam over 1½ ft. of silty clay loam or clay loam, underlain by loam, sandy loam, or loamy sand sediments.	10+	10+	0-12	A-4(8)	ML	.8-2.5	.24	4.6-5.5	Moderate to low
			12-30	A-6(13)	CL	.8-2.5	.23	4.5-5.8	High
			30-60	A-2-4	SM or SC	.8-5.0	.16	5.0-6.0	Low
Zanesville silt loam (340) 1 ft. of silt loam over 1 to 2 ft. of silty clay loam, underlain by sandstone and occasionally shale bedrock.	....	1½-3½	0-12	A-4(8)	ML	.8-2.5	.24	5.0-6.0	Moderate to low
			12-36	A-6(10-13)	CL	.2-.8	.27	4.6-5.5	Moderate to high

[a] The information in this table is based on data (see Table 23) wherever possible. Where data were unavailable, estimates were made.
[b] Numbers in parenthesis refer to group indexes which range from 0 for the best to 20 for the poorest material for engineering purposes.

Table 25. — SUITABILITY OR NEED OF SOILS FOR SPECIFIC HIGHWAY AND AGRICULTURAL ENGINEERING PRACTICES[a]

Soil type name and No.	Suitability in highway construction: For winter grading	Suitability in highway construction: As source of: Topsoil	Suitability in highway construction: As source of: Sand and gravel	Suitability in highway construction: For vertical alignment of highways: Materials	Suitability in highway construction: For vertical alignment of highways: Drainage	Suitability for ponds: Embankments	Suitability for ponds: Reservoirs	Drainage needs	Suitability for sprinkler irrigation	Need for graded terraces and diversions	Need for sod waterways
Belknap silt loam (382)	Poor. High water table, highly susceptible to frost action.	Fair.	Poor.	Bedrock may be close to surface.	Seepage at bedrock; high water table. Frequent flooding.	Poor stability. Fills over 15′ high need 10′ wide stability berm at mid-height on downstream side. Use sheepsfoot roller.	Fair to poor. Check depth to bedrock. Consider use of sealant additive to reduce seepage loss.	Surface ditches recommended.	Suitable. Low to moderate intake rate.	Use diversions to intercept upland runoff.	Not needed.
Bonnie silt loam (108)	Poor. High water table, highly susceptible to frost action.	Poor.	Poor.	Bedrock may be close to surface.	Seepage at bedrock; high water table. Frequent flooding.	Poor stability. Fills over 15′ high need 10′ wide stability berm at mid-height on downstream slope of fill. Use sheepsfoot roller.	Fair to poor. Consider use of sealant additive to reduce seepage loss. Check depth to bedrock.	Tiling not recommended. Use surface ditches.	Questionable due to slow permeability in subsoil.	Use diversions to intercept upland runoff.	Not needed.
Burnside silt loam (427)	Poor. Bedrock at shallow depth, medium to high susceptibility to frost action.	Poor.	Poor.	Bedrock at shallow depth.	Seepage at bedrock.	Unsuitable.	Unsuitable.	Artificial drainage not needed.	Suitable if bedrock is below 24″ depth. Low to moderate intake rate.	Soil not suitable.	Not needed.
Darwin clay (71)	Poor. Clay with high water table, medium to high susceptibility to frost action.	Poor.	Poor.	Very plastic clay.	High water table. Frequent flooding.	Fair stability with flat side slopes. Use sheepsfoot roller. Good for cores and blankets. High shrinkage when dry.	Good.	Tiling not recommended. Use surface ditches.	Unsuitable.	Use diversions to intercept upland runoff.	Not needed.
Dupo silt loam (180)	Poor. High water table, highly susceptible to frost action.	Poor.	Poor.	Very plastic clay below 3′ depth.	High water table. Frequent flooding.	Fair to good. Use sheepsfoot roller.	Good.	Use ditches. Tiling is questionable due to variable depth to impervious layer.	Suitable with adequate drainage. Low to moderate intake rate.	Use diversions to intercept upland runoff.	Not needed.
Ginat silt loam (460)	Poor. High water table, highly susceptible to frost action.	Fair to poor.	Poor.	Plastic clay.	High water table.	Fair to good. Use sheepsfoot roller.	Good.	Tiling not recommended. Use surface ditches.	Unsuitable.	Not needed.	Not needed.
Grantsburg silt loam (301)	Fair. Medium to high susceptibility to frost action.	Good.	Poor.	Deep silt, unstable when wet.	Seepage at 2½′ depth.	Poor. Control moisture and use sheepsfoot roller. Fill heights of 18′ to 22′ need stability berm 10′ wide at midheight on downstream slope.	Fair to good. Check depth to bedrock.	Artificial drainage not needed.	Suitable. Low to moderate intake rate.	Adapted on suitable topography.	Needed. Fragipan at 2½′ to 3′ depth. Use lowest practicable velocity.

