SOIL SURVEY OF

Dakota County, Nebraska

United States Department of Agriculture
Soil Conservation Service
In cooperation with
University of Nebraska
Conservation and Survey Division

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

Major fieldwork for this soil survey was completed in the period 1967-71. Soil names and descriptions were approved in 1972. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1972. This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Middle Missouri Tributaries Natural Resource District.

HOW TO USE THIS SOIL SURVEY

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

Locating Soils

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

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

Finding and Using Information

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

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

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

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

Game managers, sportsmen, and others can find information about soils and wildlife in the section "Management of the Soils for Wildlife."

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

Scientists and others can read about soil formation and classification in the section "How the Soils of Dakota County were Formed and How They Are Classified."

Newcomers in Dakota County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

***Cover:* Contour farming, grassed waterways, farmstead windbreak, and livestock pond on soils of the Moody-Judson-Crofton association.**

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SOIL SURVEY OF DAKOTA COUNTY, NEBRASKA

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UNITED STATES DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE, IN COOPERATION WITH UNIVERSITY OF NEBRASKA, CONSERVATION AND SURVEY DIVISION

DAKOTA COUNTY is in the northeastern part of Nebraska (fig. 1). It has a total area of 255.4 square miles, or 163,456 acres. The county is almost square, being 18 miles long on the southern edge and 17 miles long on the western edge. The county is bounded on the east by the State of Iowa and on the north in part by the State of South Dakota. The Missouri River is the approximate boundary between Dakota County and the States of South Dakota and Iowa. The State and county boundaries shown on the maps in this publication are approximate along the Missouri River and along the borders where the county lines are not in the roads. The boundary between Nebraska and Iowa and South Dakota was plotted from a base map compiled by the U.S. Corps of Engineers, dated January 30, 1940. This boundary between Nebraska and Iowa was established as the State line by the Iowa-Nebraska Boundary Compact of 1943.

Dakota County was organized on March 7, 1855. It was named after the Dakota Indians, commonly called the Sioux. Dakota City, the county seat, was organized on September 20, 1856. The first settlement in Dakota County was made in 1855 near the present site of Homer. The early settlers were plagued by serious infestations of grasshoppers and by severe winters.

The most serious hazard through the years has been flooding. Damage has been widespread when streams overflow. Flooding from upland streams has also caused considerable damage. South Sioux City, the largest town, and Dakota City are subject to flooding by the Missouri River. Homer is flooded by Omaha Creek. In former years loss of life and property because of flooding was common, but large dams on the Missouri River and other flood control projects in adjoining States have greatly reduced this hazard. Water erosion is the most common hazard where the upland soils are cultivated.

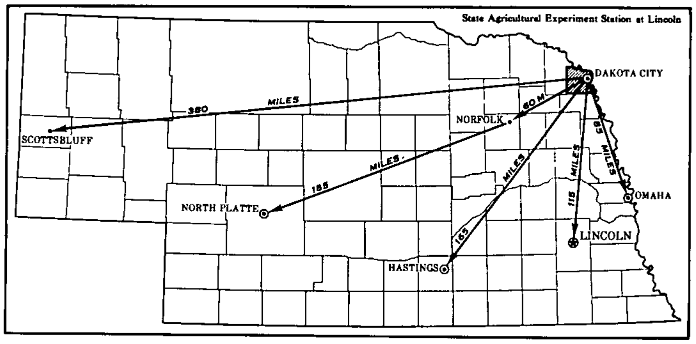

Figure 1.—**Location of Dakota County in Nebraska.**

The population of the county was 10,401 in 1950. By 1970 it had increased to 13,137, according to the census of that year.

The county is served by railroads and trucking firms and by a barge line on the Missouri River. Federal and State highways cross the county.

Farming, cattle raising and fattening, and related farming industries, such as meat processing, are important enterprises in the county. Feed grains grown in the county are fed locally or shipped to major terminals in nearby Sioux City, Iowa, across the river from the northeast corner of the county. Corn is the main crop, but soybeans are important. Some vegetable crops are also grown. Alfalfa hay is a major crop and is used for hay or is dehydrated in a local plant. Most pasture is in the steep uplands where the hazard of erosion is severe.

Most of the soils in the county formed under grass, though some of the soils on uplands along bluffs formed partly under deciduous trees. The most common parent material of the uplands is Peoria loess. Sedimentary bedrock outcrops in the bluff area. Soils on bottom lands that formed in alluvium make up about 45 percent of the county. The suitability of a soil for crops depends primarily on texture, structure, slope, content of organic matter, and drainage. Range of use is more limited on sandy soils or on the steep silty soils that erode easily if cultivated. Poorly drained soils cannot be used satisfactorily for cultivated crops until drainage is improved.

The first soil survey of Dakota County was made in 1919 (*5*).[1] This survey updates the first survey and provides additional information and larger maps that show the soils in greater detail.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in Dakota County, where they are located, and how they can be used. The soil scientists went into the county knowing they likely would find many soils they had already seen and perhaps some they had

[1] Italic numbers in parentheses refer to Literature Cited, p. 88.

not. They observed the steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

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

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

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a soil series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Crofton silt loam, 11 to 15 percent slopes, is one of several phases within the Crofton series.

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

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

Some mapping units are made up of soils of different series or of different phases within one series. One such kind of mapping unit, the soil complex, is shown on the soil map of Dakota County.

A soil complex consists of areas of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils, and the pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant soils, joined by a hyphen. Sansarc-Nora complex, 11 to 30 percent slopes, is an example.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called land types and are given descriptive names. Alluvial land is a land type in this survey.

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

Soil scientists observe how soils behave when used as a growing place for native and cultivated plants and as material for structures, foundations for structures, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this to the slow permeability of the soil or its high water table. They see that streets, road pavements, and foundations for houses are cracked on a named kind of soil, and they relate this failure to the high shrink-swell potential of the soil material. Thus, they use observation and knowledge of soil properties, together with available research data, to predict limitations or suitability of soils for present and potential uses.

After data have been collected and tested for the key, or benchmark, soils in a survey area, the soil scientists set up trial groups of soils. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. They then adjust the groups according to the results of their studies and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

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

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

The terms for texture used in the title of the associations apply to the texture of the surface layer. For example, in the title of Blyburg-Blencoe-Luton association, the words "clayey" and "silty" refer to the texture of the surface layer.

Soil association names and delineations on the general soil map do not fully agree with those of the general soil map in adjacent counties published at a different date. Differences on the maps are the result of improvements in the classification or refinements in soils series concepts. In addition, more precise maps are needed because the uses of the general soil map have expanded in recent years. The more modern maps meet this need.

The soil associations in Dakota County are discussed in the following pages.

1. Nora-Crofton-Moody Association

Well-drained, gently sloping to steep, silty soils on uplands

This association consists of an upland landscape where narrow ridgetops separate steeper sides of drainageways (fig. 2). Soils of the ridgetops are gently sloping to moderately sloping. The soils on the long sides of drainageways are moderately sloping to strongly sloping. The larger drainageways include a band of gently sloping colluvial soils on foot slopes adjacent to the steeper uplands. This dissected landscape has small intermittent drainageways that merge into larger ones. All of the surface drainage moves to the upper parts of Minnow, Otter, and Elk Creeks.

This association makes up about 19 percent of the county. Nora soils make up about 32 percent of this association, Crofton soils 32 percent, and Moody soils 16 percent. Minor soils make up the remaining 20 percent.

Nora soils are on uplands where they occupy ridgetops and sides of divides. They are moderately sloping

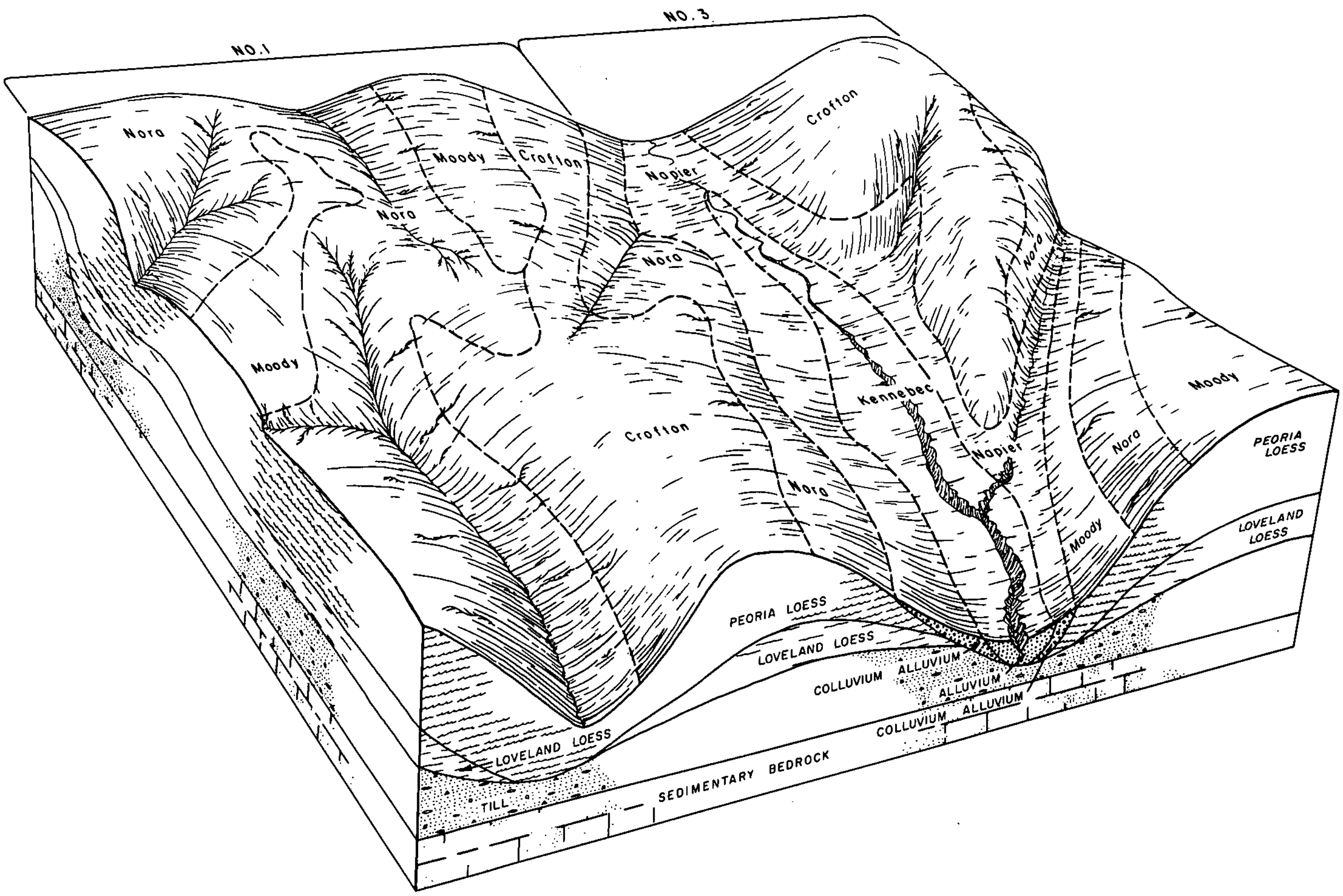

Figure 2.—**Pattern of soils and underlying material in the Nora-Crofton-Moody association and the Crofton-Nora-Napier association.**

and strongly sloping. They are deep, friable, well-drained soils that have a surface layer of silt loam and a subsoil of silt loam to silty clay loam. The underlying material is silt loam.

Crofton soils occupy the steeper ridgetops. They are strongly sloping to steep. They are well-drained, friable soils that are silt loam throughout. Crofton soils can be identified in the upland landscape by their light color and the many lime concretions on the surface (fig. 3).

Moody soils occupy ridgetops and areas that parallel drainageways. They are gently sloping to moderately sloping. They are well-developed, well-drained soils that have a surface layer and subsoil of silty clay loam. Their underlying material is lighter colored silt loam.

The minor soils of this association are in the Napier and Kennebec series. Napier soils occupy colluvial foot slopes that border the steeper loess uplands. Kennebec soils are in the narrow bottoms of the small drainageways below areas of Napier soils.

Farms in this association are mainly of the diversified cash grain-livestock type. The farms range from 160 to 400 acres in size. Most of the acreage is in crops that are fed to cattle being fattened in dry lots for market. Corn, alfalfa hay, and soybeans are the crops most commonly grown. Some of the steepest soils and some eroded areas have been seeded to grasses and are used for pasture.

Soil erosion is the principal hazard in this association. Controlling runoff and maintaining fertility are the principal concerns of management. Organic matter needs to be increased on the eroded soils. All of the locally grown crops are successfully grown on these soils.

This soil association has some good farm-to-market roads, but not all section lines have roads on them. Roads are mostly of dirt construction or have only a small amount of gravel. Paved highways cross the area. Several grain and livestock markets are readily available within the county as well as in adjacent counties. Many fattened cattle are sold directly to packers.

Figure 3.—**Contour farming, grassed waterways, and a farmstead windbreak on soils of the Nora-Crofton-Moody association and the Crofton-Nora-Napier association.**

2. Moody-Judson-Crofton Association

Well-drained, gently sloping to moderately sloping, silty soils on uplands and foot slopes

This association is part of a large upland divide. It separates the drainageways that flow northward to the Missouri River from those that flow southward towards Logan Creek and Omaha Creek. Soils of the divides are gently sloping on the broad ridgetops. Those on the short sides of the divides are moderately sloping (fig. 4). There is a narrow band of gently sloping colluvial soils on foot slopes adjacent to the steeper uplands.

This association makes up about 6 percent of the county. Moody soils make up about 75 percent of this association, Judson soils 13 percent, and Crofton soils 9 percent. Minor soils make up the remaining 3 percent.

Moody soils occupy slightly convex ridgetops and smooth concave lower slopes along drainageways. They are gently sloping to moderately sloping. They are well-drained soils with a surface layer and subsoil of silty clay loam. The underlying material, at a depth of 38 inches, is silt loam.

Judson soils are on foot slopes and are nearly level to gently sloping. They are well drained. They have a surface layer and subsoil of silty clay loam.

Crofton soils are on convex areas that form drainage divides. They are gently sloping to moderately sloping. They are well drained and are silt loam throughout. Crofton soils can be identified by their light color and the many lime concretions in their surface layer.

The minor soils of this association are in the Calco and Nora series. Calco soils are at the bottom of larger drainageways where the water table is high and flooding occurs. Nora soils are on the sides of drainageways or between Moody and Crofton soils on hillsides.

Farms in this association are diversified and are mainly cash grain-livestock farms. They range from 160 to 200 acres in size. Major crops are alfalfa hay, corn, and soybeans. Soils on the divides are mainly cultivated; the poorly drained soils on bottom lands are used primarily for pasture, most of which is tame grass.

Soil erosion is the principal hazard on the cultivated soils of this association. Flooding is a hazard on bottom lands of the narrow upland drainageways. Water conservation and maintenance of fertility are the principal concerns in managing cultivated soils. Content of organic matter needs to be improved and maintained on eroded soils.

Roads are of dirt or gravel construction. Not all sec-

Figure 4.—**Gently sloping Moody soils on broad divides of the Moody-Judson-Crofton association.**

tion lines have roads. Farm produce is marketed mainly within the county, but some is delivered to adjacent Thurston County. Grain and livestock markets are readily available within the county as well as in Sioux City, Iowa. Most fattened cattle are sold directly to packers.

3. Crofton-Nora-Napier Association

Well-drained, gently sloping to steep, silty soils on bluffs, uplands, and foot slopes

This association consists mainly of narrow ridgetops and long, strongly sloping to steep hillsides. The area is dissected by small, narrow valleys (fig. 2) that drain surface water in a northeasterly direction. Major streams that drain the area are Elk, Pigeon, Fiddlers, and Wigle Creeks. The bluff area along the Missouri River Valley and deeply entrenched ravines are also prominent features of the landscape. Fiddlers and Wigle Creeks drain to Omaha Creek. Soils on hillsides have slopes of 11 to 30 percent.

This association makes up about 30 percent of the county. Crofton soils make up about 45 percent of this association, Nora soils 25 percent, and Napier soils, 20 percent. Minor soils and land types make up the remaining 10 percent.

Crofton soils are on the narrow divides. They are strongly sloping to steep. They are well-drained, friable soils that are silt loam throughout.

Nora soils are strongly sloping to steep. They are generally below areas of Crofton and Moody soils. They are well-drained soils that have a surface layer of silt loam and a subsoil of silt loam to silty clay loam. The underlying material is silt loam.

Napier soils occupy foot slopes adjacent to the uplands. They are gently sloping to strongly sloping. They are well-drained soils that have a surface layer of silt loam and a subsoil of silt loam to light silty clay loam.

The minor soils of this association are in the Ida, Kennebec, Moody, and Sansarc series and in the Gullied land-Ida complex. Ida soils are confined mainly to the wooded bluffs adjoining the Missouri River Valley. Moody soils are on divides and also on hillsides above Napier soils. Kennebec soils occur in the bottoms and narrow drainageways. Sansarc soils, which are shallow and formed in shale, occur primarily in the southeastern part of the association. The Gullied land-Ida complex occurs in the deeply dissected drainageways, including the ravines and the very steep adjoining land.

Farms in this association are mainly grain-livestock farms, ranging from 240 to 600 acres in size. They are under dryland management. About 60 percent of the acreage of this association is cultivated. The rest is in grass or native woodland. Corn, oats, and alfalfa are the major crops. Some grain is fed to cattle or hogs to fatten them for market. Cow-calf operations are common on nearly all farms.

In this association the main concerns of management are slowing runoff and maintaining good tilth and high fertility. Soil erosion is the principal hazard on cultivated soils in the uplands. Proper maintenance and improvement of the existing tame and native pastures and the woodland areas are also concerns of good management.

Only a few good farm-to-market roads are in this association. Some roads are on section lines, but many follow ridgetops or valleys. Some paved highways cross the area. Grain and livestock markets are readily available within the county and in Sioux City, Iowa. Most fattened cattle are sold directly to packers.

4. Omadi-Kennebec-Napier Association

Moderately well drained and well drained, nearly level to gently sloping, silty soils on bottom lands and foot slopes.

This association occurs mainly in narrow valleys formed by tributary streams of the Missouri River. It includes a narrow strip along the western edge of the Missouri River Valley where soils formed in tributary sediment. It also includes narrow bands of colluvial slopes on valley sides. The creek channels are narrow and moderately deep and meander through the bottom lands except in a few places where the channels have been straightened. Most of these creeks overflow their banks during periods of high rainfall, flooding the low bottom lands. Most valleys have some areas that have a moderately high water table.

This association makes up about 10 percent of the county. Omadi soils make up 38 percent of this association, Kennebec soils 27 percent, and Napier soils 18 percent. Minor soils and land types make up the remaining 17 percent.

Omadi soils are in the Missouri River Valley, adjacent to the bluffs where Elk, Pigeon, and Omaha Creeks deposited their sediment. They are nearly level, stratified, deep, friable, and moderately well drained. They are silt loam throughout. Flooding on these soils has been virtually eliminated by canals that transport the waters to the Missouri River.

Kennebec soils are in wide bottom lands that drain the uplands. They are nearly level, deep, friable, and moderately well drained. They are silt loam throughout. These soils are subject to occasional flooding except where they are on stream terraces.

Napier soils are on foot slopes adjacent to steeper uplands. They are gently sloping, deep, friable, and well drained. They are silt loam throughout.

The minor soils of this association are in the Calco and Forney series and the Napier-Gullied land complex. The poorly drained Calco soils occupy bottom lands. The Napier-Gullied land complex is in the deep, wide channels that are stabilized by trees. These stream channels provide drainageways for the association. Forney silt loam, overwash phase, is on bottom lands of the Missouri River where upland silts were deposited over clayey soils.

Farms in this association are mainly cash grain and livestock farms. They generally range from 300 to 400 acres in size. Nearly all of the acreage is cultivated. Irrigation is not used because of the flooding hazard. Corn, soybeans, and alfalfa hay are the principal crops. Some areas adjacent to creeks that flood, or where the soil is wet most of the time, are used for pasture. Some grain is fed to cattle or hogs to fatten them for market.

Flooding and soil wetness along creeks are the principal hazards in this association. Water conservation and maintenance of good tilth and high fertility are the main concerns of management. All the crops commonly grown in the county are grown successfully in this association.

Most roads in this association parallel the valleys; some cross the valleys in a few areas. Roads are of dirt or gravel construction. Grain and livestock markets are readily available within the county as well as in Sioux City, Iowa. Grain is fed locally to cattle and swine, and excess grain is shipped to major grain terminals outside the county. Fattened cattle are generally sold directly to packers.

5. Forney Association

Poorly drained, nearly level, clayey soils on bottom lands

This association consists of bottom lands in the western part of the Missouri River Valley. This is a large, slightly depressional area that was formerly swampland. It received much of the upland waters from Elk and Pigeon Creeks before drainage canals were constructed.

This association makes up 3 percent of the county. It consists almost entirely of soils in the Forney series.

Forney soils are deep, firm, and poorly drained. They are stratified soils that are silty clay or clay throughout.

Nearly all of the acreage is cultivated, but few farm operators live in the area. Farms range from 160 to 400 acres in size. Corn, soybeans, and alfalfa hay are the principal crops. Some areas are irrigated.

The soils in this association are droughty and difficult to cultivate. Runoff is slow, and ponded water is the principal hazard. There is a lack of suitable outlets for the ponded water. Maintaining good tilth is the main concern of management.

Not all section lines in this association have roads. Most roads are improved dirt roads. One highway crosses the association. Grain markets are readily available within the county as well as at major grain terminals in Sioux City, Iowa.

6. Blyburg-Blencoe-Luton Association

Moderately well drained to poorly drained, nearly level, silty and clayey soils on high bottom lands

This association occurs on the high bottom lands of the Missouri River Valley. It occupies the highest elevations of the valley and is nearly level. The area is drained by a series of shallow, natural channels that cross the landscape.

This association makes up about 10 percent of the county. Blyburg soils make up about 55 percent of the association, Blencoe soils 14 percent, and Luton soils 13 percent. Minor soils make up the remaining 18 percent.

Blyburg soils are deep, friable, and moderately well drained. They are silt loam throughout.

Blencoe soils are deep, firm, and somewhat poorly drained. They are silty clay in the upper part of the profile and silt loam or very fine sandy loam in the lower part.

Luton soils are deep, firm, and poorly drained. They are silty clay or clay throughout.

The minor soils of this association are in the Forney and Sarpy series. Forney soils occur in old channel areas and in other low areas that were formerly flooded. Sarpy soils are sandy and are in long areas that formed the banks of former stream channels.

Farms in this association are mainly cash grain-livestock farms. They generally range from 80 to 240 acres in size, but a few are larger. Most of the acreage is cultivated. Some is irrigated. Corn, soybeans, and alfalfa are the principal crops. Fattening cattle and swine in dry lots is a common enterprise in this area.

Flooding and ponding of water in swales and depressions are the principal hazards in this association. Cultivation is difficult. Maintaining good tilth is an important concern of management. Most of the soils are well suited to irrigation. Artificial drainage is beneficial in most areas and is necessary in some cultivated area. Surface drains generally move excess water from the fields to roadside ditches, which serve as part of the drainage network.

Two paved highways and several rail lines cross this association. Most section lines have improved dirt or gravel roads. This association provides good possibility for urban and industrial expansion. Grain markets are readily available within the county as well as at major grain and livestock terminals in Sioux City, Iowa. Most fattened livestock are sold directly to packers.

7. Haynie-Albaton-Onawa Association

Moderately well drained to poorly drained, nearly level, silty and clayey soils on low bottom lands adjacent to the Missouri River

This association occurs on bottom lands along the Missouri River, and except for the area where the main part of South Sioux City is built, it is at the lowest elevations. It is generally level, but in a few places it is hummocky. In places it is as much as 5 miles wide. Crescent-shaped Crystal Lake, Blyburg Lake, and swales mark old river channels (fig. 5). Below South Sioux City the riverbank has been stablized and the river is confined to a stable channel. In most areas above South Sioux City some stabilization work has been done on the channel.

This association makes up about 19 percent of the county. Haynie soils make up about 21 percent of this association, Albaton soils 19 percent, and Onawa soils 14 percent. Minor soils and land types make up the remaining 46 percent.

Haynie soils are at a slightly higher elevation than the other major soils of this association. They are deep, friable, and moderately well drained. They are silt loam throughout.

Figure 5.—**A former river channel provides water for recreation areas in the Haynie-Albaton-Onawa association.**

Albaton soils occupy swales and other large, low-lying areas. They are deep, firm, and poorly drained. They are silty clay throughout.

Onawa soils are intermediate in elevation. They are deep, firm, and somewhat poorly drained. Their profile is silty clay in the upper part and silt loam or very fine sandy loam at a depth of 2 to 3 feet.

The minor soils of this association are in the Sarpy, Blake, Grable, Modale, Percival, Owego, and Waubonsie series and in Alluvial land and Marsh. Sarpy soils occur mainly along the banks of the Missouri River. Grable, Modale, and Waubonsie soils are nearly level and occur in slightly higher areas. Owego and Percival soils occupy lower lying, swalelike positions. All are within a few miles of the river.

Farms in this association are mainly cash grain farms. Most of them range from 280 to 600 acres in size, but a few are as large as 3,000 acres. Most of the acreage is in cultivated crops, mainly corn and soybeans, but in a few areas there are vegetable farms. Also, alfalfa is grown for hay. A few small areas are used for recreation.

The soils in this association have a high content of lime, but they benefit from applications of nitrogen and phosphorus. In some areas artificial drainage is needed, and V-shaped drainage ditches are generally used. Flooding from the Missouri River, once a hazard, is no longer of serious consequence, but infrequent flooding does occur in areas where the Elk, Pigeon, and Omaha Creek Canals cross this association. The sandy soils are subject to blowing. Sprinkler and furrow border irrigation are used on a few farms.

In many parts of this association there are no roads because the areas were subject to frequent flooding before the dams on the Missouri River were constructed. Most roads are of dirt construction, a few are graveled, and there are a few highways, mainly near South Sioux City. Grain is either marketed locally to elevators within the county or delivered to major grain terminals in Sioux City.

8. Ida-Monona Association

Well-drained, moderately sloping to very steep, silty soils on bluffs and uplands

This association consists of moderately sloping to steep soils on narrow ridgetops and the adjacent moderately sloping to very steep soils that border drainageways. Deeply entrenched, very steep ravines are an important feature of the landscape. Part of this association is on upland bluffs along the Missouri River Valley where hillsides are steep and very steep. This area is dissected by small, narrow valleys that drain northerly onto bottom lands of the Missouri River Valley.

This association makes up only about 3 percent of the county. Ida soils make up 48 percent of this association, and Monona soils 41 percent. Minor soils and land types make up the remaining 11 percent.

Ida soils are on the highest part of the landscape on narrow ridgetops and convex areas that border drainageways. They also make up parts of the bluffs along the Missouri River Valley. They are strongly sloping to very steep, deep, and well drained. They are silt loam throughout and are high in lime.

Monona soils have slightly convex slopes and occur below areas of Ida soils. They are moderately sloping to steep, deep, friable, and well drained. They are silt loam throughout and are neutral or mildly alkaline.

The minor soils of this association are in the Napier, Judson, and Sansarc series and the Gullied land-Ida complex. Napier and Judson soils occur on concave foot slopes below the adjacent steeper uplands. They are deep, dark colored, silty, and neutral or slightly acid. Sansarc soils are shallow; they formed in shale. They occur primarily on convex areas that border drainageways. The Gullied land-Ida complex is very steep and occurs in drainageways that are stabilized by trees and shrubs.

Only a few farmsteads are in this association, and most of them occur at the base of bluffs along the Missouri River Valley. About 75 percent of the acreage is in native woodland and grass, which provide excellent habitat for wildlife. The trees are used for fuel and fenceposts. A few trees are of marketable quality. The remaining acreage is used for dryland cultivated crops. Major crops are alfalfa hay, corn, and oats.

Water erosion is the main hazard on cultivated soils in this association. Because of steep slopes, many areas need to be reseeded to grasses. Proper management is needed to improve the quality of merchantable trees.

Only one road crosses the association, and it is of dirt construction. Grain and livestock markets are readily available within the county. Cow-calf operations are more common in this association than elsewhere in the county.

Descriptions of the Soils

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

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for moist soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

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

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

The acreage and proportionate extent of each mapping unit are shown in table 1. Many of the terms used in describing soils can be found in the "Glossary" at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*6*).

A given soil series in this county may be identified by a different name in a recently published soil survey of an adjacent county. Some soil boundaries may not match adjoining areas. Such differences result from changes in concepts of soil classification that have occurred since publication.

Albaton Series

The Albaton series consists of deep, nearly level, poorly drained soils that formed in recent calcareous silty or clayey alluvium. These soils are on bottom lands of the Missouri River Valley. In places they are in swales and depressions. A seasonal water table is at a depth of 4 to 5 feet where these soils occur in low-lying areas that were formerly channels.

In a representative profile, the surface layer is very dark grayish brown silty clay 8 inches thick. A transi-

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

Soil	Area	Extent
	Acres	*Percent*
Albaton silty clay, 0 to 2 percent slopes	5,787	3.5
Albaton silty clay, depressional, 0 to 1 percent slopes	145	.1
Albaton silty clay loam, 0 to 2 percent slopes	135	.2
Alluvial land	1,546	1.0
Blake silty clay loam, 0 to 2 percent slopes	2,744	1.7
Blencoe silty clay, 0 to 2 percent slopes	2,340	1.3
Blyburg silt loam, 0 to 2 percent slopes	4,832	2.9
Blyburg silt loam, 2 to 6 percent slopes	373	.2
Blyburg silty clay loam, 0 to 2 percent slopes	2,224	1.4
Blyburg silty clay, overwash, 0 to 2 percent slopes	1,467	.9
Calco silt loam, overwash, 0 to 2 percent slopes	749	.5
Calco silty clay loam, 0 to 2 percent slopes	274	.2
Crofton silt loam, 2 to 6 percent slopes, eroded	461	.3
Crofton silt loam, 6 to 11 percent slopes, eroded	3,586	2.2
Crofton silt loam, 11 to 15 percent slopes	1,275	.8
Crofton silt loam, 11 to 15 percent slopes, eroded	15,444	9.4
Crofton silt loam, 15 to 30 percent slopes	3,368	2.1
Crofton silt loam, 15 to 30 percent slopes, eroded	9,112	5.6
Forney silt loam, overwash, 0 to 2 percent slopes	1,593	1.0
Forney silty clay, 0 to 2 percent slopes	4,610	2.8
Forney soils, swales, 0 to 2 percent slopes	617	.4
Grable very fine sandy loam, 0 to 2 percent slopes	3,091	1.9
Gullied land-Ida complex, 30 to 60 percent slopes	2,091	1.2
Haynie silt loam, 0 to 2 percent slopes	6,841	4.2
Ida silt loam, 11 to 17 percent slopes, eroded	1,320	.8
Ida silt loam, 17 to 30 percent slopes	696	.4
Ida silt loam, 17 to 30 percent slopes, eroded	365	.2
Ida soils, 30 to 60 percent slopes	2,189	1.3
Judson silty clay loam, 0 to 2 percent slopes	500	.3
Judson silty clay loam, 2 to 6 percent slopes	1,351	.8
Kennebec silt loam, 0 to 2 percent slopes	875	.5
Kennebec silt loam, overwash, 0 to 2 percent slopes	3,476	2.1
Luton silty clay, thin surface, 0 to 2 percent slopes	2,110	1.3
Marsh	180	.2
Modale silt loam, 0 to 2 percent slopes	617	.4
Monona silt loam, 6 to 11 percent slopes	312	.2
Monona silt loam, 11 to 17 percent slopes	874	.5
Monona silt loam, 17 to 30 percent slopes	834	.5
Moody silty clay loam, 2 to 6 percent slopes	1,272	.8
Moody silty clay loam, 6 to 11 percent slopes	6,620	4.1
Moody silty clay loam, 6 to 11 percent slopes, eroded	2,199	1.4
Moody-Nora silty clay loams, 11 to 15 percent slopes	2,544	1.6
Napier silt loam, 2 to 6 percent slopes	13,401	8.2
Napier silt loam, 6 to 11 percent slopes	1,149	.7
Napier silt loam, 11 to 15 percent slopes	4,456	2.7
Napier-Gullied land complex, 2 to 11 percent slopes	880	.5
Nora silt loam, 2 to 6 percent slopes, eroded	1,099	.7
Nora silt loam, 6 to 11 percent slopes	1,515	.9
Nora silt loam, 6 to 11 percent slopes, eroded	850	.5
Nora silt loam, 11 to 15 percent slopes	11,097	6.8
Nora silt loam, 11 to 15 percent slopes, eroded	3,507	2.2
Nora silt loam, 15 to 30 percent slopes	3,877	2.4
Omadi silt loam, 0 to 2 percent slopes	6,147	3.8
Onawa silty clay, 0 to 2 percent slopes	4,739	2.9
Owego silty clay, 0 to 2 percent slopes	1,044	.6
Percival silty clay, 0 to 2 percent slopes	558	.3
Sansarc-Nora complex, 11 to 30 percent slopes	581	.4
Sarpy fine sand, 2 to 11 percent slopes	1,421	.8
Sarpy loamy fine sand, 0 to 6 percent slopes	1,638	1.0
Sarpy silty clay, overwash, 0 to 2 percent slopes	1,162	.7
Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes	273	.2
Water areas less than 40 acres	803	.5
Borrow pits and Gravel pits	40	[1]
Total	163,456	100.0

[1] Less than 0.05 percent.

tional layer, about 19 inches thick, is dark grayish-brown silty clay. The underlying material, extending to a depth of 60 inches, is dark grayish-brown silty clay. Mottles are within 8 inches of the surface.

Albaton soils have slow permeability and moderate available water capacity. The organic-matter content is moderately low, and natural fertility is low. The surface layer, transitional layer, and underlying material are moderately alkaline in reaction. These soils release moisture slowly to plants.

Albaton soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Albaton silty clay, 0 to 2 percent slopes, in a cultivated field 400 feet west and 150 feet south of the northeast corner of SW¼ sec. 22, T. 29 N., R. 9 E.

Ap—0 to 8 inches very dark grayish-brown (2.5Y 3/2) silty clay, dark grayish-brown (2.5Y 4/2) dry; strong, fine, blocky structure parting to strong, fine and medium, granular; very hard, firm; slight effervescence; moderately alkaline; abrupt, smooth boundary.

AC—8 to 27 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; few, fine, distinct, reddish-brown (7.5YR 4/4) mottles; strong, medium and fine, blocky structure; very hard, firm; strong effervescence; moderately alkaline; clear, smooth boundary.

Cg—27 to 60 inches, dark grayish-brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; many, medium, distinct, strong-brown (7.5YR 5/6) and gray (5Y 5/1) mottles; strong, medium and coarse, blocky structure; very hard, firm; a few silty strata that are less than one-fourth inch thick and have fine platy structure; violent effervescence; moderately alkaline.

The A horizon ranges from 5 to 10 inches in thickness; from dark gray to very dark grayish brown in color; and from silty clay to silty clay loam in texture. It is mildly alkaline or moderately alkaline. The AC horizon is dark grayish-brown or olive-gray silty clay or clay. In some places there is a Ab horizon. The Cg horizon has strata of different colors that range from dark grayish brown to olive gray. It is clay or silty clay, but in places there are strata less than 6 inches thick that have a slightly lower clay content. Some areas have silty clay loam and coarser material below a depth of 42 inches. Mottles range from few to many and are reddish brown, strong brown, or gray.

Albaton soils are near Onawa, Percival, Blake, Grable, Haynie, and Sarpy soils. They formed in thicker clay deposits than Onawa and Percival soils and lack the coarser textured IIC horizon of those soils. Albaton soils have more clay in the C horizon than Blake, Haynie, Grable, or Sarpy soils.

Albaton silty clay loam, 0 to 2 percent slopes (Aa).—This soil is in areas that have received material deposited by floodwater within the past 20 years. It is on bottom lands of the Missouri River Valley. Areas range from 10 to 40 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer and transitional layer are silty clay loam and about 9 inches thick. The underlying material is also more stratified with varying textures and colors.

Included with this soil in mapping are small areas where the surface layer and transitional layer are thicker, ranging from 8 to 20 inches in thickness.

Poor internal drainage, moderate available water capacity, and clayey texture are the principal limitations if this soil is cultivated. This soil is not difficult to till, and timeliness of field operations is not critical. Runoff is slow, and some ponding occurs.

Nearly all the acreage of this soil is cultivated. Corn, alfalfa, and soybeans are the principal crops. Capability units IIIw–2 dryland and IIIw–1 irrigated; windbreak suitability group 2.

Albaton silty clay, 0 to 2 percent slopes (Ab).—This soil is in the Missouri River Valley in areas that have received recent deposits of soil material. Areas of this soil range from 15 to 400 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Onawa and Percival soils and areas of Albaton silty clay loam, 0 to 2 percent slopes, and Albaton silty clay, depressional, 0 to 1 percent slopes.

A clayey surface layer and slow surface drainage are the principal limitations if this soil is cultivated. Ponding of water occurs in some places. Where this soil occurs in swales or old channel areas, water is commonly within a depth of 5 feet.

Maintaining tilth is difficult, and timeliness of operation is an important concern in managing this soil. An inadequate supply of moisture as well as its uneven distribution are also factors that can limit production. Some land leveling is needed for gravity irrigation.

Most of the acreage of this soil is cultivated. Corn, alfalfa, and soybeans are the principal crops. Both dryland and irrigation management are used. Capability units IIIw–1 dryland and IIIw–1 irrigated; windbreak suitability group 2.

Albaton silty clay, depressional, 0 to 1 percent slopes (Ac).—This soil is in slightly depressional or narrow swalelike areas on bottom lands. Most areas are former stream channels and range from 10 to 20 acres in size. Depth to the water table ranges from 4 to 5 feet.

This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly thicker.

Included with this soil in mapping are small areas of a deep, gray, very poorly drained soil that has fine sand at a depth below 42 inches.

Lack of adequate surface drainage, excessive ponding, and lack of suitable outlets are the principal limitations where this soil is cultivated. Runoff is very slow.

Nearly all the acreage is in grass or waste areas. A limited acreage is cultivated, mainly to corn, soybeans, and alfalfa hay. Capability unit Vw–1 dryland; windbreak suitability group 10.

Alluvial Land

Alluvial land (0 to 2 percent slopes) (Ad) is a land type that occurs on Missouri River bottom lands. In most places it is adjacent to the Missouri River and in old abandoned channels of that stream. The water table is between depths of about 1 foot and 3 feet and fluctuates with the level of the river.

Alluvial land is nearly level or depressional. Slopes are mainly 0 to 2 percent, but in places they are as much as 6 percent. In places, the surface is unstable and subject to soil blowing. The soil material is fine sand throughout. The areas are poorly drained and are occasionally flooded, particularly when the water level of the river is high.

Included with this land type in mapping are small areas that have a surface layer of dark grayish-brown silty clay or clay 6 to 10 inches thick.

Permeability is rapid in most areas, and the available water capacity is low. Natural fertility and organic-matter content are low. This land type is moderately alkaline throughout.

Nearly all of the acreage is in wildlife or waste areas. The vegetation consists mainly of a sparse growth of grasses and weeds. Sparse to thick stands of small willow trees grow on the drier sites. The wetter areas have marshy vegetation. Some of the old stream channels are filled with water.

Alluvial land is excellent for wildlife habitat. It also has a good potential for recreation. A few small areas are cultivated. Capability unit Vw–7; windbreak suitability group 10.

Blake Series

The Blake series consists of deep, nearly level, somewhat poorly drained soils that formed in alluvium. These soils are in fairly broad areas of bottom lands in the Missouri River Valley.

In a representative profile, the surface layer is very dark grayish-brown silty clay loam 7 inches thick. The underlying material extends to a depth of 60 inches. It is very dark grayish-brown silty clay loam in the upper part, dark grayish-brown silt loam and fine sandy loam in the middle part, and grayish-brown silt loam in the lower part. The soil is calcareous below a depth of 16 inches. Part of the underlying material is mottled and stratified with light and dark colors.

Blake soils have moderately slow permeability in the upper 16 inches and moderate permeability below this depth. They have a high available water capacity. Their organic-matter content is moderately low, and their natural fertility is low. They release moisture readily to plants.

Blake soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Blake silty clay loam, 0 to 2 percent slopes, in a cultivated field 1,368 feet north and 180 feet west of the southeast corner of sec. 28, T. 29 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate, medium and fine, granular structure; slightly hard, friable; slightly compacted; mildly alkaline; abrupt, smooth boundary.

C1—7 to 16 inches, very dark grayish-brown (2.5Y 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; moderate, coarse, blocky structure parting to weak, medium and fine, subangular blocky; soft, friable; moderately alkaline; clear, smooth boundary.

IIC2—16 to 23 inches, dark grayish-brown (2.5Y 4/2) and grayish-brown (2.5Y 5/2) light silt loam, stratified grayish brown (2.5Y 5/2) and very dark grayish brown (2.5Y 3/2) dry; weak, coarse, blocky structure parting to weak, medium and fine, granular; slightly hard, friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIC3—23 to 31 inches, dark grayish-brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak, coarse, blocky structure; soft, very friable; violent effervescence; moderately alkaline; clear, gradual boundary.

IIC4—31 to 40 inches, dark grayish-brown (2.5Y 4/2) fine sandy loam, light brownish gray (2.5Y 6/2) dry; few, fine, faint, light olive-brown (2.5Y 5/6) mottles; weak, fine, platy structure; soft, very friable; violent effervescence; moderately alkaline; clear, gradual boundary.

IIIC5—40 to 60 inches, grayish-brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; massive; soft, very friable; violent effervescence; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness. It is very dark grayish-brown or dark-brown silty clay loam or light silty clay loam. The C1 horizon is commonly stratified and ranges from very dark grayish brown to grayish brown. It ranges from silty clay loam to very fine sandy loam, but in places it includes layers that are ¼ inch to 6 inches thick and that have darker colors and either finer texture or slightly coarser texture. The Ap horizon ranges from mildly alkaline to moderately alkaline.

In Dakota County, Blake soils have a thinner layer of silty clay loam and an A horizon that is darker in color than that defined in the range for the Blake series, but these differences do not alter the usefulness and behavior of the soils.

Blake soils are near Haynie, Waubonsie, Grable, Sarpy, Albaton, and Onawa soils and are similar to Blyburg soils. They have Ap and C1 horizons that are finer textured than those in Haynie or Waubonsie soils. Blake soils are not underlain by sand, as are the Grable soils. They are not so sandy as Sarpy soils. Blake soils are not so fine textured in the Ap and C1 horizons as Albaton and Onawa soils. They have a finer textured C1 horizon and are not so well drained as Blyburg soils.

Blake silty clay loam, 0 to 2 percent slopes (Ba).—This soil formed in silty and loamy alluvium and is on Missouri River bottom lands. The areas range from 10 to 20 acres in size.

Included with this soil in mapping are small areas of Onawa silty clay, 0 to 2 percent slopes, and Haynie silt loam, 0 to 2 percent slopes.

There are few limitations to the use of this soil. Runoff is slow, but there are few small, wet areas associated with this soil. Flooding is an infrequent hazard. This is one of the better soils in Dakota County for growing crops.

Nearly all the acreage is cultivated. Corn, alfalfa, and soybeans are the principal crops. Both dryland and irrigation management are used. Capability units I–1 dryland and I–3 irrigated; windbreak suitability group 1.

Blencoe Series

The Blencoe series consists of deep, nearly level, somewhat poorly drained soils that formed in alluvium. These soils are clayey in the upper 24 inches and silty below this depth. They are on Missouri River bottom lands.

In a representative profile, the surface layer is black silty clay 15 inches thick. The subsoil, about 9 inches thick, is dark grayish-brown, firm, light silty clay. The underlying material, extending to a depth of 60 inches, is grayish-brown silt loam.

Blencoe soils have very slow permeability in the upper 24 inches and moderate permeability below this depth. They have a high available water capacity. Their organic-matter content is high, and their natural fertility is medium. They release moisture slowly to plants.

Blencoe soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Blencoe silty clay, 0 to 2 percent slopes, in a cultivated field 1,320 feet north and 50 feet west of the southeast corner of sec. 7, T. 28 N., R. 9 E.

Ap—0 to 10 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; weak, coarse, blocky structure parting to weak, moderate, granular, very hard, very firm; neutral; gradual, smooth boundary.

A12—10 to 15 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; weak, medium, granular structure; very hard, very firm; neutral; gradual, smooth boundary.

B2—15 to 24 inches, dark grayish-brown (2.5Y 4/2) light silty clay, grayish brown (2.5Y 5/2) dry; moderate, coarse, blocky structure parting to strong, medium, blocky; very hard, very firm; neutral; abrupt, smooth boundary.

IIC1—24 to 30 inches, grayish-brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few, fine, faint, strong-brown (7.5YR 5/6) mottles; weak, coarse, blocky structure parting to weak, medium and fine, platy; slightly hard, friable; many fine tubular pores; few soft lime accumulations; strong effervescence; moderately alkaline; gradual, smooth boundary.

IIC2—30 to 60 inches, grayish-brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak, coarse, blocky structure parting to weak, medium and fine, granular; soft, friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

The A horizon ranges from 7 to 20 inches in thickness. It is black grading to very dark gray. The B2 horizon ranges from dark gray to grayish brown. In some places there is a B3 horizon about 6 inches thick that is silty clay loam. Depth to carbonates corresponds to the thickness of the clayey material. Depth to the IIC1 horizon ranges from 15 to 30 inches. Strata that are ½ inch to 6 inches thick and finer textured than silt loam are common in the IIC horizon. Clayey layers thicker than 6 inches occur in some places in the IIC2 horizon.

In Dakota County, Blencoe soils have a thinner layer of clayey material in the upper part of the profile and are shallower to carbonates than defined in the range for the series, but these differences do not alter the usefulness and behavior of the soils.

Blencoe soils are near Forney, Luton, and Blyburg soils. The C horizon is not so fine textured as in Luton and Forney soils. Blencoe soils have finer textured A and B horizons than Blyburg soils, and lime occurs at a greater depth than in those soils.

Blencoe silty clay, 0 to 2 percent slopes (Bb).—This soil is on Missouri River bottom lands. The areas range from 20 to 100 acres in size.

Included with this soil in mapping are a few areas where the clayey material is thinner than that described in the representative profile. In some places the underlying material is silty clay loam. Also included are a few areas of Luton soils.

A clayey surface layer, slow surface drainage, and ponding of water in some areas are the principal limitations where this soil is cultivated. Maintaining good tilth and preparing a good seedbed are difficult, and timeliness of operations is an important factor in managing this soil. Lack of uniform distribution of rainfall during the growing season is a common limitation. Runoff is slow.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIw–1 dryland and IIw–1 irrigated; windbreak suitability group 2.

Blyburg Series

The Blyburg series consists of deep, nearly level to gently sloping, moderately well drained soils that formed in silty alluvium. These soils are on Missouri River bottom lands.

In a representative profile, the surface layer is very dark brown and very dark grayish-brown silt loam 15 inches thick. The underlying material is dark grayish-brown light silt loam.

Blyburg soils have moderate permeability and a high available water capacity. Their organic-matter content is moderate, and their natural fertility is medium. They release moisture readily to plants.

Blyburg soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Blyburg silt loam, 0 to 2 percent slopes, in a cultivated field 1,140 feet south and 400 feet west of the northeast corner of sec. 2, T. 28 N., R. 8 E.

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

A12—7 to 11 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, very friable; neutral; gradual, smooth boundary.

A13—11 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (2.5Y 4/2) dry; weak, coarse, subangular blocky structure parting to weak, medium and fine, granular; soft, very friable; few fine pores; strong effervescence; moderately alkaline; clear, smooth boundary.

C1—15 to 21 inches, dark grayish-brown (10YR 4/2) light silt loam, grayish brown (2.5Y 5/2) dry; weak, coarse, subangular blocky, structure parting to weak, medium and fine, subangular blocky; soft, very friable; many fine pores; strong effervescence; moderately alkaline; clear, wavy boundary.

C2—21 to 60 inches, dark grayish-brown (10YR 4/2) light silt loam, grayish brown (2.5Y 5/2) dry; massive; soft, very friable; many fine pores; violent effervescence; moderately alkaline.

The A horizon ranges from 7 to 15 inches in thickness. It is most commonly very dark brown and very dark grayish brown but ranges to black. Texture is silt loam or silty clay loam. Some areas have an overwash deposit of very dark gray, firm silty clay that is 7 to 14 inches thick. Thin strata of coarser or finer textured material occur below a depth of 42 inches in places. The C horizon ranges from silt loam to very fine sandy loam.

Blyburg soils are near Blencoe, Luton, Forney, and Blake soils. They are not so fine textured in the upper 24 inches as Blencoe soils but have similar texture below this depth. Blyburg soils are better drained than Luton and Forney soils and have a silty rather than clayey texture. Blyburg soils have a coarser C1 horizon and are better drained than Blake soils.

Blyburg silt loam, 0 to 2 percent slopes (Bc).—This soil is deep and is on bottom lands. The areas are the remnants of old meander scars of the Missouri River. They range from 20 to 300 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas that have a surface layer of silty clay loam and that occur in the lowest areas. Also included are slightly convex areas where the surface layer is thinner and is moderately alkaline at a depth of 7 inches.

This soil has few limitations and is one of the better soils in Dakota County for growing crops. Runoff is slow.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units I–1 dryland and I–6 irrigated; windbreak suitability group 1.

Blyburg silt loam, 2 to 6 percent slopes (BcC).—This soil borders drainageways that cross the bottom lands. The areas range from 10 to 40 acres in size. In some places narrow, nearly level channels are in this mapping unit.

This soil has a profile similar to the one described as representative for the series, but the surface layer is 7 inches thick and is mildly alkaline. The underlying material is very fine sandy loam.

Included with this soil in mapping are small areas of Forney soils, swales, 0 to 2 percent slopes, in channels and Blyburg silt loam, 0 to 2 percent slopes, in nearly level areas.

Lack of sufficient moisture is the principal limitation where this soil is dryfarmed. Soil blowing is a hazard in the sandier areas if the surface is not protected. Runoff is medium.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIe–1 dryland and IIIe–6 irrigated; windbreak suitability group 1.

Blyburg silty clay loam, 0 to 2 percent slopes (Bd).—This soil is on bottom lands. It is in slightly concave areas along and around the perimeter of finer textured soils. It is most commonly associated with Blyburg silt loam, 0 to 2 percent slopes, which occurs at a higher elevation, and with Blencoe soils, which occur at a lower elevation. The areas range from 10 to 40 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is silty clay loam that averages 12 inches in thickness but ranges from 7 to 15 inches in thickness. This soil is moderately well drained to somewhat poorly drained. Workability is only fair.

Included with this soil in mapping are small areas of Blencoe soils.

Ponding of water is the principal limitation where this soil is cultivated. Runoff is slow.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units I–1 dryland and I–3 and irrigated; windbreak suitability group 1.

Blyburg silty clay, overwash, 0 to 2 percent slopes (Be).—This soil is on bottom lands. It occurs in areas between the Forney soils and Blyburg silt loam, 0 to 2 percent slopes. The areas range from 20 to 60 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is an overwash deposit of silty clay that ranges from 7 to 14 inches in thickness. Thin strata of light-colored silt loam commonly separate the overwash surface layer and the buried former surface layer. This buried layer is light silty clay loam. In some places it has a few soft lime accumulations. The silty underlying material is at a depth ranging from 30 to 42 inches.

Flooding is currently not a concern on this soil. Water ponding in some of the lower areas and a clayey surface layer are the principal limitations where this soil is cultivated. Runoff is slow. It is difficult to maintain good tilth on this soil.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIw–1 dryland and IIw–1 irrigated; windbreak suitability group 2.

Calco Series

The Calco series consists of deep, nearly level, poorly drained soils that formed in silty alluvium. These soils are on bottom lands along major streams that drain the uplands. Depth to the water table ranges from 2 feet in spring to 6 to 8 feet in fall.

In a representative profile, the surface layer is silty clay loam about 40 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material is very dark gray silty clay loam. The soil is calcareous throughout.

Calco soils have moderately slow permeability and a high available water capacity. Their organic-matter content is high or moderate, and their natural fertility is high. They release moisture readily to plants.

Calco soils are suited to cultivated crops under both dryland and irrigation management. The more poorly drained areas, however, are better suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Calco silty clay loam, 0 to 2 percent slopes, in a cultivated field 2,340 feet south and 1,360 feet east of the northwest corner of sec. 36, T. 28 N., R. 7 E.

Ap—0 to 6 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate, medium and fine, granular structure; hard, very friable; slight effervescence; moderately alkaline; abrupt, smooth boundary.

A12—6 to 16 inches, black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate, coarse, blocky structure parting to weak, medium and fine, subangular blocky; slightly hard, friable; few small accumulations of lime; violent effervescence; moderately alkaline; gradual, smooth boundary.

A13—16 to 28 inches, black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; few, faint, distinct, dark-brown (7.5YR 4/4) mottles; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, firm; many small accumulations of lime; many fine pores; violent effervescence; moderately alkaline; gradual, smooth boundary.

A14—28 to 40 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; few, fine, faint, dark-brown (7.5YR 4/4) mottles; weak, coarse, prismatic structure parting to moderate, medium, subangular blocky; hard, firm; few small concretions of lime; many fine pores; violent effervescence; moderately alkaline; gradual, smooth boundary.

C—40 to 60 inches, very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak, coarse, blocky structure; hard, firm; violent effervescence; moderately alkaline.

The A horizon ranges from 30 to 40 inches in thickness. It is black to very dark-gray silt loam or silty clay loam. In places, there is a layer of overwash material, 12 to 34 inches thick, that consists of very dark grayish-brown silt loam or light silty clay loam. Snail shells are in the Ap horizon in some places. Few to common, distinct, gray and dark reddish-brown or brown mottles are in the lower part of the A horizon. The C horizon is dark-gray or very dark gray silt loam or silty clay loam.

Calco soils are near Kennebec soils. They are finer textured throughout and are more poorly drained than Kennebec soils.

Calco silt loam, overwash, 0 to 2 percent slopes (Ca).—This soil is deep and is on bottom lands along small upland drainageways. It occurs along streams that have a low gradient and generally no defined channel. These areas range from 10 to 30 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is an overwash deposit of very dark grayish-brown stratified silt loam 12 to 34 inches thick. Few to common, distinct, gray and dark reddish-brown mottles are in some strata. The entire profile is also more stratified with varying colors than the representative profile. Mottles are present in the overwash material. Depth to the water table is commonly 6 to 8 feet in fall and slightly higher in spring. Wet areas where the water table is within a depth of 2 feet are shown on the detailed soil map by a special spot symbol.

Slow runoff, a fluctuating water table, and occasional flooding are the principal limitations. Flooding causes some deposition of light-colored silty material on the surface. Tilling and planting are commonly delayed by wetness. Flooding and the resulting siltation can cause some damage to crops if the floods occur when the crops are small. Suitable drainage outlets are also difficult to obtain. Organic-matter content is moderate.

Nearly all the acreage is in pasture or hay. Capability units IIw-4 dryland and IIw-4 irrigated; windbreak suitability group 2.

Calco silty clay loam, 0 to 2 percent slopes (Cb).—This soil is on bottom lands along streams that drain the uplands. The areas range from 10 to 40 acres in size. Depth to the water table ranges from 2 to 6 feet. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few small areas that have a surface layer of calcareous silt loam 2 to 6 inches thick. Also included are small areas of Kennebec silt loam, 0 to 2 percent slopes.

Wetness is the principal hazard, but this soil can be drained artificially. Some areas in narrow valleys that have deeply entrenched drainageways are naturally drained. In cultivated areas tilling and planting have to be delayed because of the excessive wetness. Runoff is slow. Land leveling is needed for gravity irrigation. Organic-matter content is high.

About half the acreage is cultivated, and half is in pasture. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIw-4 dryland and IIw-3 irrigated; windbreak suitability group 2.

Crofton Series

The Crofton series consists of deep, gently sloping to steep, well-drained soils that formed in loess. These soils are in the western part of the uplands, and they occupy narrow ridgetops and the upper hillsides of narrow drainage divides. Their slopes are mainly convex.