Table 25. — Continued

Soil type name and No.	Suitability in highway construction					Suitability for ponds		Drainage needs	Suitability for sprinkler irrigation	Need for graded terraces and diversions	Need for sod waterways
	For winter grading	As source of		For vertical alignment of highways							
		Topsoil	Sand and gravel	Materials	Drainage	Embankments	Reservoirs				
Hosmer silt loam (214)	Fair. Medium to high susceptibility to frost action.	Good.	Poor.	Deep silt, unstable when wet.	Seepage at 3′-4′ depth.	Poor. Control moisture and use sheepsfoot roller. Fill heights of 18′ to 22′ need 10′ wide stability berm at mid-height on downstream slope.	Fair.	Artificial drainage not needed.	Suitable. Low intake rate.	Terraces adapted on suitable topography.	Needed. Fragipan at 3′ depth. Use lowest practicable velocity.
Karnak clay (426)	Poor. Heavy clay with high water table, medium to high susceptibility to frost action.	Poor.	Poor.	Clay, very plastic.	Frequent flooding. High water table.	Fair stability with flat side slopes. Use sheepsfoot roller. Good core and blanket material. High shrinkage when dry.	Good.	Cannot be tiled. Use surface ditches.	Unsuitable.	Diversions may be useful in some locations but normally would not be economically feasible.	Not needed.
Piopolis silty clay loam (420)	Poor. High water table, medium to high susceptibility to frost action.	Poor.	Poor.	Plastic clay.	High water table. Frequent flooding.	Good. Use sheepsfoot roller.	Good.	Tiling is questionable. Use surface ditches.	Unsuitable.	Diversions may be useful in some locations but normally would not be economically feasible.	Not needed.
Robbs silt loam (335)	Fair. Highly susceptible to frost action.	Fair, if fertilized.	Poor.	Plastic clay; sandstone bedrock at 5′-8′ depth.	Seepage at 1½′ depth.	Good. Use sheepsfoot roller.	Good. Check depth to bedrock.	Tiling is questionable. Use surface ditches.	Unsuitable.	Terraces adapted on suitable topography	Needed on sloping areas.
Rocky limestone land (94)	Poor. Shallow to bedrock, low susceptibility to frost action.	Poor.	Poor.	Limestone bedrock within 12″ depth.	......	Unsuitable.	Unsuitable.	Artificial drainage not needed.	Unsuitable.	Soil not suitable.	Soil not suitable.
Rocky sandstone land (9)	Poor. Shallow to bedrock, low susceptibility to frost action.	Poor.	Poor.	Sandstone bedrock within 12″ depth.	......	Unsuitable.	Unsuitable.	Artificial drainage not needed.	Unsuitable.	Soil not suitable.	Soil not suitable.
Sciotoville silt loam (462)	Fair. Medium to high susceptibility to frost action.	Fair to good.	Poor.	Plastic clay.	......	Good. Use sheepsfoot roller.	Good, but check for underlying sand strata.	Artificial drainage not needed.	Suitable. Low to moderate intake rate.	Soil not suitable.	May be needed on sloping areas. Slopes usually short.
Sharon silt loam (72)	Fair. Medium to high susceptibility to frost action.	Good.	Poor.	Silt to at least 5′ depth; unstable when wet.	Occasional flooding.	Poor. Unstable when wet. Control moisture and use sheepsfoot roller.	Good. Check depth to bedrock.	Use surface ditches.	Suitable. Moderate intake rate.	Use diversions to intercept upland runoff.	Usually not needed.