In a representative profile, the surface layer is very dark grayish-brown silt loam 6 inches thick. Many lime concretions are on the surface and throughout the surface layer (fig. 6). Beneath this is a transitional layer of dark-brown silt loam about 9 inches thick. The underlying material, extending to a depth of 60 inches, is dark-brown silt loam. The entire profile is calcareous.

Crofton soils have moderate permeability and a high available water capacity. Their organic-matter content and their natural fertility are low. They release moisture readily to plants.

Crofton soils in gently sloping to strongly sloping areas are suited to cultivated crops, but the hazard of erosion is severe. The steep and severely eroded soils are better suited to native grass and other less intensive uses than they are to cultivated crops. These soils are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Crofton silt loam, 11 to 15 percent slopes, eroded, in a cultivated field 1,020 feet south and 200 feet west of the northeast corner of sec. 9, T. 27 N., R. 7 E.

Figure 6.—**Profile of Crofton silt loam. This loess soil is weakly developed and has lime throughout the profile.**

Ap—0 to 6 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; soft, very friable; many medium concretions of lime; violent effervescence; moderately alkaline; abrupt, smooth boundary.

AC—6 to 15 inches, dark-brown (10YR 3/3) silt loam, light brownish gray (10YR 6/2) dry; weak, coarse, subangular blocky structure parting to weak, medium and fine, granular; soft, very friable; many medium concretions of lime; violent effervescence; moderately alkaline; clear, smooth boundary.

C—15 to 60 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; many, large, light olive-brown (2.5Y 5/4) mottles, many, medium, light brownish-gray (2.5Y 6/2) mottles, and few, small, strong-brown (7.5YR 5/6) mottles; weak, coarse, blocky structure; soft, very friable; few medium concretions of lime; violent effervescence; moderately alkaline.

The A horizon ranges from 6 inches in thickness in cultivated areas to 10 inches in uneroded areas or in areas of native grass. It is silt loam that ranges from very dark brown to dark grayish brown in cultivated areas and from dark gray to very dark brown in uneroded areas. Concretions of lime range from few to many and from small to large. The AC horizon ranges from 5 to 12 inches in thickness and is dark brown to dark grayish brown. In some of the more severely eroded areas, the AC horizon is absent. The C horizon ranges from dark brown to pale brown in color. Lime occurs as concretions or is disseminated in the soil material; on the surface in most places, lime concretions are abundant. Some strong-brown and light brownish-gray mottles are commonly present within a depth of 15 inches.

Crofton soils are near Nora, Moody, Monona, and Ida soils and are similar to Ida soils. Crofton soils differ from Nora, Moody, and Monona soils in that they lack a B horizon. They have a thinner, lighter colored A horizon than Nora soils. Crofton soils are not so fine textured in the upper part of the profile as Moody soils, and they have lime higher in the profile than those soils. They have lime higher in the profile than Monona soils. Crofton soils occur in a slightly drier climate than Ida soils.

Crofton silt loam, 2 to 6 percent slopes, eroded (CfC2).—This soil is in the loess uplands. It is mainly on convex ridgetops that are drainage divides and are 100 to 200 feet in width. The areas range from 10 to 30 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly lighter colored.

Included with this soil in mapping are small areas of Nora soils.

Because of the slope, texture, and low organic-matter content, this very friable soil is susceptible to sheet erosion and rill erosion. Erosion is the principal hazard where the soil is cultivated. Maintaining organic-matter content is a concern of management. Runoff is medium.

Nearly all the acreage is cultivated, but a few small areas are in pasture. Corn, oats, and alfalfa hay are the principal crops. Capability units IIIe–9 dryland and IIIe–6 irrigated; windbreak suitability group 5.

Crofton silt loam, 6 to 11 percent slopes, eroded (CfD2).—This soil is in the loess uplands. It is on rounded ridgetops and convex hillsides that are a part of drainage divides. The areas are comparatively small, ranging from 10 to 30 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is lighter colored.

Included with this soil in mapping are small areas of Moody silty clay loam, 2 to 6 percent slopes, and Nora silt loam, 6 to 11 percent slopes.

Because of the slope, silty texture, and low organic-matter content, this very friable soil is susceptible to water erosion. Sheet and rill erosion are the principal hazards if this soil is cultivated. This soil has good workability, but management practices that increase the infiltration rate of moisture are needed. Runoff is medium.

Nearly all the acreage is cultivated, and small areas are in grass. Corn, soybeans, oats, and alfalfa hay are the principal crops. Capability units IVe–9 dryland and IVe–6 irrigated; windbreak suitability group 5.

Crofton silt loam, 11 to 15 percent slopes (CfE).—This soil is in the loess uplands. It is on sharp ridgetops and convex hillsides of drainage divides. Areas range from 20 to 100 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is very dark brown and is 6 inches thick.

Included with this soil in mapping are small areas that are noncalcareous to a depth of 10 inches. Also included are areas of Nora silt loam, 11 to 15 percent slopes, in slightly concave areas. Eroded areas are shown on the detailed soil map by a special spot symbol.

Maintaining a good plant cover is a necessary part of good management. Runoff is rapid.

Nearly all the acreage is in native grasses or deciduous trees and shrubs. Capability unit IVe–9 dryland; windbreak suitability group 5.

Crofton silt loam, 11 to 15 percent slopes, eroded (CfE2).—This soil is on sharp ridgetops and on the convex sides of drainage divides that drain the loess uplands. The areas range from 50 to 200 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few small areas of Nora silt loam, 11 to 15 percent slopes, eroded, in concave areas. Also included are a few areas of steeper Crofton soils commonly along the upper areas of small drainageways.

Water erosion is a hazard on this soil. Small ditches and rills form during intense rainstorms, but these are generally plowed in as part of regular tillage. Low organic-matter content and an inadequate supply of moisture are common limitations. Maintaining tilth is not a serious concern, but maintaining organic-matter content is a concern of management. Runoff is rapid.

Most of the acreage is cultivated or has been reseeded to grass, and a few areas are in native grass. Corn, oats, and alfalfa hay are the principal crops. Capability unit IVe–9 dryland; windbreak suitability group 5.

Crofton silt loam, 15 to 30 percent slopes (CfF).—This soil is in the loess uplands where it occupies irregular, very narrow, convex ridgetops. Irregular catstep slopes occur in the steepest areas. Areas range from 20 to 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is dark grayish brown and is 6 inches thick. The transitional layer is 6 to 10 inches thick and pale brown to grayish brown in color. The soil is calcareous at the surface or within 10 inches of the surface.

Included with this soil in mapping are small areas of Nora silt loam, 15 to 30 percent slopes, in concave areas or on east-facing side slopes. Also included are areas of gullied land that occur along drainageways in some areas. Glacial till and outcrops of shale are indicated by spot symbols on the detailed soil map.

Runoff is rapid.

Most of the acreage is in native grass or woodland. It is too steep for successful cultivation. The native grasses consist mainly of big bluestem, little bluestem, side-oats grama, and switchgrass. Bur oak is the most common tree species. A few areas are cultivated. Capability unit VIe–9; windbreak suitability group 10.

Crofton silt loam, 15 to 30 percent slopes, eroded (CfF2).—This soil is in the loess uplands and occupies eroded, concave, narrow ridgetops. It has irregular slopes. Areas range from 20 to 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is lighter colored.

Included with this soil in mapping are small areas that are not eroded. Also included are small areas of Nora silt loam, 15 to 30 percent slopes. Outcroppings of glacial till and shale are shown by spot symbols on the detailed soil map.

Water erosion is the principal hazard on this soil. In places small rills and gullies form, and these are plowed in with each successive tillage. Fertility and the supply of plant nutrients, particularly nitrogen, are low. Runoff is rapid.

Nearly all the acreage was once cultivated, but because the erosion hazard is so severe, some areas are now seeded to native grass. A few areas are still cultivated. Capability unit VIe–9; windbreak suitability group 10.

Forney Series

The Forney series consists of deep, nearly level to depressional, poorly drained soils that formed in alluvium. The alluvium is mainly clayey. These soils are stratified and are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is silty clay about 15 inches thick. It is black in the upper and middle parts and very dark grayish-brown in the lower part. The subsoil, about 10 inches thick, is very dark grayish-brown, firm silty clay. At a depth of 25 inches is a layer of black silty clay about 12 inches thick. This layer is the surface layer of an older soil that was buried by river sediment. The subsoil and underlying material of this buried soil are dark-gray and gray, very firm silty clay and extend to a depth of 60 inches.

Forney soils have very slow permeability and a moderate available water capacity. Their organic-matter content is moderate, and their natural fertility is medium. They release moisture slowly to plants.

Forney soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Forney silty clay, 0 to 2 percent slopes, in a cultivated field 2,350 feet east and 50 feet north of the southwest corner of NW¼ sec. 16, T. 28 N., R. 8 E.

Ap—0 to 6 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; strong, coarse, angular blocky structure parting to strong, medium, blocky; compacted because of tillage; very hard, firm; neutral; abrupt, smooth boundary.

A12—6 to 11 inches, black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; very thin strata of silt loam at a depth of 8 inches; strong, very fine, blocky structure; very hard, firm; very few, small, soft accumulations of lime; neutral; abrupt, smooth boundary.

A13—11 to 15 inches, very dark grayish-brown (2.5Y 3/2) silty clay, dark gray (10YR 4/1) dry; strong, fine granular structure; very hard, firm; slight effervescence; moderately alkaline; abrupt, smooth boundary.

B2g—15 to 25 inches, very dark grayish-brown (2.5Y 3/2) silty clay, dark gray (10YR 4/1) dry; strong, very fine, blocky structure; very hard, firm; very small, soft accumulations of lime; organic stains coating peds; violent effervescence; moderately alkaline; gradual, smooth boundary.

A11bg—25 to 30 inches, black (2.5Y 2/0) silty clay, dark gray (2.5Y 4/0) dry; strong, fine, granular structure; very hard, firm; few snail shells; small, soft accumulations of lime; slight effervescence; moderately alkaline; gradual, smooth boundary.

A12bg—30 to 37 inches, black (2.5Y 2/0) silty clay, dark gray (2.5Y 4/0) dry; strong, very fine, blocky structure parting to strong, fine, granular; very hard, firm; few snail shells; small soft accumulations of lime; slight effervescence; moderately alkaline; gradual, smooth boundary.

B2bg—37 to 54 inches, dark-gray (N 4/0) silty clay, gray (N 5/0) dry; many, fine, distinct, dark-brown (7.5YR 4/4) mottles; strong, very fine, blocky structure; very hard, firm; mildly alkaline; gradual, smooth boundary.

Cbg—54 to 60 inches, gray (N 5/0) silty clay, light brownish gray (N 6/0) dry; many, coarse, distinct dark-brown (7.5YR 4/4) mottles; strong, very fine, blocky structure; very hard, firm; few, soft, large accumulations of lime; many fine concretions of lime; strong effervescence; moderately alkaline; abrupt, smooth boundary.

The A horizon ranges from 6 to 15 inches in thickness and from black to very dark grayish brown in color. It is clay and silty clay, but in places there is an overwash of silt loam on the surface. This overwash ranges from neutral to moderately alkaline. The B2g horizon ranges from 4 to 18 inches in thickness and is very dark grayish brown to dark gray in color. It ranges from silty clay to clay. The A11bg horizon ranges from black to dark gray and is 5 to 10 inches thick. This horizon is the surface layer of an older soil buried by recent clayey sediment. In most places, more than one Ab horizon is in a profile 5 feet deep. The B2bg horizon ranges from dark gray to grayish brown. Generally, it is clay or silty clay, but in places there are thin strata of silty clay loam. Depth to lime ranges from 10 to 30 inches. The Ap horizon is neutral to mildly alkaline.

In Dakota County the Forney soils are more stratified and are shallower to free carbonates than is defined as the range for the series, but these differences do not alter the usefulness and behavior of the soils.

Forney soils are near Blyburg, Blencoe, Omadi, and Luton soils. They have a finer textured C horizon than Blyburg, Blencoe, or Omadi soils. Forney soils are more stratified than Luton soils.

Forney silt loam, overwash, 0 to 2 percent slopes (Fn).—This soil is on the Missouri River bottom lands. Areas range from 40 to 200 acres in size. The soil formed in calcareous, silty sediment that was deposited over the original dark-colored surface layer. It occurs in areas that are most susceptible to flooding; some of these areas are near large drainage ditches.

This soil has a profile similar to the one described as representative for the series, but it has an overwash of silt loam. This material is very dark brown and calcareous and averages about 17 inches in thickness, but it ranges from 10 to 30 inches. Some stratification is present. This material is calcareous in places.

Included with this soil in mapping are areas where the buried surface layer is silty clay loam. These buried soils grade to silty clay with increasing depth.

Flooding is not currently a hazard, but some ponding occurs in low places. The surface layer generally has good tilth and is easy to work. Runoff is slow or very slow.

Most of the acreage is cultivated. Both dryland and irrigation management are used. Capability units

IIw-2 dryland and IIw-2 irrigated; windbreak suitability group 2.

Forney silty clay, 0 to 2 percent slopes (Fo).—This soil is deep and is on Missouri River bottom lands. It occurs in swales and other low areas. The areas range from 40 to 600 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few areas where the soils are not so clayey between depths of 17 and 36 inches. Also included are areas where the soil is silty below a depth of 36 inches. These included soils have slightly better natural drainage than this Forney soil. Other soils are included that have a light-colored silty layer, less than 6 inches thick, that overlies the uppermost buried dark-colored soil.

Excessive wetness and clayey texture are the principal limitations where this soil is cultivated. Water from higher adjoining areas commonly ponds on the surface. Suitable outlets for draining this soil satisfactorily are lacking. Field operations are delayed in some years because of excessive wetness. The surface layer puddles easily if this soil is not cultivated at the proper moisture content. Runoff is very slow.

Nearly all the acreage is cultivated, and a small part is irrigated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIIw-1 dryland and IIIw-1 irrigated; windbreak suitability group 2.

Forney soils, swales, 0 to 2 percent slopes (Fs).—This soil is deep and is in large channel areas that cross the Missouri River bottom lands. These channels are shallow and occur about midway between the river and the bluffs. The width of the channels is 200 to 500 feet. In places, the channels divide into several smaller channels or widen into a large flood plain. In a few places, a secondary channel occurs within another channel. A water table is at a depth of 4 to 6 feet.

These soils have a profile similar to the one described as representative for the series, but it is more variable. Most commonly the soil is dark grayish-brown silty clay that is underlain in places by fine sand below a depth of 40 inches. This Forney soil has a considerably mottled subsoil.

Included with this soil in mapping are soils that have 24 inches of silty clay loam underlain by silt and sand. These included soils occur in the narrow channels and in the primary channel where a secondary channel is present. Blyburg silt loam, 2 to 6 percent slopes, occurs on the sides of drains in some areas.

Because they receive water from adjacent areas and have very slow permeability and because water runs off very slowly, these are poorly drained soils. Their poor internal drainage and their clayey surface layer are important limitations.

These soils are cultivated in most places. They are used mainly for corn, soybeans, and alfalfa hay. Capability units IIIw-1 dryland and IIIw-1 irrigated; windbreak suitability group 6.

Grable Series

The Grable series consists of deep, nearly level or slightly undulating, well-drained soils that have fine sand at a depth of about 2 feet. These soils formed in alluvium. They are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is very dark grayish-brown very fine sandy loam 9 inches thick. The underlying material is grayish-brown very fine sandy loam in the upper part and dark grayish-brown fine sand in the lower part.

Grable soils have moderate permeability to a depth of 24 inches and rapid permeability below that depth. Their available water capacity is moderate. Their organic-matter content is moderately low, and their natural fertility is low. They release moisture readily to plants.

Grable soils are suited to cultivated crops under both dryland and irrigation management. Crops show the effect of short droughty periods. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Grable very fine sandy loam, 0 to 2 percent slopes, in a cultivated field 2,590 feet west and 1,000 feet north of the southeast corner of sec. 8, T. 27 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak, fine, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, very friable; mildly alkaline; abrupt, smooth boundary.

A12—7 to 9 inches, very dark grayish brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; weak, fine, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, very friable; few very fine pores; mildly alkaline; clear, smooth boundary.

C1—9 to 24 inches, grayish-brown (2.5Y 5/2) very fine sandy loam, light gray (2.5Y 7/2) dry; weak, coarse, blocky structure parting to weak, fine and medium, platy; soft, very friable; few fine pores; 1-inch strata of coarser material at depths of 10 inches and 23 inches and a thin lens of fine sand; strong effervescence; moderately alkaline; abrupt, smooth boundary.

IIC2—24 to 60 inches, dark grayish-brown (2.5Y 4/2) fine sand, light brownish gray (2.5Y 6/2) dry; single grained; loose; strong effervescence; moderately alkaline.

The Ap horizon is light silt loam or very fine sandy loam that ranges from 6 to 10 inches in thickness. It is generally mildly alkaline and calcareous but ranges to neutral and is noncalcareous in some places. The C1 horizon is mainly very fine sandy loam but in places is silt loam or fine sandy loam. Depth to the IIC2 horizon is 18 to 30 inches. The IIC2 horizon is loose loamy fine sand or fine sand. Very thin strata of loamy or clayey material occur in places within the IIC2 horizon.

Grable soils are near Blake, Haynie, Onawa, Percival, and Sarpy soils. Their IIC horizon is coarser textured than that of Blake or Haynie soils. Grable soils are not so fine textured in the A horizon and upper part of the C horizon as Onawa and Percival soils. They are finer textured in the upper part of the C horizon than Sarpy soils.

Grable very fine sandy loam, 0 to 2 percent slopes (Gb).—This soil is deep and is underlain by sandy material. It is on bottom lands in areas that have received recent deposits of alluvium. The soil is nearly level or only slightly undulating and is in narrow, convex areas closely associated with nearby sandy and clayey soils. The areas range from 10 to 50 acres in size.

Included with this soil in mapping are a few areas of Haynie, Onawa, and Percival soils and areas of Sarpy loamy fine sand, 0 to 6 percent slopes.

The moderate available water capacity and the fine sand in the underlying material result in a lack of sufficient moisture for crops late in the growing season. This is the main limitation where this soil is not irrigated. Soil blowing is a hazard where the surface is not protected. Farming operations are commonly governed by the limitations of the associated soils.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. A few areas near the Missouri River have not been cleared of trees. Capability units IIs–5 dryland and IIs–6 irrigated; windbreak suitability group 1.

Gullied Land

Gullied land occurs in narrow drainageways of uplands and bottom lands. It ranges from gently sloping to very steep. The drainageways have been severely eroded by moving water, and most of the larger areas also have active but smaller side gullies. In most areas in Dakota County, Gullied land is as least partly stabilized by mixed grass, trees, and shrubs, but in some areas the banks are nearly vertical walls.

This land type formed in material from various sources, among which are loess, colluvium, and alluvium. The soil material is deep, well drained, and mainly medium textured. It ranges from very pale brown to very dark grayish brown.

Permeability is moderate, and available water capacity is high. The natural fertility and organic-matter content range from low to high but are higher in areas of foot slopes and bottom lands than in other areas. In most areas the soil material is noncalcareous.

Gullied land is commonly too steep for the growth of cultivated crops. It is well suited to wildlife habitat and furnishes excellent cover and protection. A few areas are grazed.

In Dakota County, Gullied land is not mapped separately but occurs in complexes with Ida soils and with Napier soils.

Gullied land-Ida complex, 30 to 60 percent slopes (GuG).—This mapping unit occurs in areas of the loess uplands where drainageways are gullied. The Ida soil is at the higher elevations, and Gullied land is at the lower elevations where erosion is more severe. Gullied land and the Ida soil each make up about 50 percent of the mapping unit. Some areas serve as drainageways for runoff from adjoining soils on uplands. Most areas are stabilized, generally by grass and trees on the higher part and by trees and shrubs on the lower part. The gullies have nearly vertical banks that consist mainly of loess material, but glacial till is exposed in some places. The gullies range from 10 to 30 feet in depth and are as wide as 100 feet in places.

The Ida soil has a profile similar to the one described for the Ida series, but the surface layer is thicker and lime is at a greater depth where this soil occurs on the lower part of a slope.

Water erosion is a serious hazard in areas of this mapping unit. Small overfalls along wide drains are common. Control of erosion is difficult.

Nearly all the acreage is in permanent vegetation and is used mainly as wildlife habitat. A few areas are grazed. The soils are not suited to cultivated crops. They are too steep, and the hazard of erosion is too severe. Capability unit VIIe–7 dryland; windbreak suitability group 10.

Haynie Series

The Haynie series consists of deep, nearly level, moderately well drained soils that formed in alluvium. These soils are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is very dark grayish-brown silt loam 7 inches thick. The transitional layer is stratified, dark grayish-brown silt loam that extends to a depth of 25 inches. Beneath this layer, to a depth of 60 inches, is dark grayish-brown very fine sandy loam. The soil is calcareous throughout.

Haynie soils have moderate permeability and a high available water capacity. Their organic-matter content is moderately low, and their natural fertility is low. They release moisture readily to plants.

Haynie soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation. These are among the better soils for cultivated crops in the Missouri River Valley.

Representative profile of Haynie silt loam, 0 to 2 percent slopes, in a cultivated field 2,400 feet west and 100 feet north of the southeast corner of sec. 1, T. 88 N., R. 48 W.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, grayish brown (2.5Y 5/2) dry; weak, very fine, granular structure; soft, very friable; strong effervescence; moderately alkaline; abrupt, smooth boundary.

AC—7 to 25 inches, dark grayish-brown (10YR 4/2) silt loam, grayish brown (2.5Y 5/2) dry; many, distinct, dark yellowish-brown (10YR 4/4) mottles and few, faint gray (5Y 5/1) mottles; coarse, subangular blocky structure; soft, very friable; 1-inch strata of loamy fine sand at a depth of 24 inches and a thin lens of silty clay immediately below; violent effervescence; moderately alkaline; gradual, smooth boundary.

C—25 to 60 inches, dark grayish-brown (10YR 4/2) very fine sandy loam, grayish brown (2.5Y 5/2) dry; weak, very fine, platy structure; soft, very friable; violent effervescence; moderately alkaline.

The Ap horizon ranges from 6 to 10 inches in thickness. It ranges from very dark grayish brown to dark grayish brown and from silt loam to very fine sandy loam. The AC horizon ranges from silt loam to very fine sandy loam and from dark grayish brown to grayish brown. The C horizon ranges from silt loam to very fine sandy loam. It contains thin strata of sand, loam, silty clay loam, or clay in many places. These individual strata are generally less than 1 inch in thickness. This horizon has few to common, strong-brown, yellowish-brown, reddish-brown, or gray mottles in some places. Haynie soils are commonly mildly alkaline or moderately alkaline throughout, but their Ap horizon ranges from neutral to moderately alkaline.

Haynie soils are near Albaton, Blake, Grable, Onawa, Percival, and Sarpy soils. They are coarser textured than Albaton, Onawa, or Percival soils. They lack an underlying layer of fine sand, which the Grable and Sarpy soils have.

Haynie silt loam, 0 to 2 percent slopes (He).—This soil is deep and is on bottom lands. Most areas are long and narrow, and they parallel former stream channels. The areas range from 10 to 40 acres in size.

Included with this soil in mapping are slightly convex higher areas that have a surface layer of very fine sandy loam to loamy very fine sand. Also included are small areas of Onawa and Grable soils. Other included areas are in swales where the surface layer is silty clay loam and the soil is wetter than this Haynie soil.

Soil blowing is a hazard in areas where a coarser textured surface layer is dominant. Some land leveling is needed for gravity irrigation. Runoff is slow. In places, large areas have a network of poorly drained soils in swales; consequently, field operations have to be delayed slightly.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops, but vegetable crops are also grown. Some areas are irrigated and respond well to the additional moisture. Small stands of trees grow in some areas close to the Missouri River. Capability units I–1 dryland and I–6 irrigated; windbreak suitability group 1.

Ida Series

The Ida series consists of deep, strongly sloping to very steep, well-drained soils that formed in loess. These soils are in the eastern part of the uplands, mainly in the bluff area.

In a representative profile, the surface layer is dark-brown silt loam 6 inches thick. Beneath this is a transitional layer, 6 inches thick, of dark-brown, calcareous silt loam. The underlying material, extending to a depth of 60 inches, is brown, calcareous silt loam. Lime concretions are on the surface and throughout the profile, but they decrease in number with increasing depth.

Ida soils have moderate permeability and high available water capacity. Their organic-matter content and their natural fertility are low.

Ida soils are suited to cultivated crops under dryland management if slopes are not more than 17 percent. The hazard of erosion is very severe. The steepest soils are used mainly for pasture, but a few large areas are in native woodland (fig. 7). These soils are also suited to wildlife habitat and recreation.

Representative profile of Ida silt loam, 11 to 17 percent slopes, eroded, in a cultivated field 1,320 feet north and 650 feet west of the southeast corner of sec. 29, T, 27 N., R. 9 E.

Ap—0 to 6 inches, dark-brown (10YR 3/3) silt loam, pale brown (10YR 6/3) dry; weak, medium and fine, granular structure; soft, very friable; few small lime concretions; violent effervescence; moderately alkaline; abrupt, smooth boundary.

Figure 7.—**Native trees and shrubs on steep Ida soils.**

AC—6 to 12 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak, coarse, subangular blocky structure; soft, very friable; few small lime concretions; violent effervescence; moderately alkaline; abrupt, smooth boundary.

C—12 to 60 inches, brown (10YR 5/3) silt loam, very pale brown (10YR 7/3) dry; common, medium, faint, strong-brown (7.5YR 5/6) mottles and common, fine, faint, light brownish-gray (2.5Y 6/2) mottles; massive; soft, very friable; few lime concretions; violent effervescence; moderately alkaline.

The A horizon ranges from very dark grayish brown to dark brown in color and from 4 to 10 inches in thickness, depending mainly on the degree of erosion. The A horizon is noncalcareous in places and ranges from mildly alkaline to moderately alkaline. Lime concretions range from few to many on the surface. The AC horizon ranges from dark brown to brown. The C horizon ranges from dark brown to yellowish brown. It contains few to common strong-brown and brownish-gray mottles. It has few to many small lime concretions.

Ida soils are near Monona soils and have a profile similar to Crofton soils. They have lime higher in the profile than Monona soils, but they lack a distinct brownish B horizon, which Monona soils have. Ida soils occur in a more moist climate than Crofton soils.

Ida silt loam, 11 to 17 percent slopes, eroded (IdE2).—This soil is in the loess uplands. It is on sharp ridgetops and convex sides of drainage divides. Areas range from 10 to 60 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few small areas of Monona silt loam, 11 to 17 percent slopes. Also included are a few uneroded areas. Outcrops of glacial till and shale are shown by special spot symbols on the detailed soil map.

Runoff is rapid, and water erosion is the principal hazard on this soil. Small gullies and rills form during intense rainstorms, but these are generally plowed in as part of regular tillage. Low organic-matter content and an inadequate supply of moisture can be limitations.

Most of the acreage is cultivated, and some areas have been returned to grass. Corn, oats, and alfalfa hay are the principal crops. Because of slope and the severe hazard of erosion, the soil is better suited to grass or hay than to cultivated crops. Capability unit IVe–9 dryland; windbreak suitability group 5.

Ida silt loam, 17 to 30 percent slopes (IdF).—This soil is in the loess uplands on sharp ridgetops and on hillsides. It has irregular, convex slopes. In places the steeper slopes have catsteps.

This soil has a profile similar to the one described as representative for the series, but the surface layer is dark grayish brown and ranges from 5 to 8 inches in thickness. In many areas the soil is calcareous at or within a few inches of the surface.

Included with this soil in mapping are a few small areas of Monona silt loam, 17 to 30 percent slopes. Also included are some eroded areas. Outcrops of glacial till and shale commonly occur at the lower elevations in areas of this soil and are shown by special spot symbols on the detailed soil map.

Runoff is rapid, and water erosion is the principal hazard. In most areas, the plant cover needs to be improved.

Most of the acreage is in grass, and some areas have native trees. Capability unit VIe–9; windbreak suitability group 10.

Ida silt loam, 17 to 30 percent slopes, eroded (IdF2).—This soil is in the loess uplands on sharp, irregular, narrow ridgetops and steep, convex hillsides. In places the steeper slopes have catsteps. Areas range from 10 to 60 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly thinner.

Included with this soil in mapping are a few small areas of Monona silt loam, 17 to 30 percent slopes. Also included are the heads of a few stabilized gullies and some uneroded areas. Outcrops of glacial till and shale occur at the lower elevations in areas of this soil and are shown by special spot symbols on the detailed soil map.

Runoff is rapid, and water erosion and steepness are the principal hazards. Fertility in the eroded areas is low.

Nearly all the acreage is cultivated, but some areas have been returned to grass. Capability unit VIe–9; windbreak suitability group 10.

Ida soils, 30 to 60 percent slopes (IeG).—These soils are in the loess uplands on the drainage divides, which consist of irregular ridgetops and hillsides. They are in the steepest part of the county and make up the bluffs that border the Missouri River Valley. Areas range from 20 to 200 acres in size.

These soils have a profile similar to the one described as representative for the series, but the surface layer is very dark grayish brown and is neutral. They are noncalcareous in eroded areas and in wooded areas. Most of the surface in wooded areas is covered with a thin litter of leaves and twigs.

Included with these soils in mapping are small areas of Monona soils. Also included are stabilized gullied areas that occur in the deeply dissected drainageways. Outcrops of glacial till and shale are shown by a special spot symbol on the detailed soil map.

Water erosion is the principal hazard where the plant cover is removed, and it severely limits the use of this soil. Runoff is rapid.

Nearly all the acreage is in native woodland, but the tree stands are of poor quality. A few areas are in native grass. Capability unit VIIe–9; windbreak suitability group 10.

Judson Series

The Judson series consists of deep, nearly level to gently sloping, well-drained soils. These soils formed in silty colluvium and alluvium that derived from soil materials of the adjacent uplands. They are on foot slopes, alluvial fans, and in narrow valleys along upland drainageways.

In a representative profile, the surface layer is silty clay loam about 30 inches thick. It is black in the upper part and very dark brown in the middle and lower parts. The subsoil is dark-brown, friable silty clay loam that extends to a depth of 60 inches.

Judson soils have moderate permeability and high available water capacity. Their organic-matter content and their natural fertility are high. These soils release moisture readily to plants. They are easy to till and receive additional moisture and plant nutrients from higher areas.

Judson soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Judson silty clay loam, 0 to 2 percent slopes, in a cultivated field 600 feet south and 150 feet west of the northeast corner of SW¼ sec. 13, T. 28 N., R. 7 E.

Ap—0 to 6 inches, black (10YR 2/1) light silty clay loam, very dark grayish brown (10YR 3/2) dry; moderate, medium and fine, granular structure; slightly hard, friable; slightly acid; abrupt, smooth boundary.

A12—6 to 15 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate, medium, subangular blocky structure parting to moderate, medium and fine, granular; slightly hard, friable; slightly acid; abrupt, smooth boundary.

A13—15 to 30 inches, very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry, very dark grayish brown (10YR 3/2) crushed; moderate, medium, subangular blocky structure parting to moderate, medium and fine, granular; slightly hard, friable; many tubular pores; slightly acid; gradual, smooth boundary.

B1—30 to 40 inches, dark-brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; moderate, fine, prismatic structure parting to moderate, medium and fine, subangular blocky; slightly hard, friable; few thin films on vertical faces of peds; many tubular pores; neutral; gradual, smooth boundary.

B2—40 to 60 inches, dark-brown (10YR 4/3) light silty clay loam, brown (10YR 5/3) dry; moderate, medium, subangular blocky structure; slightly hard, friable; many tubular pores; mildly alkaline.

The A horizon ranges from 24 to 36 inches in thickness. The Ap horizon ranges from black to very dark brown light silty clay loam or silty clay loam. In places as much as 12 inches of very dark grayish-brown silt loam overwash is on the surface. Reaction is slightly acid to neutral. The B1 and B2 horizons range from dark-brown to brown light silty clay loam to silty clay loam. Depth to the B horizon varies with the thinness of overwash.

Judson soils are near Kennebec and Napier soils of the valleys and Moody, Monona, and Nora soils of the uplands. Judson soils have a dark-brown B horizon that is lacking in Kennebec soils, and they are also somewhat finer textured below a depth of about 40 inches. Judson soils are finer textured to a depth of 40 inches than Napier soils but have similar color. Judson soils have a thicker A horizon than Moody, Monona, or Nora soils.

Judson silty clay loam, 0 to 2 percent slopes (Ju). —In most areas, this soil is on foot slopes at the edges of valleys, between the bottom lands and uplands. The areas range from 30 to 200 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few areas where the surface layer is silt loam because overwash has been deposited. Also included are areas that have a thinner surface layer and a lighter colored subsoil.

This soil has few limitations, but some land leveling is needed for gravity irrigation. This is one of the better soils for cultivated crops in Dakota County. It is highly fertile and is easy to work. Runoff is slow.

Most of the acreage is cultivated. Both dryland and irrigation management are used. Capability units I–1 dryland and I–3 irrigated; windbreak suitability group 1.

Judson silty clay loam, 2 to 6 percent slopes (JuC). —This soil is deep. It is in the uplands on colluvial foot slopes along narrow drainageways. Areas range from 30 to 200 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is very dark grayish-brown to dark-brown overwash 10 inches thick. This layer is calcareous silt loam in some areas.

Included with this soil in mapping are small areas of Kennebec silt loam, overwash, 0 to 2 percent slopes.

Runoff is medium, and rill and gully erosion and siltation are hazards on this soil. During hard rains, runoff flows across these areas to drainageways. Ditches and gullies can form in natural drainageways. This soil is generally managed separately from other soils. It is one of the better soils in Dakota County for crops.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIe–1 dryland and IIIe–3 irrigated; windbreak suitability group 4.

Kennebec Series

The Kennebec series consists of deep, nearly level, moderately well drained soils that formed in silty alluvium deposited by streams or washed from nearby hillsides. These soils are on bottom lands of upland drainageways that have entrenched channels. The channels provide natural drainageways for the areas.

In a representative profile, the surface layer is very dark brown silt loam 30 inches thick. Beneath this is a transitional layer of very dark gray silt loam 12 inches thick. The underlying material, extending to a depth of 60 inches, is very dark gray silt loam.

Kennebec soils have moderate permeability and a high available water capacity. Their organic-matter content is moderate or high, and their natural fertility is high. They release moisture readily to plants. They are subject to flooding in some areas.

Kennebec soils are well suited to cultivated crops under both dryland and irrigation management. They are among the more easily tilled soils in Dakota County. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Kennebec silt loam, 0 to 2 percent slopes, in a cultivated field 1,000 feet south and 600 feet east of the northwest corner of sec. 35, T. 29 N., R. 7 E.

Ap—0 to 5 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak, medium and fine, granular structure; soft, very friable; mildly alkaline; abrupt, smooth boundary.

A12—5 to 15 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak, medium and fine, granular structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

A13—15 to 30 inches, very dark brown (10YR 2/2) silt loam, very dark grayish brown (10YR 3/2) dry; weak, medium, subangular blocky structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

AC—30 to 42 inches, very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; soft, very friable; mildly alkaline; gradual, smooth boundary.

C—42 to 60 inches, very dark gray (10YR 3/1) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; soft, very friable; mildly alkaline.

The A horizon ranges from 28 to 40 inches in thickness. It ranges from silt loam to light silty clay loam in texture and from very dark brown to very dark grayish brown in color. The boundary between the A and C horizon is somewhat arbitrary and in most places is indistinct. The C horizon ranges from very dark brown to very dark gray in color. The AC and C horizons range from silt loam to light silty clay loam.

Kennebec soils are near Calco, Judson, and Napier soils. They are not so fine textured as Calco soils and are deeper to lime and are better drained. They are not so well drained as Judson and Napier soils, and they lack a B horizon, which those soils have.

Kennebee silt loam, 0 to 2 percent slopes (Ke).—This soil is deep and is on bottom lands along major streams and drainageways throughout the uplands. Areas range from 10 to 30 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few small areas of Kennebec silt loam, overwash, 0 to 2 percent slopes, and areas of Judson and Napier soils. Also included in mapping are small areas that are somewhat poorly drained.

Runoff is slow, and flooding occurs infrequently on this soil. Some runoff from adjoining drainageways drains onto this soil. Generally, this soil does not have serious limitations, and it is one of the better soils for cultivated crops in Dakota County. Some land leveling is needed for gravity irrigation and protection from possible flooding. Organic-matter content is high.

Most of the acreage is cultivated. Both dryland and irrigation management are used. Some small areas are in pasture. Capability units I–1 dryland and I–6 irrigated; windbreak suitability group 1.

Kennebec silt loam, overwash, 0 to 2 percent slopes (Ko).—This soil is deep. It is on bottom lands along major streams and drainageways throughout the uplands. It is occasionally flooded. Areas range from 40 to 160 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is thinly stratified with light- and dark-colored silt loam. This layer is an overwash deposit that ranges from 12 to 24 inches in thickness. It is generally noncalcareous, but in many places it is weakly calcareous.

Included with this soil in mapping are small areas of Kennebec silt loam, 0 to 2 percent slopes, and Calco silt loam, overwash, 0 to 2 percent slopes. Also included are a few areas that are higher in elevation and are not flooded.

Runoff is slow, and occasional flooding is the principal hazard. Where protected from flooding, this is one of the better soils for cultivated crops in Dakota County. Channel straightening and some land clearing are generally needed in order to successfully cultivate all areas of this soil. Organic-matter content is moderate.

Nearly all the acreage is cultivated and used mainly for corn, soybeans, and alfalfa. Smaller areas are in grass. These areas are generally dissected by meandering drainageways, and a few areas have isolated trees. Capability units IIw–3 dryland and IIw–6 irrigated; windbreak suitability group 1.

Luton Series

The Luton series consists of deep, nearly level, poorly drained soils that formed in clayey alluvium. These soils are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is black silty clay 13 inches thick. The subsoil is firm silty clay about 28 inches thick. It is very dark gray in the upper part and dark grayish brown in the middle part. The lower part has mixed dark grayish-brown and dark-gray colors and medium, distinct, yellowish-brown mottles. The underlying material, to a depth of 60 inches, is dark grayish-brown and dark-gray mottled silty clay. Lime occurs in seams or as concretions below a depth of 17 inches.

Luton soils have very slow permeability and moderate available water capacity. Their organic-matter content is moderate, and their natural fertility is medium. They release moisture slowly to plants.

Luton soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Luton silty clay, thin surface, 0 to 2 percent slopes, in a cultivated field 1,220 feet east and 200 feet north of the southwest corner of sec. 6, T. 27 N., R. 9 E.

Ap—0 to 7 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong, very fine, granular structure; very hard, firm; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; strong, very fine, blocky structure; very hard, firm; shiny films on vertical faces of peds; neutral; gradual, smooth boundary.

B21g—13 to 17 inches, very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; strong, fine, blocky structure; very hard, firm; few, thin, discontinuous films on faces of peds; few snail shells; neutral; wavy, smooth boundary.

B22g—17 to 35 inches, mixed dark grayish-brown (2.5Y 4/2) and dark-gray (N 4/0) silty clay, grayish brown (2.5Y 5/2) and gray (N 5/0) dry; strong, medium, blocky structure; very hard, firm; few slickensides; accumulations of soft lime in seams; violent effervescence; moderately alkaline; gradual, smooth boundary.

B3g—35 to 41 inches, mixed dark grayish-brown (2.5Y 4/2) and dark-gray (N 4/0) silty clay, grayish brown (2.5Y 5/2) and gray (N 6/0) dry; few, medium, distinct, yellowish-brown (10YR 5/6) mottles; moderate, medium, blocky structure; very hard, firm; accumulations of soft lime in seams; violent effervescence; moderately alkaline; gradual, smooth boundary.

Cg—41 to 60 inches, dark grayish-brown (2.5Y 4/2) and dark-gray (2.5Y 4/1) silty clay, grayish brown (2.5Y 5/2) and gray (N 5/0) dry; common, fine, faint, yellowish-brown (10YR 5/6) mottles; strong, coarse, blocky structure; very hard, firm; films on faces of peds; few small lime concretions; violent effervescence; moderately alkaline.

The A horizon ranges from 12 to 16 inches in thickness. It is silty clay or clay in texture and ranges from black to very dark gray in color. The Ap and A1 horizons are generally neutral in reaction, but in places they are slightly acid. The B horizon is silty clay or clay. The B21g horizon is generally neutral but ranges to mildly alkaline. Soft lime concretions and fossil snail shells are commonly present in the B horizon. The B horizon is calcareous, but in many places the matrix is noncalcareous. The C horizon is olive-gray to dark-gray silty clay or clay. Lime concretions are present in places. The intensity of mottling in the C horizon ranges from faint to prominent.

In Dakota County the Luton soils have a thinner A horizon and contain free carbonates nearer the surface than is defined as within the range for the series, but these differences do not alter their usefulness and behavior.

Luton soils are near Blyburg, Blencoe, and Forney soils. They are finer textured throughout than Blyburg soils. Luton soils lack the coarser textures within a depth of 15 to 30 inches, whereas the Blencoe soils do not. They are not so stratified or so poorly drained as the Forney soils.

Luton silty clay, thin surface, 0 to 2 percent slopes (Lu).—This soil is deep and clayey and is on bottom lands. The areas range from 20 to 200 acres in size.

Included with this soil in mapping are small areas of strongly alkaline soils. Also included are soils that have a sequence of two or three dark layers that overlie gray layers in the subsoil and underlying material. These dark layers represent older soils buried by more recent soil deposition. Near large drainage ditches are included soils that have 6 to 12 inches of very dark grayish-brown silt loam overwash.

Wetness is a severe limitation. Water ponds in places because runoff is slow and internal drainage is very slow. The clayey surface layer results in poor tilth. This soil is difficult to cultivate and can be effectively tilled only within a narrow range of moisture content. A good, mellow, firm seedbed is difficult to obtain.

Most of the acreage is cultivated. Both dryland and irrigation management are used. Capability units IIIw–1 dryland and IIIw–1 irrigated; windbreak suitability group 2.

Marsh

Marsh (0 to 2 percent slopes) (Mh) occurs in wet areas that were formerly river channels or small lakes. It is nearly level or depressional. During high seasonal rainfall these areas are periodically flooded. The vegetation consists of coarse grasses, cattails, rushes, and similar plants. Willow trees occupy the driest sites.

This land type formed in material that is mainly silty or clayey in the upper 6 inches and fine sand below that depth, but in a few places the soil material is silty or clayey to a depth of 60 inches. In areas of Marsh either shallow water is on the surface or water is within a depth of 24 inches. Small, shallow bodies of open water occur within these areas.

Marsh is excellent for fishing and waterfowl hunting. These areas also are excellent habitat for wetland wildlife. Capability unit VIIIw–7; windbreak suitability group 10.

Modale Series

The Modale series consists of deep, stratified, nearly level, moderately well drained to somewhat poorly drained soils that are underlain by clayey material at a depth of about 24 inches. These soils are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is silt loam 10 inches thick. It is very dark grayish brown in the upper part and dark grayish brown in the lower part. The transitional layer is mottled grayish-brown silt loam 15 inches thick. Below this, and extending to a depth of 36 inches, is mottled, very dark grayish-brown silty clay loam that is 11 inches thick. This was the surface layer of an old, now buried soil. The next layer, extending to a depth of 60 inches, is dark grayish-brown silty clay. The soil is calcareous throughout.

Modale soils have moderate permeability in the upper part and slow permeability in the lower part. Their available water capacity is high. Their organic-matter content is moderately low, and their natural fertility is medium. They release moisture readily to plants. Root growth is somewhat restricted by the clayey underlying material in excessively wet years. Modale soils are easily worked, and tilth is easy to maintain.

Modale soils are suited to cultivated crops under both dryland and irrigation management. They also are suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Modale silt loam, 0 to 2 percent slopes, in a cultivated field 2,490 feet west and 1,300 feet south of the northeast corner of sec. 33, T. 29 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (2.5Y 3/2) silt loam, grayish brown (2.5Y 5/2) dry; weak, medium and fine, granular structure; slightly hard, very friable; slight effervescence; mildly alkaline; abrupt, smooth boundary.

A12—7 to 10 inches, very dark grayish-brown (2.5Y 3/2) silt loam, grayish brown (2.5Y 5/2) dry; weak, coarse, blocky structure parting to weak, medium and fine, subangular blocky; slightly hard, very friable; slight effervescence; mildly alkaline; clear, smooth boundary.

AC—10 to 25 inches, grayish-brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few fine, faint, yellowish-brown (10YR 5/4) mottles; weak, coarse, blocky structure parting to weak, medium and fine, subangular blocky; soft, very friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIAb—25 to 36 inches, very dark grayish-brown (10YR 3/2) silty clay loam, grayish brown (2.5Y 5/2) dry; many, fine, faint, brown (10YR 5/3) mottles; moderate, medium and fine, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, firm; violent effervescence; moderately alkaline; clear, smooth boundary.

IICb—36 to 60 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; strong, medium and fine, blocky structure; hard, firm; violent effervescence; moderately alkaline.

The A horizon ranges from very dark grayish brown to very dark gray in color and from 6 to 10 inches in thickness. It is mildly alkaline or moderately alkaline. The AC horizon is stratified silt loam or very fine sandy loam and ranges from grayish brown to very dark grayish brown. The darkest layers are in areas where silty material from upland drainageways has been deposited recently and has accumulated on bottom lands. The thickness of the silty stratified material ranges from 20 to 40 inches. The IIAb horizon ranges from silty clay loam to silty clay in texture and from 6 to 12 inches in thickness. The IICb horizon ranges from silty clay to clay. The AC and IIAb horizons have mottles that range from few to many and from faint yellowish brown to brown. The mottles are more numerous where there are thin strata of contrasting soil textures.

Modale soils in the county lack strong contrast in texture within a thickness of 5 inches, which is characteristic of the series, and they have a darker colored surface layer than is defined as within the range for the series. But these differences do not alter their usefulness and behavior.

Modale soils are near Albaton, Blake, Haynie, Onawa, and Waubonsie soils. Their A and AC horizons are not so fine textured as those in Albaton soils. Modale soils lack a silty C horizon, which the Blake, Haynie, and Onawa soils have. Modale soils have less sand in the layers above the clayey C horizon than Waubonsie soils.

Modale silt loam, 0 to 2 percent slopes (Mk).—This soil is deep and is on bottom lands. The most common landscape has very gentle, narrow, long alternating rises and swales. The soil occurs where former stream channels deposited silty sediment that covered the clayey underlying material. The areas range from 20 to 40 acres in size.

Included with this soil in mapping are a few small areas where the clayey underlying material is within a depth of 12 inches.

This soil has few serious limitations where it is cultivated. In some seasons, however, a perched water table is above the clayey underlying material, and this can result in a wetness problem for a short period. Runoff is slow.

Most of the acreage is cultivated. Corn, soybeans, and alfalfa are the main crops. Both dryland and irrigation management are used. A few areas near the river channel are in trees. Capability units I–1 dryland and I-6 irrigated; windbreak suitability group 1.

Monona Series

The Monona series consists of deep, moderately sloping to steep, well-drained soils that formed in loess. These soils are on uplands.

In a representative profile, the surface layer is dark grayish-brown silt loam 15 inches thick. The subsoil, about 25 inches thick, is dark-brown very friable silt loam. The underlying material, extending to a depth of 60 inches, is brown silt loam. The soil is calcareous at a depth of 50 inches.

Monona soils have moderate permeability and high available water capacity. The organic matter content is moderate, and natural fertility is medium, but the amount of organic matter is variable and depends on the degree of erosion. These soils have good tilth. They release moisture readily to plants.

Where they are not too steep, Monona soils are suited to cultivated crops under both dryland and irrigation management. The steeper soils are better suited to pasture than to other uses. Many areas are in native woodland. Monona soils are also suited to grass, trees and shrubs in windbreaks, wildlife habitat, and recreation.

Representative profile of Monona silt loam, 6 to 11 percent slopes, in a cultivated field 1,056 feet north and 100 feet west of the southeast corner of sec. 29, T. 27 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; soft, very friable; slightly acid; gradual, smooth boundary.

A12—7 to 15 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; soft, very friable; neutral; gradual, smooth boundary.

B1—15 to 20 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak, coarse, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, very friable; common fine pores; neutral; gradual, smooth boundary.

B2—20 to 30 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak, coarse, prismatic structure parting to weak, coarse, blocky; slightly hard, very friable; common fine pores; neutral; gradual, smooth boundary.

B3—30 to 40 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak, coarse, subangular blocky structure parting to weak, medium and fine, granular; slightly hard, very friable; common fine pores; mildly alkaline; gradual, smooth boundary.

C1—40 to 50 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; weak, coarse, blocky structure; slightly hard, very friable; common fine pores; mildly alkaline; gradual, smooth boundary.

C2—50 to 60 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; massive; soft, very friable; common fine pores; strong effervescence; moderately alkaline.

The A horizon ranges from very dark grayish brown to very dark brown in slightly eroded areas. It ranges from 6 to 16 inches in thickness. The B horizon ranges from 12 to 40 inches in thickness and from silt loam to light silty clay loam in texture. Depth to lime ranges from 24 to 40 inches in the strongly sloping to moderately steep areas.

Monona soils are near Crofton, Ida, Moody, and Nora soils. They have a brown B horizon, whereas the Crofton and Ida soils do not. The B horizon is more friable and less clayey than that of Moody soils and is also less well developed. Monona soils are leached of lime to a greater depth than Nora soils, and they lack a Ca horizon, which Nora soils have.

Monona silt loam, 6 to 11 percent slopes (MnD).—This soil is deep and is on uplands. It occurs mainly on lower, slightly concave sides of drainage divides and around the upper ends of drainageways. Areas range from 10 to 30 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas where the surface layer is dark brown and 6 inches thick. Also included are small areas of Ida soils.

Runoff is medium, and water erosion is the principal hazard on this soil. The results of sheet and rill erosion are evident in many places, and gullies form in a few drainageways. Maintaining tilth is not a concern. In areas that have a thin surface layer, fertility is low.

Nearly all the acreage is cultivated. Corn, oats, and alfalfa hay are the main crops. Capability unit IIIe–1 dryland and IVe–6 irrigated; windbreak suitability group 4.

Monona silt loam, 11 to 17 percent slopes (MnE).—This soil is deep and is on uplands. It occupies low, slightly concave areas that are parts of drainage divides. This soil occupies entire hillsides on some east- and north-facing slopes. It is generally below the steep Ida soils. Areas range from 10 to 30 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer and subsoil are thinner. Depth to lime ranges from 24 to 40 inches.

Included with this soil in mapping are small areas of Ida soils that occupy convex areas. Also included are small outcrops of glacial till and shale. Areas of Napier silt loam, 6 to 11 percent slopes, are adjacent to some drainageways.

Runoff is rapid, but the erosion hazard is slight since most areas are under natural vegetation. Maintaining adequate plant cover is an important part of good management.

Most of the acreage is in native grass or woodland. Only a few areas are cultivated. Capability unit IVe–1 dryland; windbreak suitability group 4.

Monona silt loam, 17 to 30 percent slopes (MnF).—This soil is deep and is on uplands. It occupies hillsides that are below ridgetops occupied by Ida soils. The areas are irregularly shaped and follow the drainageways.

This soil has a profile similar to the one described as representative for the series, but the surface layer and subsoil are thinner. In most places the soil is calcareous at a depth of about 24 inches, but in some places lime is below a depth of 40 inches. The depth of calcareous material is greater in areas that are wooded and is quite variable, depending on slope and direction of exposure.

Included with this soil in mapping are small, convex areas of Crofton soils. Also included are small areas of Napier soils and areas of Napier-Gullied land complex.

Runoff is rapid, and the erosion hazard is slight where a good growth of vegetation is maintained. Maintaining plant cover is an important part of good management on this soil.

Nearly all the acreage is in woodland. A few areas are in grass. The trees are mainly elms, oak, and basswood, but some black walnut grows along the lower drainageways. Capability unit VIe–1; windbreak suitability group 10.

Moody Series

The Moody series consists of deep, gently sloping to strongly sloping, well-drained soils that formed in loess. These soils are on uplands.

In a representative profile, the surface layer is very dark brown silty clay loam 11 inches thick. The subsoil, about 24 inches thick, is dark-brown, friable silty clay loam. The underlying material, extending to a depth of 60 inches, is dark-brown silty clay loam in the upper part and brown silt loam in the lower part. Depth to calcareous material is 47 inches.

Moody soils have moderately slow permeability and high available water capacity. Their organic-matter content is moderate. Their natural fertility is low to medium, depending on the amount of erosion that has taken place. They release moisture readily to plants.

Moody soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Moody silty clay loam, 6 to 11 percent slopes, in a cultivated field 2,040 feet east and 216 feet south of the northwest corner of sec. 18, T. 27 N., R. 7 E.

Ap—0 to 7 inches, very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak, medium and fine, granular structure; hard, very friable; slightly acid; abrupt, smooth boundary.

A12—7 to 11 inches, very dark brown (10YR 2/2) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak, medium, subangular blocky structure parting to weak, medium and fine, granular; hard, friable; slightly acid; gradual, smooth boundary.

B21—11 to 16 inches, dark-brown (10YR 3/3) silty clay loam, brown (10YR 5/3) dry; weak, coarse, blocky structure parting to weak, medium, subangular blocky; hard, friable; slightly acid; clear, wavy boundary.

B22—16 to 29 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate, medium, prismatic structure parting to moderate, medium, subangular blocky; hard, friable; neutral; clear, wavy boundary.

B23—29 to 35 inches, dark-brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; weak, coarse, prismatic structure parting to weak, medium, subangular blocky; hard, friable; neutral; gradual, wavy boundary.

C1—35 to 38 inches, dark-brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; weak, coarse, subangular blocky structure; hard, very friable; neutral; gradual, wavy boundary.

C2—38 to 50 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; weak, coarse, subangular blocky structure; soft, very friable; neutral; gradual, wavy boundary.

C3—50 to 60 inches, brown (10YR 5/3) silt loam, pale brown (10YR 6/3) dry; light olive-brown (2.5Y 5/4) mottles and few, fine, faint, gray (5Y 5/1) mottles; massive; soft, very friable; violent effervescence; mildly alkaline.

The A horizon ranges from 6 to 16 inches in thickness and from silty clay loam to heavy silt loam in texture. Where some of the B horizon is mixed into the plowed layer by cultivation, the Ap horizon is brown or dark brown. There is an A3 horizon in some profiles, and, where present, it ranges from 4 to 8 inches in thickness. The B horizon ranges from 24 to 42 inches in thickness. Some areas have a B3 horizon that is silt loam or light silty clay loam. Calcium carbonate concretions or disseminated lime are within a depth of 30 to 50 inches. Concretions do not occur in all areas. The C horizon ranges from brown to pale brown and has gray and reddish-brown mottles.

The eroded Moody soil has a lighter colored, thinner surface layer than is defined as within the range for the Moody series, but this difference does not alter the usefulness or significantly alter the behavior of the soil.

Moody soils are near Crofton and Nora soils. They have a finer textured B horizon and are more strongly developed than Nora soils. Moody soils have lime at a greater depth than Crofton soils, and unlike the Crofton soils they have a B horizon.

Moody silty clay loam, 2 to 6 percent slopes (MoC).—This soil is deep and is in the loess uplands. It is on smooth, very slightly convex, wide ridgetops that are drainage divides. Areas range from 20 to 60 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is dark brown and about 10 inches thick. Depth to lime ranges from 40 to 50 inches.

Included with this soil in mapping are a few, small, convex areas of Crofton silt loam, 2 to 6 percent slopes, eroded, and small areas of Moody soils that have a surface layer that is 6 inches thick.

Runoff is medium, and the hazard of water erosion is moderate. In places, small rills form that are plowed in with each successive tillage. Workability is fair where some of the subsoil is not mixed with the surface layer during cultivation.

Most of the acreage is cultivated, and only a few acres are in grass. Corn, oats, soybeans, and alfalfa hay are the principal crops. Both dryland and irrigation management are used. Capability units IIe–1 dryland and IIIe–3 irrigated; windbreak suitability group 4.

Moody silty clay loam, 6 to 11 percent slopes (MoD).—This soil is deep and is in the loess uplands. It is in slightly concave areas that parallel intermittent drainageways and also is at the head of drainageways. The areas are generally long and narrow and follow the pattern of the drainageways. They range from 20 to 40 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Crofton and Nora soils that have slightly convex slopes and small areas of Judson soils along drainageways. A few small areas are eroded.