[a] All soils have severe limitations for use as septic tank sewage disposal fields except Unity, Wartrace, and Wheeling which have slight limitations and Sharon which has moderate to severe limitations depending on the degree of flooding hazard.

(Table is concluded on next page.)

Table 25. — Concluded

Soil type name and No.	Suitability in highway construction					Suitability for ponds		Drainage needs	Suitability for sprinkler irrigation	Need for graded terraces and diversions	Need for sod waterways
	For winter grading	As source of		For vertical alignment of highways		Embankments	Reservoirs				
		Topsoil	Sand and gravel	Materials	Drainage						
Stoy silt loam (164)	Fair. Medium to high susceptibility to frost action.	Fair, if fertilized.	Poor.	Plastic clay; sandstone bedrock at 8′-10′ depth.	......	Fair to good. Use sheepsfoot roller.	Fair to good.	Tiling is questionable. Use surface ditches on level areas.	Unsuitable.	Terraces adapted on suitable topography.	Needed on sloping areas.
Unity sandy loam (175)	Good. Medium to low susceptibility to frost action.	Fair.	Poor.	Good subgrade material below 3′ depth.	Good internal drainage.	Poor. High piping hazard. Use sheepsfoot or rubber-tired roller.	Poor.	Artificial drainage not needed.	Suitable. Rapid intake rate. Low water-holding capacity.	Terraces adapted on suitable topography.	Needed on sloping areas. Soil somewhat drouthy.
Wartrace silt loam (215)	Fair. Medium to high susceptibility to frost action.	Good.	Poor.	Deep silt, unstable when wet.	Well drained.	Fair to poor. Control moisture. Fills 18′-22′ high need 10′ wide stability berm at mid-height. Use sheepsfoot roller.	Fair.	Artificial drainage not needed.	Suitable. Moderate intake rate.	Terraces adapted on suitable topography.	Needed. Design for lowest velocity practicable.
Weinbach silt loam (461)	Fair. Medium to high susceptibility to frost action.	Fair.	Poor.	Plastic clay.	......	Good. Use sheepsfoot roller.	Good.	Surface ditches recommended on level areas. Tiling is questionable.	Suitable. Low to moderate intake rate.	Terraces adapted on suitable topography.	Needed on sloping areas.
Wellston-Muskingum complex (339-425)	Poor. Very shallow to sandstone bedrock, low susceptibility to frost action.	Poor.	Poor.	Sandstone bedrock within 18″ depth.	Seepage at bedrock.	Unsuitable.	Unsuitable.	Artificial drainage not needed.	Unsuitable.	Soil not suitable.	Soil not suitable. Sandstone within 1½′ depth. Drouthy.
Wellston-Muskingum complex, limestone variants (L339-425)	Same as Wellston-Muskingum complex (339-425).										
Wheeling silt loam (463)	Good below 3′ depth. Medium to high susceptibility to frost action.	Good.	Poor.	Fair to good subgrade material below 2½′ depth.	......	Poor. High piping hazard. Use sheepsfoot or rubber-tired roller.	Poor.	Artificial drainage not needed.	Suitable. Moderate intake rate.	Terraces adapted on suitable topography.	Needed. Design for lowest practicable velocities.
Zanesville silt loam (340)	Poor. Shallow to bedrock, medium to high susceptibility to frost action.	Good, if bedrock is not too shallow.	Poor.	Sandstone bedrock within 3½′ depth.	Seepage at bedrock.	Unsuitable.	Unsuitable.	Artificial drainage not needed.	Suitable if not too shallow to bedrock. Moderate intake rate.	Terraces adapted where not too shallow to bedrock.	Needed. Design for lowest practicable velocities.