Runoff is medium, and water erosion is the principal hazard where this soil is cultivated. Fertility in the eroded areas is low. Workability is good in most areas but is only fair where some of the subsoil is a part of the plow layer.

Nearly all the acreage of this soil is used for corn, soybeans, and alfalfa hay. Both dryland and irrigation management are used. Capability units IIIe–1 dryland and IVe–3 irrigated; windbreak suitability group 4.

Moody silty clay loam, 6 to 11 percent slopes, eroded (MoD2).—This soil is in the loess uplands. It is on drainage divides that are slightly convex and also is at the head of drainageways. Areas of this soil range from 10 to 30 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is dark brown and about 7 inches thick. The surface layer directly overlies the upper part of the subsoil. Some of the upper part of the subsoil has been mixed with the remaining original surface layer during cultivation. This soil has a more clayey surface layer than the uneroded Moody soils. Depth to lime ranges from 35 to 48 inches.

Included with this soil in mapping are small areas of Crofton soils.

Runoff is medium, and water erosion is the principal hazard. Fertility is low to medium. Workability is not so good as in the uneroded Moody soils.

Nearly all the acreage is cultivated and used mainly for corn, soybeans, and alfalfa hay. Some areas are in pasture. Controlling further loss of soil and plant nutrients through erosion is the main concern of management. Capability units IIIe–8 dryland and IVe–3 irrigated; windbreak suitability group 4.

Moody-Nora silty clay loams, 11 to 15 percent slopes (MpE).—This mapping unit is on smooth to slightly convex sides of divides between drainageways. The soils are mainly on east-facing side slopes and also around the head of small drainageways. To a lesser extent, they are on west-facing side slopes. The areas range from 10 to 30 acres in size. The Moody soil makes up 50 to 85 percent of each area, the Nora soil 15 to 50 percent, and other soils 0 to 15 percent.

The profiles of Moody and Nora soils in this mapping unit are similar to the ones described as representative for their respective series, but the thickness of the surface layer and subsoil varies from place to place. Depth to lime is greater and content of clay in the subsoil is greater on east-facing slopes.

Included with this complex in mapping are small areas of severely eroded soils that have lost most of their original dark-colored surface layer; tillage has mixed the remaining surface layer with the subsoil. Also included are small areas of Crofton soils that have convex slopes.

Runoff is rapid, and water erosion is the principal hazard where the soils are cultivated. Workability is only fair in the eroded areas. The lighter colored areas have low fertility.

Nearly all the acreage is cultivated. Corn, oats, and alfalfa hay are the principal crops. Small areas are in grass. Capability unit IVe–1 dryland; windbreak suitability group 4.

Napier Series

The Napier series consists of deep, nearly level to strongly sloping, well-drained soils that formed in colluvial-alluvial material washed down from nearby hillsides. These soils are on foot slopes and bottom lands that are in small intermittent drainageways of the uplands.

In a representative profile, the surface layer is very dark-brown silt loam about 30 inches thick. The subsoil extends to a depth of 60 inches. The upper part is very dark grayish-brown friable silt loam, and the lower part is dark-brown firm silt loam.

Napier soils have moderate permeability and a high available water capacity. Their organic-matter content and their natural fertility are high. These soils are easy to till, and they release moisture readily to plants.

Napier soils are suited to cultivated crops under both dryland and irrigation management. Small, inaccessible areas are commonly in pasture or woodland. These soils are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Napier silt loam, 2 to 6 percent slopes, in a cultivated field 1,000 feet south and 150 feet west of the northeast corner of sec. 26, T. 28 N., R. 7 E.

Ap—0 to 7 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, medium and fine, granular structure; soft, very friable; many roots; neutral; abrupt, smooth boundary.

A12—7 to 17 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, coarse, blocky structure parting to weak, medium and fine, granular; soft, very friable; many roots; common fine pores; neutral; gradual, smooth boundary.

A13—17 to 30 inches, very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, coarse, blocky structure parting to weak, medium and fine, granular; soft, very friable; few fine roots; many fine pores; neutral; gradual, smooth boundary.

B1—30 to 38 inches, very dark grayish-brown (10YR 3/2) silt loam, dark brown (10YR 5/2) dry; weak, coarse, subangular blocky structure parting to weak, medium and fine, subangular blocky; soft, friable; few roots; many fine pores; neutral; gradual, smooth boundary.

B2—38 to 60 inches, dark-brown (10YR 4/3) silt loam, brown (10YR 5/3) dry; weak, coarse, blocky structure parting to moderate, medium, subangular blocky; slightly hard, firm; very few roots; many fine pores; neutral.

The A horizon ranges from 24 to 36 inches in thickness. Reaction is neutral or slightly acid. In some places, there is a mildly alkaline silt loam overwash 6 to 12 inches thick. The B1 horizon is very dark grayish brown or dark brown. It is neutral to slightly acid in reaction. The B2 horizon is silt loam or heavy silt loam. The profile is noncalcareous to a depth of more than 60 inches in the nearly level areas and to a depth of as little as 24 inches in sloping areas.

Napier soils are near Kennebec soils on the bottom lands and near Monona, Moody, and Nora soils on the adjoining uplands. Napier soils are not so dark in the lower part of the profile as Kennebec soils and have a B horizon, which Kennebec soils lack. They occupy a similar position in the landscape but are not fine textured as Judson soils. They have a thicker, darker A horizon than Monona, Moody, or Nora soils. In addition they are not so fine textured in the B horizon as Moody and Nora soils. Depth to lime is generally greater than in Nora soils.

Napier silt loam, 2 to 6 percent slopes (NaC).—This soil is deep and is on concave foot slopes as well as on alluvial fans. The areas are narrow and range from 10 to 40 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are a few areas of Kennebec soils and Napier silt loam, 6 to 11 percent slopes. Also included in some places is an overwash deposit of dark grayish-brown, calcareous silt loam 6 to 12 inches thick.

Runoff is medium, and water erosion, which causes rills, gullies, and siltation, is a hazard on this soil. Land leveling is needed for gravity irrigation. This soil has excellent workability.

Most of the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. A few areas are in grass or woodland. Both dryland and irrigation management are used. Capability units IIe–1 dryland and IIIe–6 irrigated; windbreak sutiability group 4.

Napier silt loam, 6 to 11 percent slopes (NaD).—This soil is deep and is in concave areas along drainageways. Areas are long, narrow, and irregularly shaped and range from 10 to 20 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner or 24 to 30 inches thick.

Included with this soil in mapping are small areas of Nora soils near the upper part of the slope and areas of Napier silt loam, 2 to 6 percent slopes, along drainageways.

Water erosion is a hazard on this soil. In places small rills and gullies form that are plowed in with each successive tillage. Cropping patterns of this soil are generally determined by those used on the nearby associated soils.

Most of the acreage is cultivated, but some areas are in pasture. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIIe–1 dryland and IVe–6 irrigated; windbreak suitability group 4.

Napier silt loam, 11 to 15 percent slopes (NaE).—This soil is deep and is in slightly concave areas that border intermittent drainageways in the uplands. Areas range from 10 to 20 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is slightly thinner or about 24 inches thick. In addition, depth to carbonates is less and ranges from 24 to 30 inches in most areas.

Included with this soil in mapping are small areas of Nora and Moody soils. Also included are areas of Napier silt loam, 2 to 6 percent slopes, along drainageways.

Water erosion is the principal hazard on this soil. Rill and gully erosion also are hazards.

Most of the acreage is cultivated, but a few areas are in grass or woodland. Corn, oats, and alfalfa hay are the principal crops. Capability unit IVe–1; windbreak suitability group 4.

Napier-Gullied land complex, 2 to 11 percent slopes (NgD).—This mapping unit occupies foot slopes and bottom lands within narrow drainageways of the uplands. The gullied part represents channels that have been severely eroded by moving water. It is generally stabilized by mixed grass, trees, and shrubs. Most areas have active small side gullies. Some gullies are as wide as 40 feet and as deep as 15 feet. There are springs in the gullies in some areas. The Gullied land part of this complex makes up about 55 percent of the mapping unit, and Napier soil makes up the remaining 45 percent.

The Napier soil in this complex has a profile similar to the one described as representative for the series. but the surface layer is slightly darker in color and slightly thicker.

Water erosion is a severe hazard in areas of this complex. There is tendency for the small side gullies to become larger. Management practices that can control the erosion are expensive and difficult to install. Although the gullies are stabilized by plant cover, the heads of the gullies are still actively increasing in size.

Nearly all the acreage is grazed. This complex is excellent wildlife habitat. Capability unit VIIe–7; Napier soil is in windbreak suitability group 4 and Gullied land in windbreak suitability group 10.

Nora Series

The Nora series consists of deep, gently sloping to steep, well-drained soils that formed in loess (fig. 8). These soils are on uplands.

In a representative profile, the surface layer is very dark grayish brown silt loam 13 inches thick. The subsoil, 20 inches thick, is very dark grayish-brown, very friable silt loam in the upper part and dark grayish brown, friable light silty clay loam in the lower part. A zone of calcium carbonate accumulation occurs at a depth of 19 inches. The underlying material, extending to a depth of 60 inches, is dark-brown, calcareous silt loam.

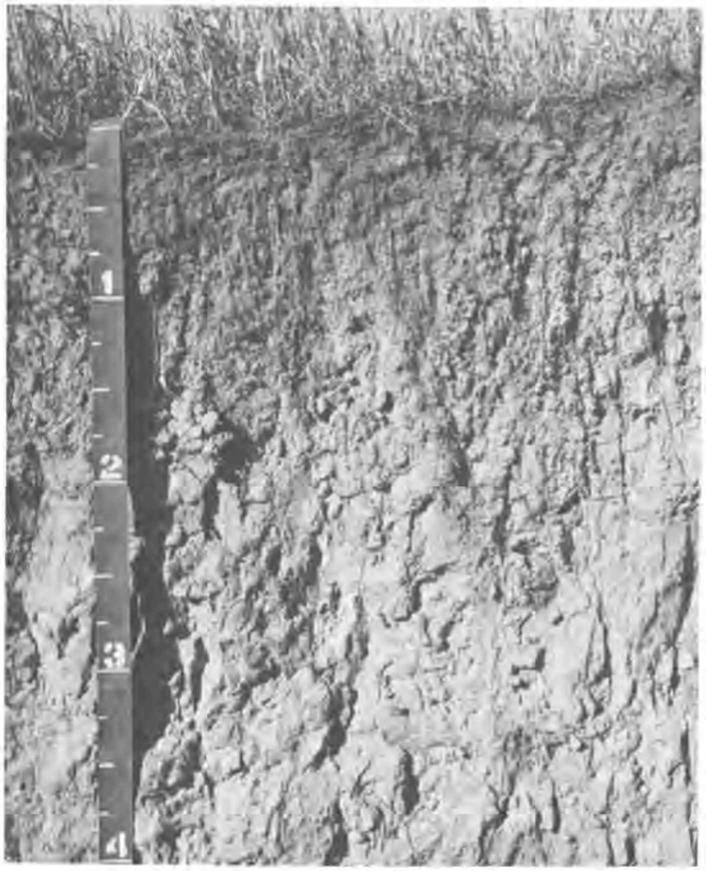

Figure 8.—**Profile of Nora silt loam. Lime is at a depth of about 19 inches.**

Nora soils have moderate permeability and a high available water capacity. Their organic-matter content is moderate or low, and their natural fertility is medium or low, depending on the amount of erosion that has taken place. They have good workability, and they release moisture readily to plants.

The gently sloping to strongly sloping Nora soils are suited to cultivated crops under both dryland and irrigation management. The steep areas are suited to grass or woodland. All areas are suited to grass, wildlife habitat, and recreation. These soils are also suited to trees and shrubs where the slope is not more than 17 percent.

Representative profile of Nora silt loam, 11 to 15 percent slopes, in a cultivated field 1,420 feet south and 230 feet west of the northeast corner of sec. 29, T. 28 N., R. 7 E.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, coarse, blocky structure parting to weak, medium and fine, granular; soft, very friable; neutral; abrupt, smooth boundary.

A12—7 to 13 inches, very dark grayish-brown 10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak, coarse, blocky structure parting to weak, medium and very fine, granular; soft, very friable; common fine pores; neutral; clear, smooth boundary.

B2—13 to 19 inches, very dark grayish-brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) crushed; grayish brown (10YR 5/2) dry; weak, coarse, blocky structure parting to weak, medium, subangular blocky; slightly hard, very friable; common fine pores; neutral; clear, smooth boundary.

B3ca—19 to 33 inches, dark grayish-brown (10YR 4/2) light silty clay loam, brown (10YR 5/3) dry; weak, coarse, prismatic structure parting to weak, moderate, subangular blocky; slightly hard, friable; common fine and medium lime concretions; violent effervescence; moderately alkaline; gradual, smooth boundary.

C—33 to 60 inches, dark-brown (10YR 4/3) silt loam, pale brown (10YR 6/3) dry; weak, coarse, prismatic structure; slightly hard, very friable; common fine pores; few fine and medium lime concretions; violent effervescence; moderately alkaline.

The A horizon is very dark grayish brown or very dark brown. It ranges from 7 to 15 inches in thickness. The B2 horizon is very dark grayish-brown to dark-brown silt loam or light silty clay loam. The B2 horizon is absent in some areas of the eroded soils. The B3ca horizon is dark grayish brown to dark brown in color. The number of concretions ranges from few to many. The B horizon ranges from 6 to 24 inches in thickness. It has few lime concretions but contains much disseminated lime. Depth to calcareous material ranges from 10 to 30 inches.

In Dakota County the eroded Nora soils have a lighter colored and thinner A horizon than is defined as within the range for the series, but this difference does not alter the usefulness or behavior of the soils.

Nora soils are near Crofton and Moody soils. They have a B horizon that is lacking in the Crofton soils, and they are deeper to lime than those soils. The B horizon of Nora soils is thinner and not so fine textured as that of Moody soils, and they are not so deep to lime as Moody soils.

Nora silt loam, 2 to 6 percent slopes, eroded (NoC2).—This soil occurs on ridgetops in the drainage divides of the loess uplands. It has short, convex slopes. Areas range from 10 to 20 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is lighter colored and is only about 6 inches thick. This surface layer rests directly on the subsoil. A part of the subsoil is incorporated into the plow layer, giving it a very dark grayish-brown or dark grayish-brown color. In addition, the plow layer is more clayey than in uneroded Nora soils. Depth of lime ranges from 12 to 25 inches.

Included with this soil in mapping are small areas of Moody and Crofton soils.

Water erosion is the principal hazard on this soil. Soil fertility is medium or low, and workability is fair. Reducing runoff and water erosion and increasing organic-matter content are the main concerns of management.

Nearly all the acreage is cultivated. Corn, oats, and alfalfa hay are the main crops, but a small acreage is in soybeans. Capability units IIIe–8 dryland and IIIe–6 irrigated; windbreak suitability group 4.

Nora silt loam, 6 to 11 percent slopes (NoD).—This soil is in the loess uplands on drainage divides and ridgetops. The areas are irregularly shaped and range from 10 to 20 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is thicker and depth to lime is greater.

Included with this soil in mapping are small, convex areas of Crofton soils.

Runoff is medium in cultivated areas, and the hazard of erosion is moderate. In places, small rills form that are plowed in with each successive tillage. Reducing runoff and maintaining the organic-matter content are concerns of management.

Most of the acreage is cultivated. A few areas are irrigated. Capability units IIIe–1 dryland and IVe–6 irrigated; windbreak suitability group 4.

Nora silt loam, 6 to 11 percent slopes, eroded (NoD2).—This soil is deep and is in the loess uplands. It is on drainage divides and has short, convex slopes. The areas are irregularly shaped and range from 10 to 25 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is thinner or about 6 inches thick. This layer lies directly on the subsoil. Some of the upper part of the subsoil is incorporated into the plow layer, giving it a dark grayish-brown or brown color. The plow layer of this soil is more clayey than that of the uneroded Nora soils. Depth to lime ranges from 10 to 24 inches.

Included with this soil in mapping are small areas of Moody soils along lower elevations and Crofton soils in convex areas.

Runoff is medium, and water erosion is the principal hazard on this soil. Soil fertility is medium or low, and workability is fair. Increasing the organic-matter content and reducing runoff are the main concerns of management.

Nearly all the acreage is cultivated. Corn, oats, and alfalfa hay are the main crops. Some areas are in pasture. Capability units IIIe–8 dryland and IVe–6 irrigated; windbreak suitability group 4.

Nora silt loam, 11 to 15 percent slopes (NoE).—This soil is in the loess uplands on drainage divides in slightly concave areas. The soil occurs downslope from Crofton soils. Areas range from 10 to 60 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Crofton soils that are on the upper part of convex slopes. Small areas of Napier and Moody soils are included at the base of slopes.

Runoff is rapid, and water erosion is a hazard. In places small rills form that are plowed in with each successive tillage. Control of runoff is an important concern of management.

Most of the acreage is cultivated. Corn, oats, and alfalfa hay are the principal crops. A few areas are in grass. Capability unit IVe–1; windbreak suitability group 4.

Nora silt loam, 11 to 15 percent slopes, eroded (NoE2).—This soil is on drainage divides in the loess uplands. Slopes are slightly convex. Areas range from 10 to 60 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is only about 6 inches thick. It is dark grayish brown to brown and more clayey than that in uneroded Nora soils. Mixed with the surface layer is some of the upper part of the subsoil. Depth to lime ranges from 10 to 20 inches.

Included with this soil in mapping are small, convex areas of Crofton soils in some of the higher places, and concave areas of Moody soils in some of the lower places.

Runoff is rapid, and water erosion is the principal hazard. Fertility is medium over most of the area but low in the more eroded areas. Workability is fair. The organic-matter content is low.

Nearly all the acreage is cultivated. Corn, oats, and alfalfa hay are the main crops. Many areas have been reseeded to native grass or pasture. Capability unit IVe–8 dryland; windbreak suitability group 4.

Nora silt loam, 15 to 30 percent slopes (NoF).—This soil is deep. It is on drainage divides in the loess uplands. Areas range from 20 to 70 acres in size and are steep and irregularly shaped.

This soil has a profile similar to the one described as representative for the series, but the thickness of the surface layer and subsoil are variable. The surface layer ranges from 6 inches in convex areas to 20 inches in concave areas. Depth to lime ranges from 12 to 30 inches. A zone of lime accumulation is lacking in areas.

Included with this soil in mapping are small areas of soils that are similar to Napier soils and that have concave slopes, and areas of Crofton soils that have sharply convex slopes. Also included are areas of Nora soils that have very steep, north- or east-facing slopes.

Runoff is rapid, and water erosion is the principal hazard on this soil. Fertility is medium over most of the areas but low in the eroded areas. Maintaining and improving plant cover is an important concern of management.

Nearly all the acreage is in native grass or deciduous trees. Capability unit VIe–1; windbreak suitability group 10.

Omadi Series

The Omadi series consists of deep, nearly level, moderately well drained soils that formed in silty alluvium. This silty material was deposited on the Missouri River bottom lands by major upland streams before channels were constructed to carry the water across the bottom lands to the Missouri River.

In a representative profile, the surface layer is black silt loam 12 inches thick. The transitional layer, 8 inches thick, is stratified dark-gray calcareous silt loam. The underlying material, extending to a depth of 60 inches is calcareous silt loam. The upper part is stratified and mottled dark gray and very dark grayish brown, and the lower part is very dark gray.

Omadi soils have moderate permeability and a high available water capacity. Their organic-matter content is moderate, and their natural fertility is high. They release moisture readily to plants.

Omadi soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Omadi silt loam, 0 to 2 percent slopes, in a cultivated field 1,600 feet south and 50 feet west of the northeast corner of sec. 13, T. 28 N., R. 7 E.

Ap—0 to 7 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak, very fine, granular structure; slightly hard, very friable; neutral; abrupt, smooth boundary.

A12—7 to 12 inches, black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak, medium, subangular blocky structure parting to weak, fine, granular; slightly hard, very friable; neutral; abrupt, smooth boundary.

AC—12 to 20 inches, stratified dark-gray (10YR 4/1) and very dark gray (10YR 3/1) silt loam, light gray (10YR 7/1) and gray (10YR 5/1) dry; few, faint, fine, brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure; slightly hard, very friable; some stratification; many worm burrows and casts; strong effervescence; moderately alkaline; abrupt, smooth boundary.

C1—20 to 38 inches, stratified dark-gray (10YR 4/1) and very dark grayish-brown (10YR 3/2) silt loam, light gray (10YR 7/1) and grayish brown (10YR 5/2) dry; many, medium, distinct, brown (7.5YR 5/6) mottles; weak, medium, subangular blocky structure, slightly hard, very friable; some stratification; violent effervescence; moderately alkaline; abrupt, smooth boundary.

C2—38 to 60 inches, very dark gray (10YR 3/1) silt loam, grayish brown (10YR 5/2) dry; many, medium, distinct, brown (7.5YR 5/6) mottles; massive; slightly hard, very friable; few, small, soft, lime nodules; violent effervescence; moderately alkaline.

The A horizon ranges from black to very dark grayish brown in color and from silt loam to light silty clay loam in texture. Depth to lime ranges from 12 to 15 inches. The AC horizon is dark gray to very dark gray, but thin strata of light gray or gray material are within a depth of 20 inches. The AC horizon is 6 to 14 inches thick. The C1 horizon is stratified and dark gray to very dark grayish brown. It has few to many, medium, distinct, brown mottles. The C2 horizon is very dark gray or dark gray and has few to many, distinct, brown mottles. Small, soft lime accumulations are in the C2 horizon in most places.

Omadi soils are near Forney, Blyburg, and Kennebec soils. Their entire profile is not so fine textured as that of Forney soils. Omadi soils have a finer textured C horizon than Blyburg soils. They have a thinner A horizon, have a lighter colored C horizon, and are not so deep to lime as Kennebec soils.

Omadi silt loam, 0 to 2 percent slopes (Om).—This soil is deep and occurs on bottom lands of the Missouri River Valley, mainly in areas adjoining the bluffs where Elk Creek, Pigeon Creek, Omaha Creek, and many small upland drainageways deposited loads of silt. Channelization has stopped this deposition. Areas range from 80 to 400 acres in size.

Included with this soil in mapping are a few areas where the surface layer is silty clay loam and a few areas where the depth to the water table is less than 4 feet. Also included are a few areas of Kennebec silt loam, overwash, 0 to 2 percent slopes.

Runoff is slow, and water ponds in some areas behind the large drainage canals. In places flooding is a hazard. This soil has excellent workability and is one of the better soils in the county for crops. Some land leveling is needed for gravity irrigation.

Most of the acreage is cultivated. Corn and soybeans are the principal crops. Both dryland and irrigation management are used. A few small areas are in grass. Capability units I–1 dryland and I–6 irrigated; windbreak suitability group 1.

Onawa Series

The Onawa series consists of deep, nearly level, somewhat poorly drained soils that formed in clay and silty alluvium. These soils are on bottom lands. The water table is at a depth of 4 to 8 feet.

In a representative profile, the surface layer is very dark grayish brown silty clay 7 inches thick. Below this, the soil material is very dark grayish-brown and dark grayish-brown, calcareous silty clay in the upper part and grayish-brown and dark grayish-brown calcareous, mottled silt loam in the lower part.

Onawa soils have slow permeability in the upper part and moderate permeability in the silty part below a depth of 18 inches. Their available water capacity is high. Their organic-matter content is moderately low, and their natural fertility is low. They release moisture readily to plants.

Onawa soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Onawa silty clay, 0 to 2 percent slopes, in a cultivated field 1,200 feet south and 1,600 feet east of the northwest corner of sec. 25, T. 29 N., R. 8 E.

Ap—0 to 7 inches, very dark grayish-brown (2.5Y 3/2) silty clay, dark grayish brown (2.5Y 4/2) crushed, grayish brown (10YR 5/2) dry; moderate, medium and fine, granular structure; extremely hard, firm; moderately alkaline; abrupt, smooth boundary.

C1g—7 to 18 inches, very dark grayish-brown (2.5Y 3/2) and dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (10YR 5/2) dry; moderate, coarse, blocky structure parting to strong, medium, angular blocky; extremely hard, firm; strong effervescence; moderately alkaline; abrupt, smooth boundary.

IIC2g—18 to 25 inches, grayish-brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few, fine, faint, dark-brown (7.5YR 4/4) mottles; weak, fine, platy structure; soft, very friable; violent effervescence; moderately alkaline; abrupt, smooth boundary.

IIC3g—25 to 60 inches, dark grayish-brown (2.5Y 4/2) silt loam, light brownish gray (2.5Y 5/2) dry; common, medium, distinct, dark-brown (7.5YR 4/4) mottles; massive; soft, friable; violent effervescence; moderately alkaline.

The Ap horizon ranges from 6 to 8 inches in thickness and from very dark gray to very dark grayish brown in color. It is silty clay or clay in texture, and mildly alkaline to moderately alkaline in reaction. The C1g horizon ranges from very dark grayish-brown to dark grayish-brown silty clay or clay. It ranges from 8 to 25 inches in thickness. In places a layer of silty clay loam, generally less than 6 inches thick, is between the C1g horizon and the IIC2g horizon. These horizons are grayish brown or light brownish gray in the upper part and dark grayish brown to light brownish gray in the lower part. They are calcareous and contain few to common, fine to medium, faint to distinct, dark-brown mottles. The lower part of the C horizon ranges from silt loam to very fine sandy loam. Strata that are less than 6 inches thick and finer or coarser textured occur in places.

In Dakota County the Onawa soils have mottles that are darker colored than is defined as within the range for the series, but this does not alter the usefulness or behavior of the soils.

The Onawa soils are near Albaton, Forney, and Owego soils. Below a depth of about 15 inches, Onawa soils are silt loam, but Albaton, Forney, and Owego soils are clay or silty clay.

Onawa silty clay, 0 to 2 percent slopes (On).—This soil is deep. It is in swales that were old stream channels and in large, broad areas where soil material has been deposited and has accumulated. The areas range from 20 to 70 acres in size.

Included with this soil in mapping are small areas that have a layer of silt loam or silty clay loam overwash material less than 10 inches thick. Also included are a few areas of Albaton soils.

Runoff is slow, and wetness is a hazard on this soil. The water table is at a depth of less than 48 inches in low areas. The clayey surface layer is difficult to work, and a good seedbed is difficult to obtain. These soils can be cultivated satisfactorily only within a narrow range of moisture content. Maintaining good tilth is a major concern of management. Even with improved drainage, cultivation is delayed because the soil is wet in some seasons.

Most of the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Some areas are in grass, and a few areas are in trees. Both dryland and irrigation management are used. Capability units IIw-1 dryland and IIw-1 irrigated; windbreak suitability group 2.

Owego Series

The Owego series consists of deep, nearly level, poorly drained and somewhat poorly drained soils that formed in clayey and silty alluvium (fig. 9). These soils are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is very dark grayish-brown silty clay 7 inches thick. The subsoil is very dark grayish-brown, firm silty clay 4 inches thick. The underlying material is grayish-brown silty loam in the upper 11 inches. Below this is dark grayish-brown silty clay that extends to a depth of 60 inches. The soil is calcareous below a depth of 11 inches.

Owego soils have very slow permeability, but the silty layer between depths of 11 and 22 inches has moderate permeability. Their available water capacity is moderate. Their organic-matter content is moderately low, and their natural fertility is low. They release moisture slowly to plants.

Owego soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Owego silty clay, 0 to 2 percent slopes, in a cultivated field 1,353 feet north and 92 feet east of the southwest corner of sec. 34, T. 29 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) silty clay, gray (10YR 5/1) dry; strong, coarse, blocky structure parting to strong, medium, blocky; hard, firm; mildly alkaline; abrupt, smooth boundary.

Bg—7 to 11 inches, very dark grayish-brown (5Y 3/1) silty clay, grayish brown (5Y 5/1) dry; moderate coarse, blocky structure parting to strong, medium, blocky; hard, firm; mildly alkaline; abrupt, smooth boundary.