[a] All soils have severe limitations for use as septic tank sewage disposal fields except Unity, Wartrace, and Wheeling which have slight limitations and Sharon which has moderate to severe limitations depending on the degree of flooding hazard.

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GLOSSARY

Aggregate — many fine soil particles held in a single mass, such as a clod, crumb, block, or prism.

Alluvial sediment — particles of different size carried by running water and left on the floodplains.

Available water — an approximation (in inches per inch of soil depth) of the capillary water in the soil when wet to field capacity. When the soil is air dry, the available water will moisten the soil to a depth of one inch.

Clay — a soil separate with mineral particles of less than .002 mm. in diameter. Clay, as a textural class, contains 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Claypan — compact soil horizon high in clay content and having a rather abrupt textural change from the overlying horizon.

Compact — said of soils that are difficult to penetrate, being made up of particles so closely packed that there is relatively little pore space between them.

Concretions — small hard nodules, or lumps, of mixed composition, shapes, and coloring (limestone concretions and dark rounded pellets of iron-manganese are common).

Fragipan — compact soil horizon high in silt and relatively low in clay content. When dry, it is very hard and brittle; when moist, the apparent cementation disappears.

Friable — easily crumbled or crushed in the fingers; a desirable physical condition in soils.

Glacial drift — any material carried by the ice or waters of glaciers and deposited either as layers of particles sorted by size or as mixed materials.

Granular structure — individual grains grouped into spherical aggregates with indistinct sides. Highly porous granules are commonly called crumbs.

Intake rate — the rate at which rain or irrigation water enters the soil (generally expressed in inches per hour). This rate is controlled partly by surface conditions (infiltration rate) and partly by subsurface conditions (permeability). It also varies with the method of applying water. The same kind of soil has different intake rates under sprinkler irrigation, border irrigation, and furrow irrigation.

Leached — dissolved and washed out of or down through the soil. This has happened with the more soluble materials, such as limestone.

Liquid limit — the moisture content at which soil passes from a plastic to a liquid state.

Mapping unit — a subdivision of a soil type having limited range in slope and in thickness of remaining surface and subsurface soil, but having a large enough area to be shown on the soil map.

Maximum dry density — the highest dry density obtained in the compaction test.

Moisture density — if a soil material is compacted at successively higher moisture contents, assuming that the compaction force remains constant, the density of the compacted material will increase until the optimum moisture content is reached. Then the density decreases with further increases in moisture content. Data showing moisture density 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 about the optimum moisture content.

Percent slope — the slant of a slope stated in percent; for example a 15-percent slope changes 15 feet in elevation for each 100 feet horizontal distance.

Permeability — the rate air or water moves through soil material in place. Permeability depends largely upon soil texture and structure.

Plastic limit — the moisture content at which soil passes from a solid to a plastic state.

Plasticity index — the numerical difference between the liquid limit and the plastic limit. The plasticity index indicates the range of moisture content within which a soil material is plastic.

Road subgrade — the soil material below the finished grade on which the base material and then the pavement are placed.

Sand — a soil separate having mineral particles ranging from 2.00 mm. to .05 mm. in diameter. As a textural class, sand contains 85 percent or more sand and not more than 15 percent clay.

Shrink-swell potential — indicates the volume change to be expected of soil material with changes in moisture content.

Silt — a soil separate having mineral particles ranging from .05 mm. to .002 mm. in diameter. As a textural class, silt contains 80 percent or more silt and less than 12 percent clay.

Weathered — disintegrated and decomposed by the action of natural elements, such as air, rain, sunlight, freezing, thawing, etc. Weathered soils are soils that have been leached and changed physically and chemically.

GUIDE TO MAPPING UNITS

Soil map symbol	Name of mapping unit	Description	Management group		Woodland group	
		Page	Symbol	Page	No.	Page
382A	Belknap silt loam, 0 to 1.5 percent slopes	13	IIw-1	44	1	57
382B	Belknap silt loam, 1.5 to 4 percent slopes	13	IIw-1	44	1	57
108A	Bonnie silt loam	15	IIIw-2	47	2	57
427A	Burnside silt loam, 0 to 1.5 percent slopes	16	IIs-1	45	7	60
427B	Burnside silt loam, 1.5 to 4 percent slopes	16	IIs-1	45	7	60
71A	Darwin clay	16	IIIw-1	46	2	57
180A	Dupo silt loam	17	I-1	42	1	57
460A	Ginat silt loam	18	IIIw-3	47	3	58
301B or XB	Grantsburg silt loam, 1.5 to 4 percent slopes	19	IIe-3	43	5	58
301$\overline{B}$ or X$\overline{B}$	Grantsburg silt loam, 1.5 to 4 percent slopes, moderately eroded	19	IIe-3	43	5	58
301C or XC	Grantsburg silt loam, 4 to 7 percent slopes	19	IIIe-2	46	5	58
301$\overline{C}$ or X$\overline{C}$	Grantsburg silt loam, 4 to 7 percent slopes, moderately eroded	19	IIIe-2	46	5	58
301$\underline{C}$ or X$\underline{C}$	Grantsburg silt loam, 4 to 7 percent slopes, severely eroded	19	IVe-1	48	5	58
301D or XD	Grantsburg silt loam, 7 to 12 percent slopes	19	IIIe-2	46	5	58
301$\overline{D}$ or X$\overline{D}$	Grantsburg silt loam, 7 to 12 percent slopes, moderately eroded	19	IIIe-2	46	5	58
301$\underline{D}$ or X$\underline{D}$	Grantsburg silt loam, 7 to 12 percent slopes, severely eroded	19	IVe-1	48	5	58
301$\overline{E}$ or X$\overline{E}$	Grantsburg silt loam, 12 to 18 percent slopes, moderately eroded	19	IVe-1	48	5	58
301$\underline{E}$ or X$\underline{E}$	Grantsburg silt loam, 12 to 18 percent slopes, severely eroded	19	VIe-1	49	5	58
214B or WB	Hosmer silt loam, 1.5 to 4 percent slopes	20	IIe-3	43	5	58
214$\overline{B}$ or W$\overline{B}$	Hosmer silt loam, 1.5 to 4 percent slopes, moderately eroded	20	IIe-3	43	5	58
214C or WC	Hosmer silt loam, 4 to 7 percent slopes	20	IIIe-2	46	5	58
214$\overline{C}$ or W$\overline{C}$	Hosmer silt loam, 4 to 7 percent slopes, moderately eroded	20	IIIe-2	46	5	58
214$\underline{C}$ or W$\underline{C}$	Hosmer silt loam, 4 to 7 percent slopes, severely eroded	20	IVe-1	48	5	58
214D or WD	Hosmer silt loam, 7 to 12 percent slopes	20	IIIe-2	46	5	58
214$\overline{D}$ or W$\overline{D}$	Hosmer silt loam, 7 to 12 percent slopes, moderately eroded	20	IIIe-2	46	5	58
214$\underline{D}$ or W$\underline{D}$	Hosmer silt loam, 7 to 12 percent slopes, severely eroded	20	IVe-1	48	5	58
214E or WE	Hosmer silt loam, 12 to 18 percent slopes	20	IVe-1	48	5	58