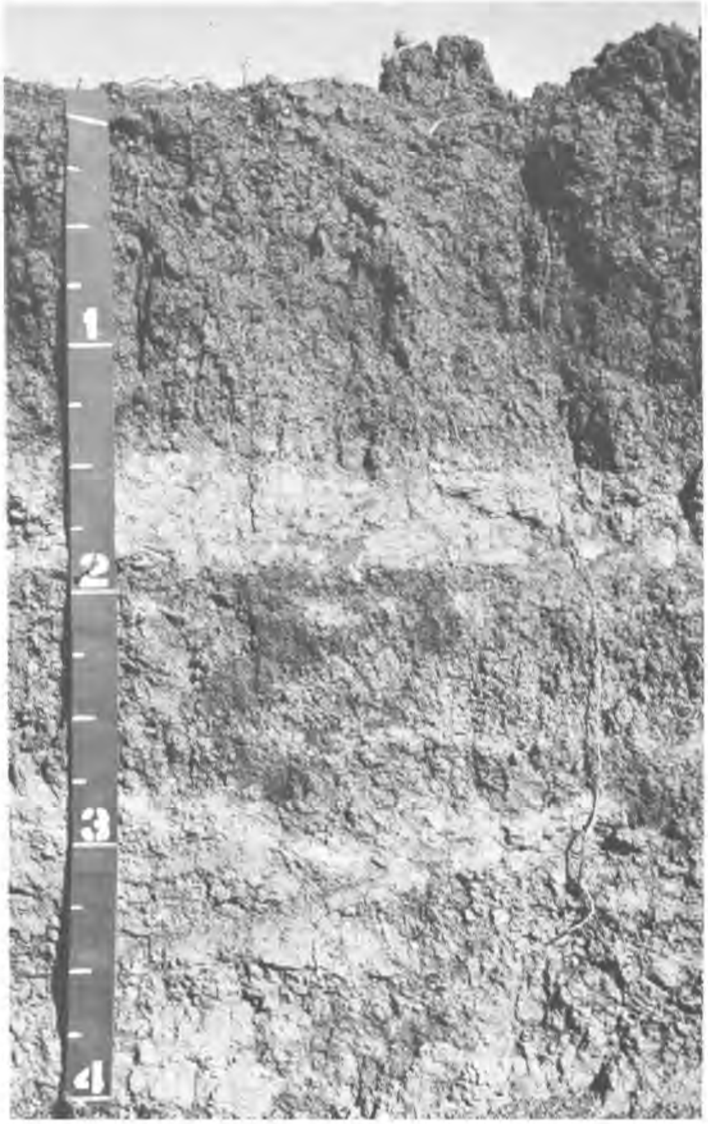

***Figure 9.*—Profile of Owego silty clay. Between depths of about 15 and 22 inches is light-colored layer of silt loam that is a distinctive feature of the Owego soils.**

IIC1—11 to 22 inches, grayish-brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; weak, medium, platy structure; soft, very friable; violent effervescence; moderately alkaline; gradual, smooth boundary.

IIIC2g—22 to 25 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate, medium, subangular blocky structure parting to strong, fine, blocky; hard, firm; violent effervescence; moderately alkaline; gradual, smooth boundary.

IIIC3g—25 to 33 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate, medium, blocky structure parting to strong, fine, blocky; hard, firm; violent effervescence; moderately alkaline; gradual, smooth boundary.

IIIC4g—33 to 60 inches, dark grayish-brown (2.5Y 4/2) silty clay, grayish brown (2.5Y 5/2) dry; strong, medium, blocky structure; hard, very firm; violent effervescence; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness and from very dark gray to very dark grayish brown in color. The Bg horizon ranges from 4 to 12 inches in thickness and from very dark grayish brown to dark gray in color. The IIC1 horizon is stratified dark grayish-brown to grayish-brown silt loam, silty clay loam, loam, or clay loam. It is 6 to 12 inches thick. The IIIC horizon is very dark gray and dark grayish-brown silty clay or clay, but thin, less clayey layers are common below a depth of 40 inches. Reaction ranges from mildly alkaline to moderately alkaline in the A and Bg horizons.

In Dakota County the Owego soils have clayey layers, in the upper part of the profile, that are slightly thinner than defined as within the range for the Owego series, and the underlying material lacks mottles. But these differences do not significantly alter the usefulness and behavior of these soils.

Owego soils are near Albaton, Blake, and Onawa soils. They have a distinct silty layer in the upper part of the C horizon, which is lacking in Albaton soils. Owego soils are silty clay in the lower part of the C horizon, and this layer is finer textured than that in Blake and Onawa soils.

Owego silty clay, 0 to 2 percent slopes (Ow).—This soil is in areas where soil material has been deposited and has accumulated and in other areas on bottom lands of the Missouri River Valley that are subject to flooding. The areas range from 20 to 60 acres in size.

Included with this soil in mapping are small areas where the silty layer in the upper part of the underlying material is thicker and other areas where it is at a greater depth. Also included are a few areas of Albaton and Blake soils.

The clayey surface layer, slow surface drainage, and ponded water in some areas are the principal limitations if this soil is cultivated. Maintaining good tilth and preparing a good seedbed are difficult. Timeliness of tillage operations is an important concern in managing this soil. The soil can be successfully cultivated only within a narrow range of moisture content. Runoff is slow.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIIw-1 dryland and IIIw-1 irrigated; windbreak suitability group 2.

Percival Series

The Percival series consists of deep, nearly level, somewhat poorly drained soils that formed in clayey and sandy alluvium. These soils are clayey in the upper part of the profile and sandy in the lower part. They are in areas of the Missouri River bottom lands where soil material has been deposited recently and has accumulated. This soil has a fluctuating water table at a depth of 4 to 8 feet. The water table subsides during dry periods, however, and droughtiness is then a hazard.

In a representative profile, the surface layer is very dark grayish-brown light silty clay 7 inches thick. The upper part of the underlying material, extending to a depth of 21 inches, is dark-gray and dark grayish-brown silty clay and silty clay loam. Below this depth, and extending to a depth of 60 inches, is dark grayish-brown and grayish-brown fine sand. Below a depth of 46 inches, the underlying material is mottled. The soil is calcareous throughout.

Percival soils have slow permeability in the clayey upper part of the profile and rapid permeability in the sandy lower part. Available water capacity is low. The organic-matter content is moderately low, and natural fertility is low. These soils release moisture slowly to plants.

Percival soils are suited to cultivated crops under both dryland and irrigation management. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Percival silty clay, 0 to 2 percent slopes, in a cultivated field 2,112 feet west and 100 feet south of the northeast corner of sec. 29, T. 28 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (2.5Y 3/2) light silty clay, grayish brown (2.5Y 5/2) dry; moderate, coarse, subangular blocky structure; hard, firm; violent effervescence; mildly alkaline; abrupt, smooth boundary.

C1g—7 to 18 inches, dark-gray (5Y 4/1) silty clay, gray (5Y 5/1) dry; strong, fine, blocky structure parting to strong, very fine, blocky; very hard, very firm; violent effervescence; moderately alkaline; abrupt, smooth boundary.

C2g—18 to 21 inches, dark grayish-brown (2.5Y 4/2) silty clay loam, grayish brown (2.5Y 5/2) dry; common, fine, prominent, dark reddish-brown (5YR 3/4) mottles; moderate, very fine, blocky structure; hard, firm; violent effervescence; moderately alkaline; clear, wavy boundary.

IIC3—21 to 24 inches, dark grayish-brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grained; loose; violent effervescence; moderately alkaline; clear, wavy boundary.

IIC4—24 to 46 inches, grayish-brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) dry; single grained; loose; violent effervescence; moderately alkaline; clear, wavy boundary.

IIC5—46 to 54 inches, dark grayish-brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; common, medium, faint, strong-brown (7.5YR 5/6) mottles; single grained; loose; violent effervescence; moderately alkaline.

IIC6—54 to 60 inches, dark grayish-brown (10YR 4/2) fine sand, light brownish gray (10YR 6/2) dry; few, faint, fine, strong-brown (7.5YR 5/6) mottles; single grained; loose; violent effervescence; moderately alkaline.

The A horizon ranges from 5 to 8 inches in thickness. It is very dark grayish-brown or very dark gray silty clay. Reaction is mildly alkaline or moderately alkaline. The C1g horizon ranges from very dark gray to dark grayish-brown silty clay or clay. The C2g horizon is dark grayish-brown to very dark gray silty clay loam or silty clay. At a depth of 15 to 30 inches, the clayey material is abruptly underlain by a IIC horizon of loamy sand or sand. This horizon ranges from dark grayish brown to grayish brown in color. In the lower part of the IIC horizon are mottles that range from common and fine to medium and faint.

Percival soils are near Onawa and Sarpy soils. They are sandy in the lower part of the C horizon rather than silty, as Onawa soils are. Percival soils are more poorly drained than Sarpy soils and are finer textured in the upper part of the profile than those soils.

Percival silty clay, 0 to 2 percent slopes (Pe).—This soil is deep. It is in areas of the Missouri River bottom lands where soil material has been deposited recently and has accumulated. It is near channels of the Missouri River, and many areas are in swales. The areas range from 20 to 40 acres in size.

Included with this soil in mapping are a few areas that have as little as 12 inches of clayey material over the underlying fine sand. Some areas have slower surface drainage as well as a high water table than is described for the Percival soils. Also included are small areas of Onawa soils and areas of Sarpy silty clay, overwash, 0 to 2 percent slopes.

A clayey surface layer, slow surface drainage, ponding of water in some areas, and the low available water capacity are limitations if this soil is cultivated. Runoff is slow. The water table is high, and the soil is wet in spring. The water table subsides during the growing season, and then droughtiness is a hazard.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Capability units IIw–1 dryland and IIw–1 irrigated; windbreak suitability group 2.

Sansarc Series

The Sansarc series consists of shallow, strongly sloping to steep, well-drained soils that formed in material weathered from shale (fig. 10). These soils are on uplands.

In a representative profile, the surface layer is dark-brown calcareous clay loam 6 inches thick. The transitional layer, 6 inches thick, is dark-brown calcareous silty clay loam. The underlying material, extending to a depth of 60 inches, is mixed light brownish-gray and dark grayish-brown partly weathered clayey shale in the upper part and mixed light brownish-gray and very dark grayish-brown, clayey, bedded shale in the lower part. A few small accumulations of calcium carbonate are below a depth of 20 inches.

Figure 10.—**Profile of Sansarc soil. This soil is shallow and formed in the underlying soft, clayey bedded shale.**

Sansarc soils have slow permeability and a very low available water capacity. Their organic-matter content and their natural fertility are low. They release moisture slowly to plants.

Sansarc soils are suited to grass, wildlife habitat, and recreation use. They are not suited to the common cultivated crops because they are too shallow and too steep.

In Dakota County, Sansarc soils are not mapped separately but occur in a complex with Nora soils.

Representative profile of Sansarc clay loam, in an area of Sansarc-Nora complex, 11 to 30 percent slopes, in a cultivated field 1,100 feet south and 2,000 feet east of the northwest corner of sec. 15, T. 27 N., R. 8 E.

Ap—0 to 6 inches, dark-brown (10YR 4/3) clay loam, brown (10YR 5/3) dry; moderate, medium and fine, granular structure; hard, firm; violent effervescence; moderately alkaline; abrupt, smooth boundary.

AC—6 to 12 inches, dark-brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; moderate, coarse, subangular blocky structure parting to moderate, medium granular; hard, firm; many roots; violent effervescence; moderately alkaline; clear, smooth boundary.

C1—12 to 20 inches, mixed light brownish-gray (2.5Y 6/6) and dark grayish-brown (5Y 4/2) slightly weathered clayey shale, mixed light olive gray (5Y 6/2) and light gray (2.5Y 7/4) dry; hard, firm; common very fine shale fragments; mildly alkaline; clear, smooth boundary.

C2—20 to 60 inches, mixed light brownish-gray (2.5Y 6/6) and very dark grayish-brown (2.5Y 3/2) bedded clayey shale, mixed light gray (2.5Y 7/4) and grayish brown (2.5Y 5/2) dry; hard, firm; few small accumulations of calcium carbonate; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness and is very dark grayish-brown to dark grayish-brown clay loam or silty clay loam. The AC horizon is dark-brown silty clay loam or clay loam. The A and AC horizons contain lime derived from adjacent areas of loess. The C horizon ranges from very dark grayish brown to grayish brown. The shale in this horizon has a wide range of color and is generally bedded. It is soft in the upper part and gets harder with increasing depth. Typically, it does not contain free carbonates. Shale, which is considerably fractured, limits the root zone for most plants, but the roots of some plants can enter fractures between the bedding planes. Depth to shale bedrock that is semihard when moist and hard when dry is 8 to 20 inches. Crystals of gypsum are commonly present.

In Dakota County the Sansarc soils are in an area of higher rainfall, have less clay in the A horizon, and have a browner color in the C horizon than is defined as within the range for the series. These differences do not alter the usefulness and behavior of these soils.

Sarsarc soils are near Nora and Crofton soils. They are shallow and formed in material weathered from shale, whereas Nora and Crofton soils are deep and formed in loess. Sansarc soils are finer textured than Nora and Crofton soils.

Sansarc-Nora complex, 11 to 30 percent slopes (SaF).—This mapping unit is on divides between drainageways. The areas range from 10 to 30 acres in size; the largest area occurs along Fiddlers and Wigle Creeks. In most areas the Sansarc soil makes up 50 to about 80 percent of the acreage, but in a few areas the Nora soil occupies the most acreage.

The profile of the Nora soil in this mapping unit is similar to the one described as representative for the Nora series, but the surface layer is slightly lighter in color and is thinner.

Included with this complex in mapping are small areas of Sansarc soils that are severely eroded and shallower to bedrock than the representative Sansarc soils. In these areas the soils are lighter in color than is typical for the series. Also included are small areas of Crofton soils. In places, the shale bedrock crops out.

The Sansarc part of this complex has a limited root zone. Available water capacity is very low. Bedrock is near the surface and crops out in some places. Runoff is rapid on both soils, and water erosion is a hazard if the soils are cultivated. Workability is difficult because of the shale bedrock and the slope.

Nearly all the acreage is in grass. Some small areas are cultivated, but these soils are not suited to tilled crops. A few areas are in trees. Capability unit VIs-4 dryland; the Sansarc soil is in windbreak suitability group 10 and the Nora soil in windbreak suitability group 4.

Sarpy Series

The Sarpy series consists of deep, nearly level to moderately sloping, excessively drained soils that formed in alluvium (fig. 11). These soils are on bottom lands of the Missouri River Valley. They formed in recent calcareous alluvium deposited by overflow from the Missouri River. The topography is dunelike in places.

In a representative profile, the surface layer is very dark grayish-brown loamy fine sand 7 inches thick. Below this is a transitional layer, about 7 inches thick, of dark grayish-brown loamy fine sand. The underlying material, extending to a depth of 60 inches, is grayish-brown fine sand. The soil is calcareous throughout.

Sarpy soils have rapid permeability and a low available water capacity. Their organic-matter content and their natural fertility are low.

Some areas of Sarpy soils are suited to cultivated crops, under both dryland and irrigation management, where the slope is not too strong. Sarpy soils are also suited to grass, trees and shrubs, wildlife habitat, and recreation.

Representative profile of Sarpy loamy fine sand, 0 to 6 percent slopes, in a cultivated field 1,700 feet east and 100 feet north of the southwest corner of sec. 7, T. 29 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) loamy fine sand, dark grayish brown (10YR 4/2) dry; single grained; loose; slight effervescence; mildly alkaline; abrupt, smooth boundary.

AC—7 to 14 inches, dark grayish-brown (10YR 4/2) loamy fine sand, grayish brown (10YR 5/2) dry; weak, coarse, blocky structure; strong effervescence; moderately alkaline; clear, smooth boundary.

C—14 to 60 inches, grayish-brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) dry; single grained; loose; violent effervescence; moderately alkaline.

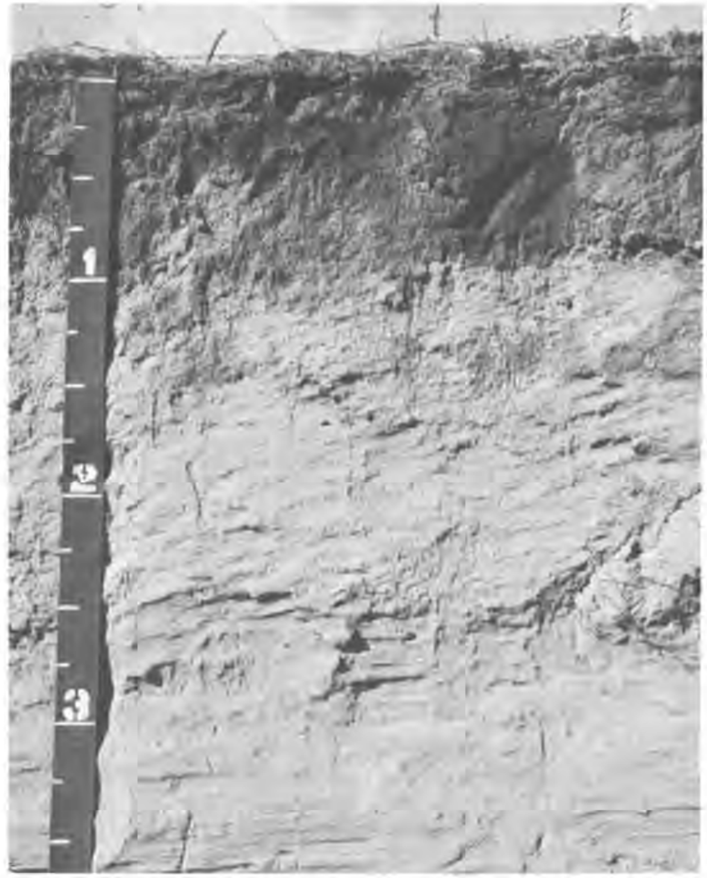

Figure 11.—**Profile of Sarpy loamy fine sand. This excessively drained sandy soil is calcareous at the surface.**

The A horizon ranges from 4 to 12 inches in thickness. It is very dark grayish brown or dark grayish brown. Most Sarpy soils have an A horizon of loamy fine sand or fine sand, but a silty clay overwash phase is also mapped in Dakota County. In some eroded areas, the C horizon of grayish-brown fine sand is at or near the surface. The A horizon is mildly alkaline to moderately alkaline and is calcareous. The AC horizon is dark grayish-brown to grayish-brown loamy fine sand or fine sand. The C horizon is pale-brown to grayish-brown loamy fine sand or fine sand. In some wet areas this layer is mottled. In some places thin layers of finer textured material are in the underlying material.

The Sarpy soils are near Haynie, Grable, and Percival soils. Their C horizon is coarser textured than that of Haynie soils. Sarpy soils are coarser textured in the AC and C horizons than Grable soils. Except for the overwash phase, Sarpy soils are coarser textured in the A and AC horizons than Percival soils.

Sarpy fine sand, 2 to 11 percent slopes (SbD).—This soil has been reworked by wind in most areas, and is near banks of the Missouri River. It has irregular short slopes and is on knolls and low dunes. The areas range from 10 to 100 acres in size; the largest areas are near the river. There, the vegetation is minimal and the soil is subject to soil blowing. Where the soil material remains in place, there is a sparse cover of trees and grasses. In a few places, the sandy material has been deposited in areas where there are older established trees.

This soil has a profile similar to the one described as representative for the series, but the surface layer is fine sand and is lighter in color.

Included with this soil in mapping are small areas that have a clayey surface layer. Also included are a few, smooth, lower areas that have coarse sand or gravel and a few small pebbles scattered on the surface.

The sandy surface layer, low organic-matter content, and low available moisture capacity are the principal limitations. Soil blowing is a hazard where this soil is not protected. This soil is droughty.

All the acreage serves as wildlife habitat or recreation areas. Capability units VIs–7 dryland and IVs–12, irrigated; windbreak suitability group 7.

Sarpy loamy fine sand, 0 to 6 percent slopes (ScC).—This soil is deep along the Missouri River bottom lands where alluvium was recently deposited. The areas range from smooth and plainlike to hummocky. Areas range from 10 to 40 acres in size. This soil has the profile described as representative for the series.

Included with this soil in mapping are small areas of Grable soils. Also included are soils that have a thin silty or clayey surface layer and that occur in low swales. Some included soils are clayey in the surface layer. A few areas of soils under Crystal Lake have a higher water table than is defined for the series. These wetter soils include the beach area of Crystal Lake.

Runoff is slow, but droughtiness and soil blowing are hazards. Maintaining cover and increasing the organic-matter content are the main concerns of management.

Nearly all the acreage is in grass or waste areas, but a few areas are cultivated. Corn is the principal crop. Capability units IVs–7 dryland and IIIs–11 irrigated; windbreak suitability group 3.

Sarpy silty clay, overwash, 0 to 2 percent slopes (So).—This soil is deep and is in the lower part of areas that were former channels of the Missouri River. The areas are smooth and range from 40 to 80 acres in size.

This soil has a profile similar to the one described as representative for the series, but the surface layer is very dark grayish-brown silty clay 6 to 12 inches thick. Below this is a layer of grayish-brown silt loam or very fine sandy loam that is 2 to 4 inches thick. At a depth of 10 to 15 inches is light brownish-gray fine sand. Some areas have loamy fine sand or loamy very fine sand in the underlying material. The entire profile is moderately alkaline and calcareous. Many, coarse, prominent, brown mottles are within a depth of 12 inches in most places and are most numerous at the point of contact between the clayey material and the sandy material.

Runoff is slow, and wetness early in spring and droughtiness later in the season are the main limitations. Where cultivated, the sandy underlying material is exposed in places, and soil blowing is a hazard.

Nearly all the acreage is in pasture, but a few areas are in alfalfa. Where this soil is intermingled with other soils and cultivated, crops normally show the effects of droughtiness. Capability units IVs–2 dryland and IVs–1 irrigated, windbreak suitability group 2.

Waubonsie Series

The Waubonsie series consists of deep, nearly level, moderately well-drained to somewhat poorly drained soils that formed in alluvium of mixed texture. These soils are on bottom lands of the Missouri River Valley.

In a representative profile, the surface layer is very dark grayish-brown very fine sandy loam 7 inches thick. The underlying material, to a depth of 21 inches, is dark grayish-brown loamy very fine sand. The next layer is the former surface layer of a now buried soil. It is very dark gray, light silty clay 8 inches thick. Below this, extending to a depth of 38 inches, is a layer of very dark grayish-brown silty clay. The next layer, extending to a depth of 60 inches, is stratified grayish-brown silt loam. The profile is calcareous throughout.

Waubonsie soils have moderately rapid permeability in the upper part, slow permeability in the middle part, and moderate permeability in the lower part. Their available water capacity is high. Their organic-matter content is moderately low, and their natural fertility is low. They release moisture readily to plants.

Waubonsie soils are suited to cultivated crops. They are also suited to grass, trees and shrubs, wildlife habitat, and recreation use.

Representative profile of Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes, in a cultivated field 1,820 feet west and 100 feet south of the northeast corner of sec. 33, T. 29 N., R. 9 E.

Ap—0 to 7 inches, very dark grayish-brown (10YR 3/2) very fine sandy loam, grayish brown (10YR 5/2) dry; single grained; soft, loose, strong effervescence; moderately alkaline; abrupt, smooth boundary.

C—7 to 21 inches, dark grayish-brown (10YR 4/2) loamy very fine sand; single grained; loose; slight effervescence; moderately alkaline; abrupt, smooth boundary.

IIAb—21 to 29 inches, very dark gray (10YR 3/1) light silty clay, dark gray (10YR 4/1) dry; weak, medium, blocky structure parting to weak, medium and strong, granular; slight hard, friable; organic stains; slight effervescence; moderately alkaline; clear, smooth boundary.

IICb—29 to 38 inches, very dark grayish-brown (10YR 3/2) silty clay, grayish brown (2.5Y 5/2) dry; moderate, coarse, blocky structure parting to moderate, medium and fine, blocky; hard, firm; strong effervescence; moderately alkaline; few small lime concretions; gradual, smooth boundary.

IIICb—38 to 60 inches, grayish-brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; massive; coarse stratification; soft, very friable; violent effervescence; moderately alkaline.

The A horizon ranges from 6 to 10 inches in thickness. It is very dark grayish-brown or dark grayish-brown very fine sandy loam or loamy very fine sand. The C horizon is fine sandy loam or loamy very fine sand. The IIAb horizon is silty clay loam or silty clay. Depth to this horizon ranges from 18 to 30 inches. The IIICb horizon begins at a depth ranging from 34 to 42 inches. It is stratified with thin layers of finer and coarser texture.

Waubonsie soils are near Haynie, Modale, and Sarpy soils. They have finer textured material at a depth of 20 to

40 inches than Haynie soils. Waubonsie soils are coarser textured at a depth of less than 20 inches than Modale soils. They are finer textured, at a depth below 20 inches, than Sarpy soils.

Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes (Wu).—This soil is deep and is on bottom lands. The areas range from 10 to 40 acres in size.

Included with this soil in mapping are areas where the clayey material is nearer to the surface than the one described as representative for the series. In places the silt loam in the underlying material is as shallow as 30 inches below the surface. Also, in places the soil is clayey to a depth below 60 inches. Also included are areas of Haynie, Sarpy, and Modale soils.

If dry or excessively tilled, this soil is subject to soil blowing. It is also slightly droughty where the clayey underlying material is deeper than typical. Because in wet seasons a perched water table above the clay layer restricts root growth, crops are susceptible to drought late in summer.

Nearly all the acreage is cultivated. Corn, soybeans, and alfalfa hay are the principal crops. Vegetable crops are also grown in some areas and are irrigated. Capability units IIs-6 dryland and IIs-8 irrigated; windbreak suitability group 3.

Use and Management of the Soils

This section provides information on the use and capabilities of the soils for crops. A brief range management section gives general information for the production of native grass. The woodland and windbreaks section gives information on the native woodland, suitability of the soils for windbreaks, and the trees suitable for each site. A short section and a table provide a choice of plants suitable for environmental plantings. The section on wildlife discusses the soil associations in the county and how wildlife habitat is affected by each. Various engineering evaluations and test data are listed for the soils in the county, and information on how these affect the use of the soil for engineering purposes is given.

Management of the Soils for Crops [2]

This section first discusses general management of dryland soils and of irrigated soils. Next, the capability system used to classify soils for the production of cultivated crops and for pastures is explained and management of the soils in the county by capability units is discussed. A table showing predicted yields of the principal crops is given.

Most soils of Dakota County are fertile and well suited to crops where the limitations and hazards have been corrected and where suitable management practices are used. Water erosion, flooding adjacent to streams, soil blowing, loss of fertility, and leaching are the principal concerns of management.

Approximately 36 percent of the soils of Dakota County have slopes of more than 10 percent, and about 11 percent have slopes of more than 17 percent. Many areas of strongly sloping soils in the Crofton, Ida, Moody, and Nora series have previously been cultivated but are now in grass and are used for pasture or hay production. Water erosion on soils of the uplands and the corresponding deposit of silt in the valleys have occurred in many places. Both sheet and gully erosion are commonly evident. The excessive runoff from the steeper slopes after heavy rains floods the bottom lands and reduces soil fertility.

General management of dryland soils

Conservation practices, such as terraces and contour farming, grassed waterways, and a cropping system that includes mulch tillage and limited use of row crops, are suited to the gently sloping and moderately sloping Moody, Nora, and Crofton soils. These practices help keep soil losses to a minimum. Soils on bottom lands, such as those in the Kennebec and Forney series, commonly require some protection from runoff water. The use of diversions above the flooded areas and good water conservation practices on the adjacent areas help to reduce the hazard of flooding.

On the steeper, more erodible soils, such as those in the Monona, Nora, and Crofton series, a management system that includes pasture and hay crops can be used. Production of an abundance of crop residue to help control erosion is not always possible on these soils. Therefore, in these areas grass or hay crops are needed to help protect the soil.

The major cultivated crop in Dakota County is corn. Soybeans, alfalfa, and oats are also important. An extensive acreage of soils on the bottom lands, such as Blencoe, Onawa, Kennebec, Forney, and Haynie soils, is in row crops. During some years, flooding on these soils is a hazard. A sizable acreage of soils on the uplands, such as those in the Nora and Moody series, also is in row crops. Barley, sorghum, and wheat are minor crops.

Pasture is principally a mixture of bromegrass, alfalfa, and other cool-season grasses or a mixture of warm-season, native grasses. The warm-season grasses are planted mainly on the steeper soils that are less desirable for crops. The cool-season grasses are grazed early in spring and early in summer and again during the late fall growing season. The warm-season grasses are grazed during June, July, and August. Some of the pasture is part of a long-term cropping system and is alternated with row crops.