214$\overline{E}$ or W$\overline{E}$	Hosmer silt loam, 12 to 18 percent slopes, moderately eroded	20	IVe-1	48	5	58
214$\underline{E}$ or W$\underline{E}$	Hosmer silt loam, 12 to 18 percent slopes, severely eroded	20	VIe-1	49	5	58
214$\overline{F}$ or W$\overline{F}$	Hosmer silt loam, 18 to 30 percent slopes, moderately eroded	20	VIe-1	49	5	58
214$\underline{F}$ or W$\underline{F}$	Hosmer silt loam, 18 to 30 percent slopes, severely eroded	20	VIIe-1	50	5	58
426A	Karnak clay	21	IIIw-1	46	2	57
420A	Piopolis silty clay loam	22	IIIw-1	46	2	57
335A	Robbs silt loam, 0 to 1.5 percent slopes	23	IIw-2	44	4	58
335B	Robbs silt loam, 1.5 to 4 percent slopes	23	IIe-4	44	4	58
94$\overline{F}$	Rocky limestone land, 18 to 30 percent slopes, moderately eroded	23	VIIs-1	50	8	60
94$\overline{G}$	Rocky limestone land, over 30 percent slopes, moderately eroded	23	VIIs-1	50	8	60
9$\overline{E}$	Rocky sandstone land, 12 to 18 percent slopes, moderately eroded	24	VIIs-1	50	8	60
9$\overline{F}$	Rocky sandstone land, 18 to 30 percent slopes, moderately eroded	24	VIIs-1	50	8	60
9$\overline{G}$	Rocky sandstone land, over 30 percent slopes, moderately eroded	24	VIIs-1	50	8	60
462A	Sciotoville silt loam, 0 to 1.5 percent slopes	25	IIw-2	44	6	59
462B	Sciotoville silt loam, 1.5 to 4 percent slopes	25	IIe-2	43	6	59
462$\overline{C}$	Sciotoville silt loam, 4 to 7 percent slopes, moderately eroded	25	IIe-2	43	6	59
462$\overline{D}$	Sciotoville silt loam, 7 to 12 percent slopes, moderately eroded	25	IIIe-1	45	6	59
72A	Sharon silt loam, 0 to 1.5 percent slopes	26	I-1	42	1	57
72B	Sharon silt loam, 1.5 to 4 percent slopes	26	IIe-1	43	1	57
164A	Stoy silt loam, 0 to 1.5 percent slopes	27	IIw-2	44	4	58
164B	Stoy silt loam, 1.5 to 4 percent slopes	27	IIe-4	44	4	58
175A	Unity sandy loam, 0 to 1.5 percent slopes	28	IIIs-1	47	6	59
175B	Unity sandy loam, 1.5 to 4 percent slopes	28	IIIs-1	47	6	59
175$\overline{C}$	Unity sandy loam, 4 to 7 percent slopes, moderately eroded	28	IIIs-1	47	6	59
215B	Wartrace silt loam, 1.5 to 4 percent slopes	28	IIe-2	43	6	59
215C	Wartrace silt loam, 4 to 7 percent slopes	28	IIe-2	43	6	59
215$\overline{C}$	Wartrace silt loam, 4 to 7 percent slopes, moderately eroded	28	IIe-2	43	6	59
215$\overline{D}$	Wartrace silt loam, 7 to 12 percent slopes, moderately eroded	28	IIIe-1	45	6	59
215$\underline{D}$	Wartrace silt loam, 7 to 12 percent slopes, severely eroded	28	IVe-1	48	6	59