Cultivated soils in Dakota County should be tested to determine their need for commercial fertilizer. There should be a correlation between the amount of moisture in the soil and the amount of fertilizer applied, especially on dryland crops. Soils that are dry in the subsoil need less fertilizer during periods of low rainfall than during periods of normal or above average rainfall. Nearly all soils respond to nitrogen fertilizer. Eroded soils of the Moody, Nora, Crofton, and Ida series commonly respond to phosphorus and zinc.

Crop residue left on the surface during tillage operations is valuable for reducing losses from soil blowing and water erosion. Mulch tillage and till-plant systems of seedbed preparation are good management

[2] Prepared by ERVIN O. PETERSON, conservation agronomist, Soil Conservation Service.

practices that reduce runoff and sediment losses. Pasture on the steeper soils of the county needs an adequate growth of grasses for protection against water erosion. In tame pasture and range, a minimum 4-inch height of grass at all times provides good protection against erosion.

General management of irrigated soils

Only a small percentage of cropland in Dakota County is irrigated. Nebraska Agricultural Statistics report 3,500 irrigated acres in the county in 1971. Water for irrigated land comes entirely from wells. Irrigation water is used primarily to supplement natural rainfall during dry years. During normal years, less irrigation is used. Soils that are level or very gently sloping are best suited to irrigation. Much water is lost if sloping soils are irrigated, and the excessive runoff causes erosion.

Where suitable quantities of underground water are available, there is a potential for increasing the amount of irrigated land and the acreage of pasture and range and for a greater use of conservation practices, particularly on the gently sloping soils.

Most of the acreage of irrigated soils in Dakota County is in the Missouri River Valley. A smaller acreage is in the uplands where irrigation water is available.

An irrigated soil generally needs management that differs from that needed on the same soil if it were dryfarmed. Different methods of irrigation generally are needed if the kind of crop grown on a particular field is changed. For example, the method used to irrigate a row crop is generally different from that used to irrigate a close-sown or pasture crop.

Furrow irrigation is the most common surface method of irrigating row crops. The water gets to the furrows between the plant rows from gated pipe. On nearly level soils, such as Kennebec and Haynie soils, the furrows are generally straight and follow field boundaries. Furrow irrigation can be used on steeper soils, such as Judson silty clay loam, 2 to 6 percent slopes, but the furrows should be on the contour to carry the water across, rather than down, the slope.

In border irrigation, the irrigation water is controlled by borders or small dikes along the sides of narrow fields. The water flows as a thin uniform sheet and is absorbed by the soil as it advances across the field. The strips need to be level and of uniform grade. Border irrigation is well suited to soils such as Haynie silt loam, 0 to 2 percent slopes.

In sprinkler irrigation, water is applied by sprinklers at a rate that the soil can absorb without runoff. Sprinklers can be used on the more sloping soils as well as on the nearly level soils. Soils, such as Monona silt loam, 6 to 11 percent slopes, are suited to the sprinkler method. Because the water can be carefully controlled, sprinklers have special uses in conservation farming, such as establishing new pastures on moderately steep slopes. In summer, however, some water is lost through evaporation, and wind drift can cause an uneven application of the water.

Sprinkler systems are of two general kinds. In one kind, sprinklers are set at a certain location, and they remain there until a specified amount of water is applied. The other kind is a center-pivot system, in which sprinklers revolve around a central point.

Soils hold a limited amount of water. Irrigation water, therefore, is applied at intervals that will keep the soil profile wet at all times. The interval varies according to the crop and the time of year. The water should be applied only as fast as the soil can absorb it. A deep irrigated soil in Dakota County holds about 2 inches of available water per foot of soil depth. A soil that is 4 feet deep and planted to a crop that sends its roots to that depth can hold about 8 inches of available water for that crop.

Better efficiency is obtained if irrigation is begun when about half of the stored water has been used by the plants. Thus, if a soil holds 8 inches of available water, irrigation should be started when about 4 inches has been removed by the crop. Irrigation should be planned to replace the amount that has been used by the crop.

Irrigated fields need management that controls or regulates the irrigation water in such a way that good crop growth is obtained without wasting water or soil. The size of the furrow stream or the sprinkler rate should be adjusted so that the water thoroughly moistens the soil without excessive runoff or erosion. The irrigation water can be recycled to irrigate the same field or other fields nearby.

Assistance in planning and laying out an irrigation system is available through the local office of the Soil Conservation Service or the county agricultural agent. Estimates concerning cost of equipment can be obtained from local irrigation equipment dealers and from manufacturers.

Irrigated soils generally produce higher yields than dryfarmed soils, but more plant nutrients, particularly nitrogen and phosphorus, are removed when the crop is harvested. Returning all crop residue to the soil and adding manure and commercial fertilizer help to restore the plant nutrients. Most soils used for grain crops respond to nitrogen. Soils disturbed during land leveling, particularly where the topsoil has been removed, respond to phosphorus, zinc, and iron. The kind and amount of fertilizer needed for specific crops should be determined by soil tests.

The principal irrigated crops in Dakota County are corn, soybeans, alfalfa, and pasture. Corn and soybeans are grown in rows 30 to 40 inches apart. Irrigation water can be applied in the furrows between the rows. Alfalfa and pasture grasses are irrigated by flooding or sprinkler systems. Sprinkler irrigation can also be used on corn and soybeans.

The cropping sequence for soils well suited to irrigation consists mainly of row crops. A change from corn to soybeans and then to alfalfa or grass helps to control the cycle of disease and insects that commonly occurs if the same crop is grown year after year. Gently sloping soils, however, such as Nora silt loam, 2 to 6 percent slopes, eroded, which are subject to erosion if irrigated, are better suited to a cropping sequence that includes several years of row crops followed by 3 to 5 years of hay or pasture. Close grown crops, such as alfalfa or a mixture of alfalfa and grass, can be grown. Strongly sloping soils, such as Napier silt loam, 6 to 11 percent slopes, are better suited to irrigated pasture crops than to row crops.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The groups are made according to the limitations of the soils if used for field crops, the risk of damage if they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible but unlikely major reclamation projects; and does not apply to horticultural crops or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, forest trees, or engineering.

In the capability system, all kinds of soils are grouped at three levels: the capability class, subclass, and unit. These are discussed in the following paragraphs.

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

Class I soils have few limitations that restrict their use.

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

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

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

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

Class VI soils have severe limitations that make them generally unsuited to cultivation and limit their use largely to pasture or range, woodland, or wildlife.

Class VII soils have very severe limitations that make them unsuited to cultivation and that restrict their use largely to pasture or range, woodland, or wildlife.

Class VIII soils and landforms have limitations that preclude their use for commerical plants and restrict their use to recreation, wildlife, or water supply or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c*, to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States but not in Dakota County, shows that the chief limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at the most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIw-2. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitation; the small letter indicates the subclass or kind of limitation as defined in the foregoing paragraph; and the Arabic numeral specifically identifies the capability unit within each subclass.

Management by capability units

In this section each of the capability units in Dakota County is discussed. Common features of the soil in each unit are described, and properties that affect management are given.

The capability units described here are based on both the dryland system of management and the irrigation system of management. The dryland and irrigated crops grown under each system are given, together with the hazards and limitations that pertain to the soils under each kind of management. Next is discussed the practices that can be used to overcome the problems involved in the management of soils of each capability unit.

The capability unit designation for each soil in the county can be found in the Guide to Mapping Units at the back of the survey. All soils in Nebraska are placed in irrigation design groups. These design groups are described in the Irrigation Guide for Nebraska. Arabic numbers in the irrigation capability unit indicate the design group to which the included soils belong.

CAPABILITY UNIT I-1, DRYLAND

This unit consists of nearly level soils that have a surface layer of silt loam or silty clay loam. These deep, well-drained to somewhat poorly drained soils are on bottom lands. The subsoil is silt loam or silty clay loam, and the underlying material is silt loam, silty clay loam, or silty clay. The surface layer is slightly acid to moderately alkaline.

Most of these soils have moderate permeability, but some have moderately slow permeability in the upper part or slow permeability in the underlying material. These soils have a high available water capacity. Their organic-matter content and natural fertility range from low to high. These soils absorb moisture easily and release it readily to plants. They have easy workability. Runoff is slow or medium.

These are some of the best soils for growing cultivated crops in Dakota County. Soil blowing is a minor hazard on some soils. Under dryland management, natural rainfall is adequate to meet crop needs in most years.

These soils are suited to all the crops commonly grown in the county and are especially suited to corn, soybeans, grain sorghum and other field crops. Row crops can be grown year after year if proper amounts of fertilizer are used and if weeds, plant disease, and insects are controlled. Crops on these soils respond well to the addition of nitrogen fertilizer. These soils also are well suited to pasture.

Grassed waterways are useful to conduct runoff away from areas of these soils. In some places, diversion ditches help prevent damage by runoff from adjacent higher areas. Grassing the turnrows helps control weeds along field borders.

CAPABILITY UNIT IIe-1, DRYLAND

This unit consists of well drained and moderately well drained, gently sloping soils. These deep soils are on broad ridgetops, colluvial foot slopes, and bottom lands. The surface layer, subsoil, and underlying material are silt loam or silty clay loam. The surface layer is slightly acid or mildly alkaline.

These soils have moderate or moderately slow permeability and a high available water capacity. Their organic-matter content is moderate to high, and their natural fertility is medium or high. These soils absorb moisture easily and release it readily to plants. Some receive additional moisture from adjacent steep areas. They are easy to work. Runoff is medium.

Erosion is not a serious hazard, but soil blowing occurs in some years. Ditches may form in natural waterways where water from adjacent land moves across areas of some soils. These soils respond well to fertilizer. Lime is needed in places to establish legumes.

These soils are suited to all crops commonly grown in the county, including corn, oats, soybeans, rye, and barley. Terraces, contour farming, and grassed waterways help to keep water from concentrating on long slopes. A cropping system that includes grasses and legumes helps to control erosion and to build a supply of organic matter, maintain fertility, and improve tilth. Keeping crop residue on the surface and using commercial fertilizer are valuable in maintaining fertility. In the year preceding the establishment of a legume crop, the soil can be tested to determine the amount of lime needed to neutralize the acidity in some of these soils.

Many farmsteads are located in areas of these soils. These soils also are well suited to trees in windbreaks, to pasture, and to garden crops.

CAPABILITY UNIT IIs-5, DRYLAND

The only soil in this unit is Grable very fine sandy loam, 0 to 2 percent slopes. This deep, well-drained soil is on bottom lands of the Missouri River Valley. The underlying material is very fine sandy loam in the upper part and find sand in the lower part. This soil is moderately alkaline throughout.

This soil is moderately permeable in the upper part and rapidly permeable in the lower part. Available water capacity is moderate. The organic-matter content is moderately low, and natural fertility is low. This soil absorbs moisture easily and releases it readily to plants. It is easy to work. Runoff is slow.

Soil blowing is a minor hazard where these soils are cultivated. The soil is droughty, and conservation of moisture is a primary concern of management. Natural rainfall is ordinarily not distributed uniformly enough throughout the growing season to meet all crop needs.

This soil is suited to all crops commonly grown in the county. Legumes, grasses, or a mixture of grasses and legumes in the cropping system help to replenish the organic-matter content and maintain fertility and aid in controling soil blowing. Keeping a cover of growing crops or crop residue on the surface with a mulch planting system helps to improve fertility and reduce soil blowing.

CAPABILITY UNIT IIs-6, DRYLAND

The only soil in this unit is Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes. This deep, moderately well drained to somewhat poorly drained soil is on bottom lands of the Missouri River Valley. The underlying material is very fine sandy loam in the upper part, silty clay in the middle part, and silt loam or very fine sandy loam in the lower part. This soil is moderately alkaline throughout.

Permeability is moderately rapid in the upper part of the underlying material, slow to very slow in the middle part, and moderate below a depth of about 38 inches. The organic-matter content is moderately low, and the natural fertility is low. This soil absorbs moisture easily and releases it readily to plants. The clayey underlying material restricts downward movement of moisture, which is especially beneficial during periods of low rainfall. This layer is deep enough and permeable enough that it does not cause ponding of water on the surface. This soil is easy to work. Runoff is slow.

Soil blowing is a hazard in cultivated areas. Under dryland management, natural rainfall is ordinarily not distributed uniformly during the growing season to meet crop needs.

This soil is suited to all crops commonly grown in the county. Soil blowing can be controlled by keeping crop residue on the surface most of the time. Commercial fertilizer and a cropping system that includes grasses and legumes aid in maintaining soil fertility.

CAPABILITY UNIT IIw-1, DRYLAND

This unit consists of nearly level, deep, moderately well drained and somewhat poorly drained soils on bottom lands of the Missouri River Valley. The surface layer is silty clay. The subsoil or upper part of the underlying material is silt loam. In some soils the underlying material is fine sand.

Most of the soils have very slow permeability in the subsoil or in the upper part of the underlying material and moderate permeability in the lower part. Some have rapid permeability in the lower part. The available water capacity is high in most soils but is low in some. The organic-matter content is moderately low to high, and the natural fertility is medium or low. These soils absorb moisture very slowly. They are difficult to work, and good tilth is difficult to maintain. The soils are sticky when wet and hard when dry. Tillage should be done at the proper moisture content of the soil, which has a narrow range. Runoff is slow, and the soils are subject to some ponding.

During periods of dry weather, these soils crack considerably upon drying, and damage to plant roots can be extensive. Wide cracks in the soil also allow excessive exaporation of soil moisture. Soil blowing in winter is a hazard when the soils are fall plowed. In spring the soils are wet, planting is delayed, and plant germination is irregular. Under dryland management, natural rainfall is inadequate to meet crop needs during some years.

The soils of this unit are suited to the crops commonly grown in the county. Where surface drainage is inadequate, the excess water can be drained away by ditches. Minimum tillage is a suitable practice on these soils. Plowing late in fall leaves a bare surface in winter. Soil blowing can be avoided during these operations by plowing narrow strips at intervals so as to prevent the surface from being exposed to wind for long periods. Organic-matter content can be maintained by returning crop residue to the soil.

CAPABILITY UNIT IIw-2, DRYLAND

The only soil in this unit is Forney silt loam, overwash, 0 to 2 percent slopes. It is a deep, poorly drained soil on bottom lands of the Missouri River Valley. The underlying material is silt loam in the upper part and grades to a silty clay in the lower part. The surface layer is neutral to mildly alkaline.

This soil has moderate permeability in the silty upper part and very slow permeability in the clayey underlying material. The available water capacity is moderate. The organic-matter content is moderate, and natural fertility is medium. This soil absorbs moisture easily but releases it slowly to plants. The clayey lower part of the subsoil and underlying material restrict downward movement of moisture, which is especially beneficial during periods of low rainfall. The clayey material seldom restricts water movement enough to cause ponding. This soil is easy to work. Runoff is slow.

Erosion is not a serious hazard on this soil. Surface drainage is needed in a few places. This soil was subject to flooding in past years but is infrequently flooded now. Under dryland management, natural rainfall is commonly inadequate to meet crop needs.

This soil is suited to the crops commonly grown in the county since it is seldom flooded. Diversions help prevent runoff from higher land from reaching areas of this soil. Shallow drainage ditches are useful in places where surface water is ponded, but adequate outlets are not always available.

CAPABILITY UNIT IIw-3, DRYLAND

The only soil in this unit is Kennebec silt loam, overwash, 0 to 2 percent slopes. This deep, moderately well drained soil is on bottom lands or upland drainageways. The underlying material is silt loam. The surface layer is mildly alkaline.

This soil has moderate permeability and a high available water capacity. The organic-matter content is moderate, and natural fertility is high. This soil absorbs moisture easily and releases it readily to plants. It is easy to work. Runoff is slow.

Bank erosion and formation of overfalls are the main concerns of management since nearly all areas of this soil have deeply entrenched drainageways. The soil is subject to occasional flooding. Under dryland management, natural rainfall is commonly adequate to meet crop needs.

This soil is suited to all crops commonly grown in the county. Areas on the adjacent uplands should be protected to control erosion and reduce runoff. Terracing the adjacent uplands and using diversions are ways to protect soils of this unit from flooding. Row crops can be grown year after year if they are properly managed. Productivity can be maintained by using fertilizer and by returning crop residue to the soil as mulch material. Grassed waterways can be constructed in locations where bank erosion and overfalls have occurred.

CAPABILITY UNIT IIw-4, DRYLAND

This unit consists of deep, nearly level, poorly drained soils on bottom lands and commonly along drainageways that have low gradients in the uplands. The surface layer is silt loam or silty clay loam, the subsoil is silt loam or silty clay loam, and the underlying material is silty clay loam. The surface layer is moderately alkaline.

These soils have moderately slow permeability and a high available water capacity. Their organic-matter content is moderate or high, and their natural fertility is high. These soils absorb moisture easily and release it readily to plants. They are easy to work. Runoff is slow.

The principal concerns of management are wetness caused by a high water table and occasional flooding and siltation. Deeply entrenched drainageways have improved the surface drainage of some areas. Where this condition exists, these soils are cultivated. The remainder are in pasture.

These soils are suited to all crops commonly grown in the county, but corn and soybeans are the principal crops. Spring-sown small grains generally are not grown on these soils because of excessive wetness early in spring. Alfalfa growth on these soils varies because in some years the root zone is restricted by the moderately high water table, and in other years growth is increased or improved by the subirrigation of the alfalfa plants.

If suitable outlets are available, tile drains help to lower the water table and control the wetness of these soils. Shallow drains can be used to remove impounded surface water. Diversions and land treatment of the drainage areas above these soils are beneficial in reducing flood damage.

CAPABILITY UNIT IIIe-1, DRYLAND

This unit consists of deep, well-drained, moderately sloping soils on uplands. The surface layer and subsoil are silt loam or silty clay loam. The underlying material is silt loam. The surface layer is slightly acid to mildly alkaline.

These soils have moderate or moderately slow permeability and a high available water capacity. Their organic-matter content is moderate to high, and their natural fertility is medium to high. These soils absorb moisture easily and release it readily to plants. They are easy to work. Some soils tend to become cloddy if tilled when wet. Runoff is medium.

Water erosion is a principal hazard when using these soils for farm crops. Lime may be needed to establish alfalfa or sweet clover.

These soils are suited to all crops commonly grown in the county, but the hazard of erosion is more severe where soybeans are grown than if other tilled or row crops are planted. The erosion can be controlled by terraces, contour farming, grassed waterways, and mulch tillage practices that leave most of the crop residue on the soil surface as a protective mulch. Fertility can be maintained by the addition of commercial fertilizer.

CAPABILITY UNIT IIIe-8, DRYLAND

This unit consists of well-drained, gently sloping and moderately sloping soils. These are deep, eroded soils on uplands. The surface layer and subsoil are silt loam or silty clay loam. The underlying material is silt loam. The surface layer is slightly acid to mildly alkaline.

These soils have moderate or moderately slow permeability and a high available water capacity. Their organic-matter content is moderately low or low, and their natural fertility is medium. These soils absorb moisture easily and release it readily to plants. Some soils tend to become cloddy if tilled when wet. Runoff is medium to rapid.

Water erosion is the principal hazard when using these soils for farm crops. Conservation of soil and water is the primary concern of management. Addition of lime may be needed to establish legumes on some soils.

These soils are suited to most crops commonly grown in the county, but they are highly erodible if used for soybeans. Growing soil-building crops, such as grasses and legumes, and returning all residue to the soil are ways of restoring the structure and improving the organic-matter content. Contour farming, terraces, waterways, and field borders help prevent erosion, conserve moisture, restore fertility, and control runoff. On some slopes, stripcropping helps to control erosion (Fig. 12). Loss of fertility is serious on these eroded soils, and fertilizer is commonly needed for good crop growth.

These soils are also well suited to pasture. Seeding cool-season grasses in one area and warm-season grasses in a separate area is a good way to provide green grazing for the entire grazing season. Cover crops can be used while the grass is becoming established to prevent erosion. Fertility for cool-season grasses can be provided by commercial nitrogen and phosphorus.

CAPABILITY UNIT IIIe-9, DRYLAND

The only soil in this unit is Crofton silt loam, 2 to 6 percent slopes, eroded. This deep, well-drained soil is on uplands. The underlying material is silt loam. The soil is high in lime and moderately alkaline throughout. Many lime concretions are on the surface.

This soil has moderate permeability and a high available water capacity. The organic-matter content and natural fertility are low. This soil absorbs moisture readily, but intense rainfall tends to break down the soil structure which causes puddling on the surface and a low rate of moisture absorption. This soil releases moisture readily to plants. It is easy to work. Runoff is medium.

Water erosion is the principal hazard when using this soil. Maintaining fertility and good soil structure in the surface layer are the primary concerns of management. The soil is deficient in nitrogen, but it responds well to applications of fertilizer. Under dryland management, natural rainfall is commonly adequate to meet crop needs.

This soil is suited to most crops commonly grown in the county, except soybeans. The soil is highly erosive where planted to row crops. Growing soil-building crops, such as grasses and legumes, in the cropping system and returning crop residue to the soil are ways of improving the structure and organic-matter content. Contour farming, terraces, grassed waterways, and field borders help prevent erosion, conserve moisture, restore fertility, and control water runoff. Loss of fertility from erosion is serious on this soil and additions of fertilizer, particularly phosphorus and nitrogen, are needed for good crop growth. The soil is also suitable for pasture or range.

CAPABILITY UNIT IIIw-1, DRYLAND

This unit consists of deep, poorly drained and somewhat poorly drained, nearly level and depressional soils on bottom lands of the Missouri River Valley. In most of these soils, the surface layer is silty clay, silty clay loam, or clay loam. It is neutral to moderately alkaline. The subsoil and underlying material are silty clay. Some soils have a thick layer of silt loam at a depth of less than 24 inches.

These soils have slow or very slow permeability and a moderate available water capacity. Their organic-matter content is moderately low or moderate, and their natural fertility is low or medium. They absorb moisture very slowly and release it slowly to plants. They are difficult to work, and good tilth is hard to maintain. The soils are sticky when wet and very hard when dry; they should be tilled at the proper moisture content. Runoff is slow to ponded. In places, water runs in from adjoining land and ponds on the surface.

Crop growth on these soils is limited by excess water. Water moves downward slowly unless the soil

Figure 12.—**Oats and corn are grown in strips on this field of Moody silty clay loam, 6 to 11 percent slopes, eroded. This soil is in capability unit IIIe–8 dryland.**

is dry. Moisture causes the clay minerals to expand, thus closing natural openings in the soils. Excess water in spring delays cultivation and restricts root growth so that the crop does not always have enough moisture in summer. Upon drying, these soils crack, and damage to plant roots is extensive. The wide cracks also allow evaporation and loss of moisture. Stream overflow is a minor hazard.

Maintaining good tilth is a major concern of management (fig. 13). Soil blowing during winter is a hazard. Natural rainfall is seldom adequate or distributed uniformly enough throughout the growing season to meet crop needs. Surface drainage can be improved by land shaping. Tile drains or open ditches can be used to lower the water table. These need to have a suitable outlet at a lower elevation than the field. Where adequate outlets are not available, the soils are better used for hay or pasture crops. Avoiding operating heavy machinery or grazing livestock in wet periods can help to reduce soil compaction. Fall plowing when moisture conditions are likely to be favorable allows these soils to mellow into better tilth over winter. Soil blowing can be controlled by leaving strips of unplowed areas in the field. Legumes, such as alfalfa, also can aid in increasing the permeability of these soils.

These soils are suited to most of the crops commonly grown in the county. Fall-sown small grains, such as wheat, are the better crops because they are planted during a time when these soils are most likely to be dry.

CAPABILITY UNIT IIIw–2, DRYLAND

The only soil in this unit is Albaton silty clay loam, 0 to 2 percent slopes. This deep, poorly drained soil is on bottom lands of the Missouri River Valley. The underlying material is silty clay. The surface layer is moderately alkaline.

This soil has slow permeability and moderate available water capacity. The organic-matter content is moderately low, and natural fertility is low. This soil absorbs moisture more easily than other Albaton soils. It is easy to work but becomes cloddy if it is tilled when wet. Runoff is slow.

The silty clay loam surface layer prevents excessive cracking of the subsoil, which commonly occurs in other Albaton soils in years of low rainfall. Maintaining tilth is not so serious a concern. Under dryland

Figure 13.—**Tillage at the proper moisture content is important on soils in capability unit IIIw-1 dryland. This cloddy plow layer is in an area of Forney silty clay, 0 to 2 percent slopes.**

management, natural rainfall is generally adequate to meet crop needs.

This soil is well suited to the more common crops grown in the county. The till-plant system can be used for row crops on this soil. This method avoids excessive tillage in spring when the soils may be wet. Areas of this soil also can be used for pasture or hay. The grasses planted should be those suited to this poorly drained soil.

CAPABILITY UNIT IVe-1, DRYLAND

This unit consists of strongly sloping, deep, well-drained soils on uplands. The surface layer is slightly acid or neutral silt loam or silty clay loam. The subsoil is silt loam or silty clay loam, and the underlying material is silt loam.

These soils have moderate or moderately slow permeability and high available water capacity. The organic-matter content is moderate or high, and the natural fertility is medium or high. These soils absorb moisture easily and release it readily to plants. They generally are easy to work, but some tend to become cloddy if tilled when wet. Runoff is rapid.

Water erosion is the primary hazard when using these soils for cultivated crops. Under dryland management, natural rainfall is commonly adequate if the soils are kept in good tilth and if runoff is reduced so as to allow water absorption that will meet crop needs.

These soils are suited to most of the crops commonly grown in the county, except soybeans. They are used mainly for cultivated crops but are also suited to range, pasture, and hay. Erosion is severe when the soils are cultivated unless practices to control erosion are used. Because the hazard of erosion is high, row crops are commonly not grown continuously in the cropping sequence. Growing legumes or grasses about 80 percent of the time and returning crop residue and adding barnyard manure to the soils are ways to control erosion, maintain fertility, and improve tilth. Contour farming, terraces, grassed waterways, stripcropping, and grass turnrows are beneficial in controlling water erosion. The use of mulch tillage machinery leaves crop residue at or near the surface, and this helps to reduce runoff and increase the rate of water intake.

The strong slopes and the consequences of erosion make permanent grass or hay one of the better uses for these soils. By using cool-season grasses for grazing early in spring and in fall and warm-season grasses planted in separate pasture for grazing in midsummer, a complete, season-long, green grazing program can be provided for livestock. These soils need to be fertilized for better growth of cool-season grasses.

CAPABILITY UNIT IVe-8, DRYLAND

The only soil in this unit is Nora silt loam, 11 to 15 percent slopes, eroded. This deep, well-drained soil is on uplands. The subsoil and underlying material are silt loam. The surface layer is mildly alkaline.

This soil is moderately permeable and has high available water capacity. The organic-matter content is low, and the natural fertility is low to medium. This soil absorbs moisture easily and releases it readily to plants. It is easy to work. Runoff is rapid.

Water erosion is the principal hazard when using this soil for farm crops. Maintaining fertility is a prime concern in management. This soil responds well to application of fertilizer. Under dryland management, natural rainfall normally is not adequate to meet all crop needs.

Except for soybeans, most crops grown in the county are suited to this soil. Suitable practices for conserving soil moisture and for controlling runoff are contour farming and terracing. In addition, grassed waterways, grassed turnrows, and seeded field boundaries are beneficial. In a good cropping system row crops are grown infrequently, and close-sown crops, hay, and pasture are grown during most years. Keeping a cover of permanent vegetation, such as grass or trees, on these soils is an effective way of conserving soil and water.

This soil is well suited to pasture, range, or hay. A combination of cool-season grasses and warm-season grasses, each in separate areas, can be used to provide a season-long green grazing system for livestock. Nitrogen fertilizer can be used on the cool-season grasses, but warm-season grasses commonly need no extra fertilization.

CAPABILITY UNIT IVe-9, DRYLAND

This unit consists of well-drained, moderately sloping and strongly sloping, deep soils on uplands. It includes both eroded and uneroded soils. These soils are primarily on narrow convex ridgetops and the upper part of slopes. The surface layer, transitional layer, and underlying material are silt loam. Small lime concretions are scattered on the surface in the eroded areas. These soils are moderately alkaline throughout.