(Guide is concluded on next page.)

GUIDE TO MAPPING UNITS — Concluded

Soil map symbol	Name of mapping unit	Description	Management group		Woodland group	
		Page	Symbol	Page	No.	Page
215$\overline{E}$	Wartrace silt loam, 12 to 18 percent slopes, moderately eroded	28	IVe-1	48	6	59
215$\underline{E}$	Wartrace silt loam, 12 to 18 percent slopes, severely eroded	28	VIe-1	49	6	59
215$\overline{F}$	Wartrace silt loam, 18 to 30 percent slopes, moderately eroded	28	VIe-1	49	6	59
461A	Weinbach silt loam, 0 to 1.5 percent slopes	30	IIw-2	44	4	58
461B	Weinbach silt loam, 1.5 to 4 percent slopes	30	IIe-4	44	4	58
461$\overline{C}$	Weinbach silt loam, 4 to 7 percent slopes, moderately eroded	30	IIIe-3	46	4	58
339-425$\overline{D}$ or Z$\overline{D}$	Wellston-Muskingum complex, 7 to 12 percent slopes, moderately eroded	31	VIIs-1	50	9	61
339-425$\underline{D}$ or Z$\underline{D}$	Wellston-Muskingum complex, 7 to 12 percent slopes, severely eroded	31	VIIs-1	50	9	61
339-425$\overline{E}$ or Z$\overline{E}$	Wellston-Muskingum complex, 12 to 18 percent slopes, moderately eroded	31	VIIs-1	50	9	61
339-425$\underline{E}$ or Z$\underline{E}$	Wellston-Muskingum complex, 12 to 18 percent slopes, severely eroded	31	VIIs-1	50	9	61
339-425$\overline{F}$ or Z$\overline{F}$	Wellston-Muskingum complex, 18 to 30 percent slopes, moderately eroded	31	VIIs-1	50	9	61
339-425$\underline{F}$ or Z$\underline{F}$	Wellston-Muskingum complex, 18 to 30 percent slopes, severely eroded	31	VIIs-1	50	9	61
339-425$\overline{G}$ or Z$\overline{G}$	Wellston-Muskingum complex, over 30 percent slopes, moderately eroded	31	VIIs-1	50	9	61
L339-425$\overline{E}$ or LZ$\overline{E}$	Wellston-Muskingum complex, limestone variants, 12 to 18 percent slopes, moderately eroded	33	VIIs-1	50	9	61
L339-425$\overline{F}$ or LZ$\overline{F}$	Wellston-Muskingum complex, limestone variants, 18 to 30 percent slopes, moderately eroded	33	VIIs-1	50	9	61
L339-425$\underline{F}$ or LZ$\underline{F}$	Wellston-Muskingum complex, limestone variants, 18 to 30 percent slopes, severely eroded	33	VIIs-1	50	9	61
463B	Wheeling silt loam, 1.5 to 4 percent slopes	33	IIe-2	43	6	59
463$\overline{C}$	Wheeling silt loam, 4 to 7 percent slopes, moderately eroded	33	IIe-2	43	6	59
463$\underline{D}$	Wheeling silt loam, 7 to 12 percent slopes, severely eroded	33	IVe-1	48	6	59
463$\overline{E}$	Wheeling silt loam, 12 to 18 percent slopes, moderately eroded	33	IVe-1	48	6	59
340D or YD	Zanesville silt loam, 7 to 12 percent slopes	34	IIIe-1	45	7	60
340$\overline{D}$ or Y$\overline{D}$	Zanesville silt loam, 7 to 12 percent slopes, moderately eroded	34	IIIe-1	45	7	60
340$\underline{D}$ or Y$\underline{D}$	Zanesville silt loam, 7 to 12 percent slopes, severely eroded	34	VIe-1	49	7	60
340$\overline{E}$ or Y$\overline{E}$	Zanesville silt loam, 12 to 18 percent slopes, moderately eroded	34	VIe-1	49	7	60
340$\underline{E}$ or Y$\underline{E}$	Zanesville silt loam, 12 to 18 percent slopes, severely eroded	34	VIe-1	49	7	60
340$\overline{F}$ or Y$\overline{F}$	Zanesville silt loam, 18 to 30 percent slopes, moderately eroded	34	VIe-1	49	7	60
340$\underline{F}$ or Y$\underline{F}$	Zanesville silt loam, 18 to 30 percent slopes, severely eroded	34	VIIe-1	50	7	60

3M—10-64—82472

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