These soils have moderate permeability and high available water capacity. The organic-matter content and natural fertility are low. These soils absorb moisture readily where the structure of the surface layer is maintained. Intense rainfall and excessive cultivation tend to destroy the soil structure, thus puddling the surface layer and reducing the absorption of moisture. These soils release moisture readily to plants. They are easy to work. Runoff is rapid.

Sheet erosion by water is the principal hazard when using these soils for farm crops. These soils respond well to applications of fertilizer. They are especially deficient in nitrogen. Natural rainfall is commonly adequate to meet crop needs.

Where these soils are used for crops, they are suited to most of the crops grown in the county. Because of excessive erosion, soybeans should not be grown on these soils. Practices for conserving moisture and for controlling water erosion are contour farming, terracing, grassed waterways, grassed turnrows, and seeded field boundaries. A cropping sequence that provides for an infrequent use of row crops and for using close-sown and grass crops most of the time also can aid in reducing soil losses. Excessive tillage of these soils should be avoided.

Part of the acreage of the soils of this capability unit is in grass and trees. The areas in grass are used for pasture or hay. A suitable use for the cultivated soils of this unit is to convert them to grass for use as pasture or hay. Some areas can be used as sites for flood control and grade control structures.

CAPABILITY UNIT IVs-2, DRYLAND

The only soil in this unit is Sarpy silty clay, overwash, 0 to 2 percent slopes. This deep, excessively drained soil is on the bottom lands of the Missouri River Valley. The underlying material is fine sand. This soil is mildly alkaline throughout.

This soil has slow permeability in the surface layer and rapid permeability in the underlying material. Available water capacity is low. The organic-matter content and natural fertility are low. This soil absorbs moisture slowly, and the moisture that is absorbed is not readily retained in the coarse underlying material. This soil is difficult to till. Runoff is slow.

Maintaining good tilth in the surface layer is the important concern of management. This soil is droughty. Under dryland management, natural rainfall is inadequate to meet crop needs.

This soil is suited to most of the common crops in the county. Mulch planting operations that leave most of the crop residue on the surface can be used to assist in maintaining good tilth and organic-matter content. Grasses and legumes grown in a cropping sequence can also be used to increase the organic-matter content and improve the tilth of the soil. Fertility can be improved by the use of commercial fertilizer.

CAPABILITY UNIT IVs-7, DRYLAND

The only soil in this capability unit is Sarpy loamy fine sand, 0 to 6 percent slopes. This deep, excessively drained soil is on bottom lands of the Missouri River Valley. Slopes are smooth to hummocky. The surface layer and transitional layer are loamy fine sand, and the underlying material is fine sand. This soil is moderately alkaline throughout.

This soil has rapid permeability and low available water capacity. The organic-matter content is low, and natural fertility is medium. This soil absorbs moisture easily. Because of its coarse texture, moisture moves easily through the soil material. This condition makes the soil droughty. This soil is difficult to cultivate because of the loose, incoherent, sandy surface layer.

Soil blowing is a major hazard where the surface layer is not protected. Natural rainfall is commonly not adequate to meet crop needs.

In Dakota County, an excellent use for this soil is range and pasture because of the severe hazard of soil blowing. This soil is marginal for cultivated crops. If the soil is cultivated, close-growing crops, such as alfalfa, grass, and small grain, are better suited than other crops. Where row crops are planted, narrow strips or fields can be alternated with strips of close-sown crops. Close-sown crops are more dependable because growth is better in the spring when rainfall is the highest and when soil blowing is not so severe.

A cropping system that keeps the soil covered with crop residue is needed. Planting row crops in the spring and then interplanting with rye and hairy vetch in the fall is a system that offers an abundance of crop residue at all times. Narrow plantings of trees that act as field windbreaks is a good practice to reduce soil blowing on large areas of this soil.

CAPABILITY UNIT Vw-1, DRYLAND

The only soil in this unit is Albaton silty clay, depressional, 0 to 1 percent slopes. This deep, poorly drained soil is in depressions that are former channels of the Missouri River. The underlying material is silty clay. This soil is moderately alkaline throughout.

This soil has slow permeability and moderate available water capacity. The organic-matter content is moderately low, and natural fertility is low. This soil absorbes moisture slowly and releases it slowly to plants. Runoff is very slow or ponded.

Water ponds on the surface following rainfall. The water table is within 5 feet of the surface. Most areas are in grass or are waste areas.

This soil is generally not suited to the common cultivated crops because of ponding. These areas are well suited to wetland wildlife. In most places suitable outlets are not available because this soil generally is lower than the surrounding soils.

CAPABILITY UNIT Vw-7, DRYLAND

This unit consists only of Alluvial land, a land type in former channels of the Missouri River. It has a water table at a depth of 1 to 3 feet; the water fluctuates with the level of the river. Small areas have water on the surface. This soil material is poorly drained. Marshy vegetation is common. Willows grow in the drier areas. The surface layer ranges from silt loam to sand. The underlying material is sand. Alluvial land is moderately alkaline.

The permeability and available water capacity are too variable to be estimated. This land type provides excellent habitat for waterfowl.

Vegetation consists mostly of sedges, reeds, and other grass plants that tolerate a high degree of wetness. During seasons of heavy rainfall, the areas are too wet for good use as grazing land. surface drains and tile drains can help lower the water table so that more desirable grasses can be established. Installing a drainage system would depend on locating suitable outlets. If the primary use is for wetland wildlife, then drainage systems should not be installed. Areas of this capability unit are better suited to use as wildlife habitat and protection. They have only limited use for grazing. The areas are too wet for crops.

CAPABILITY UNIT VIe-1, DRYLAND

This unit consists of steep, deep, well-drained soils on uplands. The surface layer, subsoil, and underlying material are silt loam. The surface layer is neutral.

These soils have moderate permeability and a high available water capacity. Their organic-matter content is moderate, and their natural fertility is medium. They absorb moisture easily and release it readily to plants. They are easy to work. Runoff is rapid.

Erosion is the principal hazard where these soils are cultivated. They are primarily used for grass.

The soils in this unit generally are not suitable for cultivation because they are too steep. They are well suited to grass and trees. Small areas that now are cultivated can be established for pasture by planting them to cool-season grasses and other areas to warm-season grasses. This can provide season-long green grazing for livestock. Cover crops can be used to prepare the land prior to seeding grasses because they help reduce erosion while the grasses are becoming established. In areas used for grazing, mowing helps control weeds and undesirable plants. In small isolated areas where these soils are surrounded by crops or are adjacent to cropland, they can be used for hay or grazing, along with the crop aftermath.

These soils are suited to trees and shrubs, which can be planted and managed for wildlife cover. Good sites for watering areas for livestock (fig. 14) or for recreation dams occur along drainageways. Sites also are available for flood control structures.

CAPABILITY UNIT VIe-9, DRYLAND

This unit consists of deep, steep, well-drained soils on uplands. These soils are mainly on narrow ridgetops and the upper parts of hillsides. The surface layer, transitional layer, and underlying material are silt loam. These soils are moderately alkaline throughout. They have small lime concretions in or immediately below the surface layer. Many areas are eroded.

These soils have moderate permeability and a high available water capacity. Their organic-matter content and natural fertility are low. They absorb moisture easily where the granular structure of the surface layer is maintained. They release moisture readily to plants. They are easy to work. Runoff is rapid.

Sheet erosion is the principal hazard when using these soils. These soils respond well to fertilizer. Natural rainfall is commonly adequate to meet crop needs (fig. 15).

These soils generally are not suitable for cultivation. Areas now being cultivated can be reseeded to grasses and converted to range. Most of the acreage is in range, and the principal native grasses are bluestem, side-oats grama, and switchgrass. Some areas are still in woodland, and oak and elm are the most common trees.

Where these soils are used for range, grazing needs to be regulated. Only half of the current year's growth of the desirable species can be safely removed. Weeds and other undesirable plants can be controlled by mowing or spraying. Good sites for livestock water or recreational dams are along some drainageways in areas of these soils.

CAPABILITY UNIT VIs-4, DRYLAND

The only mapping unit in this capability unit is Sansarc-Nora complex, 11 to 30 percent slopes. Soils in this complex have widely contrasting characteristics. They are shallow and deep, moderately steep to

Figure 14.—Many areas of soils in capability unit VIe-1 dryland, provide excellent grazing and offer potential sites for livestock ponds. This soil is Monona silt loam, 17 to 30 percent slopes.

Figure 15.—Proper land use on this area of soils in capability unit VIe-9 dryland, provides good grazing and erosion control. The soil is Crofton silt loam, 15 to 30 percent slopes.

steep, well-drained soils on uplands. The surface layer is silt loam or clay loam, and the subsoil is silt loam or silty clay loam. The underlying material is silt loam or clay. The Sansarc soils of this complex are eroded.

Soil properties are also widely contrasting. These soils have moderate or slow permeability and a very low or high available water capacity. Their organic-matter content is moderate or low, and their natural fertility is low to medium. Runoff is rapid.

Management of these soils as a unit is difficult because their characteristics range so widely. Water erosion, the low available water capacity, and low fertility are management concerns when using these soils.

The soils of this capability unit generally are not suited to cultivated crops. They are better suited to range. Areas now cultivated can be reseeded to grasses and converted to range. A cover crop is beneficial if used prior to planting grasses to control erosion while the grasses are becoming established. Most of the acreage now is in range and is used for grazing. Grazing management is essential on these soils so as to keep a suitable growth of vegetation on the land to protect the soils from erosion.

CAPABILITY UNIT VIs-7, DRYLAND

The only soil in this unit is Sarpy fine sand, 2 to 11 percent slopes. This deep, excessively drained soil is on bottom lands of the Missouri River Valley. Slopes range from smooth to hummocky with high dunes in places. The underlying material is fine sand. This soil is moderately alkaline throughout.

This soil has rapid permeability and a low available water capacity. The organic-matter content and natural fertility are low. This soil absorbs moisture easily, but most of the moisture is lost by downward percolation through the soil. Runoff is slow.

Soil blowing is the principal hazard when using this soil. Many areas are barren, and soil blowing causes the hummocky surface. Control of the blowing is needed before the areas can be stabilized. This soil is droughty.

This sandy soil generally is not suitable for use as cultivated land or for pasture. It is better suited to range or trees than to most other uses. Areas that lack a ground cover can be reseeded to grass or planted to trees. Wooded and brushy areas provide excellent habitat for wildlife.

CAPABILITY UNIT VIIe-7, DRYLAND

This unit consists of gently sloping to very steep soils that occur in a complex with Gullied land. These deep, well-drained to excessively drained soils are on foot slopes and uplands. The surface layer, subsoil, and underlying material are silt loam.

These soils have moderate permeability and a high available water capacity. Their organic-matter content is low to high, and their natural fertility is low to medium. Runoff is medium to very rapid.

Water erosion is the principal hazard on these soils. Streambank erosion is common in places. Some areas are vegetated, however, and most areas of Gullied land are naturally stabilized.

These soils can be used for limited grazing. They also are well suited for use as recreational areas. They provide both food and cover for upland game. Some areas provide sites for flood detention and grade control structures that impound water.

CAPABILITY UNIT VIIe-9, DRYLAND

This unit consists only of Ida soils, 30 to 60 percent slopes. These deep, well-drained soils are on uplands. The surface layer, transitional layer, and underlying material are silt loam. The soils are moderately alkaline throughout.

Ida soils have moderate permeability and a high available water capacity. Their organic-matter content and natural fertillty are low. They absorb moisture easily and release it readily to plants.

These soils are in grass or trees. They are too steep for cultivation and are used mainly for grazing, recreation, and wildlife habitat.

CAPABILITY UNIT VIIIw-7, DRYLAND

This unit consists only of the land type Marsh. Areas of this land type are subject to frequent flooding and have water on or near the surface during most of the year. Marsh is well suited to wetland wildlife habitat and to such recreation activities as hunting.

CAPABILITY UNIT I-3, IRRIGATED

This unit consists of nearly level, somewhat poorly drained to well-drained soils on bottom lands of the Missouri River. The surface layer and subsoil are silty clay loam, and the underlying material is silty clay loam or silt loam. The surface layer is slightly acid to mildly alkaline.

These soils have a slow intake rate, slow or moderate permeability, and a high available water capacity. Runoff is medium. The organic-matter content is moderately low to high, and natural fertility is high. These soils release moisture readily to plants.

These soils are easy to work, but they form clods when tilled under excessive moisture content. They have few restrictions under irrigation. Suitable irrigation methods include border, furrow, and sprinkler systems. Some land smoothing is generally needed for satisfactory operation of furrow and border irrigation. Runoff from adjacent higher soils can be controlled by diversions and terraces on those soils.

These soils are suited to most of the irrigated crops commonly grown in Dakota County. Corn is the principal crop.

CAPABILITY UNIT I-6, IRRIGATED

This unit consists of nearly level, deep, moderately well-drained and somewhat poorly drained soils on bottom lands of the Missouri River Valley. The surface layer is silt loam. The underlying material is silt loam, but in some soils it is silty clay. The surface layer is slightly acid to moderately alkaline.

These soils have a moderate intake rate. Permeability is moderate. It is slow in the lower part of the underlying material of some soils. The available water capacity is high. Runoff is slow to medium. These soils release moisture readily to plants. Their organic-matter content is moderately low to high, and their natural fertility is low to high.

These soils are suited to all crops generally grown in the county, but corn and alfalfa are the main crops. They have few restrictions under irrigation. Fertility can be maintained by returning crop residue to the soil and by applying commercial fertilizer and barnyard manure. Insects and plant diseases need to be controlled. Flooding from adjacent areas can be controlled by diversions that keep floodwaters from crossing these soils and by grassed waterways. Land leveling provides even distribution of irrigation water, allows uniform drainage, and reduces the hazard of waterlogging in the lower areas. It commonly is needed for border and furrow irrigation. Sprinkler irrigation is also suited to these soils.

CAPABILITY UNIT IIs-6, IRRIGATTED

The only soil in this unit is Grable very fine sandy loam, 0 to 2 percent slopes. This is a nearly level or slightly undulating, deep, well-drained soil on bottom lands of the Missouri River Valley. It is very fine sandy loam to a depth of 24 inches. Beneath this, to a depth of 60 inches, it is fine sand. The surface layer is mildly alkaline.

The soil in this unit has moderate permeability in the very fine sandy loam and rapid permeability in the underlying fine sand. The available water capacity is moderate. The organic-matter content is moderately low, and natural fertility is low. Moisture is released readily to plants. The water intake rate is moderate.

This soil is easy to work because it has good tilth. Because of the low moisture retention in the underlying fine sand, crops show the effects of drought if irrigation is not timely. Soil blowing is a hazard if the surface is not protected. The organic-matter content should be improved. Plant nutrients can be leached easily from this soil.

This soil is suited to all the irrigated crops commonly grown in the county. Applications of water should be light and frequent because the water moves rapidly through the underlying fine sand. Retaining all crop residue on the surface helps to control soil blowing and improves the organic-matter content. Fertilizer can be applied several times during the season to replace nutrients lost by leaching. Land leveling is commonly needed for efficient use of border or furrow irrigation. Sprinkler irrigation is efficient where it is suited to the soil because applications of water can be carefully regulated.

CAPABILITY UNIT IIs-8, IRRIGATED

The only soil in this unit is Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes. This deep, moderately well drained to somewhat poorly drained soil is on bottom lands of the Missouri River Valley. The underlying material is very fine sandy loam in the upper part, silty clay in the middle part, and silt loam or very fine sandy loam in the lower part. This soil is moderately alkaline throughout.

This soil has a rapid water intake rate. Permeability is moderately rapid in the upper part, slow to very slow in the middle part, and moderate in the lower part. The organic-matter content is moderately low, and the natural fertility is low. Runoff is slow. This soil is easy to work. It absorbs moisture easily and releases it readily to plants. The clayey layer in the underlying material restricts somewhat the movement of water and plant nutrients from the soil. This layer is deep enough and permeable enough so that water does not pond on the surface.

This soil is suited to most of the crops commonly grown in the county. Land leveling is needed for efficient use of border irrigation. Retaining all crop residue on the surface and applying fertilizer help to maintain fertility.

CAPABILITY UNIT IIw-1, IRRIGATED

This unit consists of nearly level, deep, moderately well drained and somewhat poorly drained soils on bottom lands of the Missouri River. The surface layer is silty clay. The subsoil or upper part of the underlying material is silty clay. At a depth of 15 to 30 inches, this layer grades to silt loam in most places, but in a few places it grades to sand. The surface layer is neutral to moderately alkaline.

These soils have a very slow intake rate. Permeability ranges from very slow to rapid depending on the texture of the underlying material. Most soils have a high available water capacity, but some soils have a low available water capacity. They release moisture slowly to plants. Runoff is slow, and the soils are subject to ponding. The organic-matter content is moderate to high, and natural fertility is low to medium.

These soils are sticky when wet and very hard when dry. They are difficult to till, and it is important to cultivate them at the proper moisture content to prevent clodding and excessive compaction, which reduce the absorption rate. Wetness can result in delayed planting, uneven germination, and poor stands. During periods of dry weather, the soils crack considerably upon drying, and damage to plant roots can be extensive. The wide cracks also lengthen the time needed for water to flow to the end of the row in furrow type irrigation.

Care should be taken to prevent drying of the soils. Excessive irrigation tends to cause the soils to be waterlogged, and this can result in a loss of nitrogen.

The principal concerns of management are poor surface drainage and restricted movement of air and water. Returning crop residue to the soil and applying fertilizer help to maintain fertility. These soils are suited to sprinkler irrigation, but improvement of surface drainage is needed to keep the crops from dying in the low areas. Land leveling is needed for the furrow and border systems.

These soils are suited to most of the crops commonly grown in the county. They are also suited to grass for irrigated pasture. Corn is the principal crop. Alfalfa tends to increase the movement of water throughout because the roots tend to open the claypan layer. Insects and plant diseases also need to be controlled.

CAPABILITY UNIT IIw-2, IRRIGATED

The only soil in this unit is Forney silt loam, overwash, 0 to 2 percent slopes. This deep, poorly drained soil is on bottom lands in the Missouri River Valley. The underlying material is silty clay loam in the upper part and grades to silty clay in the lower part. Depth to the clayey layer ranges from 15 to 30 inches. The surface layer is mildly alkaline.

This soil has a slow water intake rate. Permeability is moderate in the upper part and very slow in the lower part. Available water capacity is high. The organic-matter content is moderate, and natural fertility is medium. Runoff is slow. This soil absorbs moisture easily until the surface layer becomes saturated. Moisture is released readily to plants. The clayey layer is beneficial in restricting the downward movement of moisture, but excessive application of water can result in ponding on the surface.

This soil is easy to work. It has only a few restrictions under irrigation. In some years, wetness in the spring delays preparation of the seedbed and planting of early crops.

This soil was occasionally flooded in past years, but in recent years flooding has not been serious. Land leveling to produce smooth fields and diversions to remove excess run-in water also help in reducing the flood hazard.

This soil is better suited to corn and grass for hay or pasture than to most other crops. Returning crop residue to the soil and applying fertilizer help to maintain fertility. Furrow, border, and sprinkler irrigation are suited to this soil.

CAPABILITY UNIT IIw-3, IRRIGATED

The only soil in this unit is Calco silty clay loam, 0 to 2 percent slopes. This deep, poorly drained soil is on bottom lands. The underlying material is silty clay loam. The surface layer is moderately alkaline.

This soil has a slow water intake rate, moderately slow permeability, and a high available water capacity. The organic-matter content and natural fertility are high. Runoff is slow. This soil absorbs moisture easily and releases it readily to plants.

This soil is easy to work but will clod if worked when wet. The principal hazard is wetness caused by a high water table and occasional flooding. The high water table commonly results in delayed planting and slow germination. This soil is naturally subirrigated.

This soil is suited to irrigated corn and irrigated pasture. It can be irrigated by either gravity flow or sprinkler methods. A drainage system that lowers the water table can help to improve the efficiency of irrigation. Tile drains or a ditch drainage system can be used to improve the drainage. Suitable outlets are necessary. Diversions can prevent flooding by runoff received from higher fields.

CAPABILITY UNIT IIw-4, IRRIGATED

The only soil in this unit is Calco silt loam, overwash, 0 to 2 percent slopes. This deep, poorly drained soil is on bottom lands and along drainageways of low gradient in the uplands. The underlying material is silty clay loam. The surface layer is moderately alkaline.

This soil has moderate water intake rate and moderately slow permeability. The available water capacity is high. The organic-matter content is moderate, and natural fertility is high. Runoff is slow. This soil absorbs moisture easily and releases it readily to plants.

This soil is easy to work. The principal hazards are wetness caused by a moderately high water table and occasional flooding and siltation.

Cultivation of this soil is difficult because of the excessive wetness. In most years, wetness in spring delays preparation of the seedbed and planting of early crops. Where suitable outlets are available, drainage systems can be used to lower the water table. Land leveling is not always practical because the result can be flooding and siltation on the leveled areas. In some places, the flood hazard can be reduced by diversions that prevent runoff water from crossing this soil. Smoothing and releveling are generally needed after the soil has been flooded.

Most areas of this soil are presently in grass. Irrigated pasture is one of the best uses, but corn and soybeans are also suited if the water table is lowered.

CAPABILITY UNIT IIw-6, IRRIGATED

The only soil in this unit is Kennebec silt loam, overwash, 0 to 2 percent slopes. This deep, moderately well drained soil is on bottom lands. The underlying material is silt loam. The surface layer is mildly alkaline.

This soil has moderate intake rate, moderate permeability, and a high available water capacity. The organic-matter content is moderate, and natural fertility is high. Runoff is slow, but ponding on the surface is not a problem. The soil absorbs moisture easily and releases it readily to plants.

This soil is easy to work. The principal concerns of management for irrigation are occasional flooding and siltation. Some leveled areas need to be releveled after flood waters deposit silt. Most fields are dissected by deeply entrenched drainageways, and these can present problems for design layouts of large irrigation systems. Planting of early spring crops is sometimes delayed because of wetness. Land leveling for furrow and border irrigation can help reduce wetness. Sprinkler irrigation is well suited to this soil.

This soil is well suited to corn and grass and is also suited to other common irrigated crops. Fertility can be maintained by returning crop residue to the soil and by adding commercial fertilizer. Keeping residue on the surface helps prevent soil blowing.

CAPABILITY UNIT IIIe-3, IRRIGATED

This unit consists of gently sloping, deep, well-drained soils on broad ridgetops, colluvial foot slopes, and alluvial fans. The surface layer and subsoil are silty clay loam, and the underlying material is silty clay loam or silt loam. The surface layer is slightly acid to neutral.

These soils have a slow intake rate, moderate or moderately slow permeability, and a high available water capacity. Their organic-matter content is moderate or high, and their natural fertility is medium to high. Runoff is medium.

Soils in this unit are easy to work. They respond well to additions of fertilizer. In places, lime is needed to establish stands of legumes. These soils absorb moisture easily and release it readily to plants. Some areas receive additional moisture as runoff from adjacent sloping areas.

Controlling erosion is not a serious concern on these soils. In places, however, ditches form in natural waterways where water from adjacent land flows across the soils.

Soils in this unit have few restrictions under irrigation, though many fields are small in size and irregular in shape. Either furrow, border, or sprinkler irrigation is suitable. Land leveling is needed for furrow and border irrigation.

Where these soils are irrigated by the furrow method, bench leveling is a good way to control the furrow grade and thus control soil erosion in the furrow. Contour furrows in combination with terraces can also be used to irrigate row crops. Where soils are irrigated by sprinklers, erosion can be controlled by terraces, contour farming, and grassed waterways. Returning crop residue to the soil, keeping tillage to a minimum, and applying fertilizer are ways to control erosion and maintain fertility.

Corn and alfalfa are the main crops grown on these soils. Grasses for pasture are also well suited. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIe–6, IRRIGATED

This unit consists of gently sloping, deep, well drained and moderately well drained soils on uplands and colluvial foot slopes and on bottom lands of the Missouri River Valley. The surface layer, subsoil, and underlying material are silt loam. The surface layer is neutral to moderately alkaline.

These soils have a moderate intake rate, moderate permeability, and a high available water capacity. Their organic-matter content and natural fertility range from low to high. Runoff is medium. Some of the soils absorb moisture easily and release it readily to plants. The soils that have a low organic-matter content tend to puddle easily and do not absorb moisture so readily as the other soils in the unit.

All soils in this unit are easy to work. They are suited to border, furrow, and sprinkler irrigation. Bench leveling alters the surface of the land so that the soils have a low grade and irrigation water flows slowly. Contour furrows with or without supplemental terraces, grassed waterways, and mulch planting and minimum tillage also help to control erosion. Fertilizer will help maintain fertility. Application of irrigation water should be adjusted to the natural intake rate of the soils to offset increased runoff and thus prevent increased erosion.

The main crops are corn and alfalfa. The soils are well suited to grasses for pasture. Insects and plant diseases need to be controlled.

CAPABILITY UNIT IIIs–11, IRRIGATED

The only soil in this unit is Sarpy loamy fine sand, 0 to 6 percent slopes. This deep, excessively drained soil is on bottom lands of the Missouri River Valley. The underlying material is fine sand. This soil is mildly to moderately alkaline throughout.

This soil has a rapid water intake rate, rapid permeability, and a low available water capacity. Its organic-matter content and natural fertility are low. It is subject to severe soil blowing and lacks an abundance of the important plant nutrients, such as nitrogen and phosphorus.

Soil blowing and low moisture retention are the main concerns of management of this soil. Sprinkler irrigation is much more suitable than other methods for irrigating this soil. The water application rate of a sprinkler system can be high because the soil absorbs water so rapidly, and applications of water should be frequent because of the low moisture retention.

Corn, soybeans, alfalfa, and grass are the main crops. Mulch planting can help prevent soil blowing.

CAPABILITY UNIT IIIw–1, IRRIGATED

This unit consists of nearly level, deep, poorly drained and somewhat poorly drained soils on bottom lands of the Missouri River Valley. The surface layer generally is silty clay, but in a few areas it is silty clay loam. The subsoil and underlying material are generally silty clay, but a few soils have a layer of silt loam that occurs above a depth of 24 inches. The surface layer is neutral or moderately alkaline.

The soils have a very slow or slow rate of water intake, very slow or slow permeability, and moderate available water capacity. Runoff is slow to ponded. In places runoff water from adjoining areas ponds on the surface. In some low areas of swales, the water table is at a depth of about 5 feet. The organic-matter content is moderately low or moderate, and natural fertility is low to medium.

These soils are difficult to work and difficult to keep in good tilth. They are generally sticky when wet and very hard when dry and, as a result, should be tilled only at the proper moisture content. High levels of production are difficult to obtain on these soils, which are limited by the excess water. Wetness commonly delays cultivation in spring and restricts the growth of roots. In most areas moisture moves downward slowly. It causes the clayey part of the soils to expand, thus closing natural openings in the soils. Upon drying, these soils crack badly, and damage to plant roots can be extensive. Stream overflow is a minor concern in management. A high level of management is needed in irrigating these soils. A proper amount of water, together with the correct rate and frequency of application, is of prime importance. Drainage can be provided in places.

CAPABILITY UNIT IVe–3, IRRIGATED

This unit consists of deep, moderately sloping, well-drained soils on uplands. The surface layer and subsoil are silty clay loam. The underlying material is silt loam. The surface layer is slightly acid. Many areas are eroded.

These soils have moderately slow permeability and a high available water capacity. Their organic-matter content is moderate to low, and their natural fertility is medium to low. Runoff is medium. These soils absorb moisture easily and release it readily to plants. The intake rate is slow, and the rate is slightly less where the soils are eroded.

Soils of this unit tend to become cloddy if tilled when wet. Water erosion is the principal hazard. In places, lime may be needed for establishing legumes, such as clover or alfalfa. Sprinkler irrigation is better than most other systems for these soils. Erosion is difficult to control where other methods are used, and the cost of land preparation is high.

Because of the extreme hazard of erosion, the crops suited to irrigation on these soils are close-sown crops, such as small grains, alfalfa, and grass. Terraces and grassed waterways can help control erosion.

CAPABILITY UNIT IVe-6, IRRIGATED

This unit consists of deep, moderately sloping, well-drained soils on uplands. The surface layer, subsoil, and underlying material are silt loam. The surface layer is mildly alkaline to moderately alkaline. Some areas are eroded.

These soils have a moderate rate of water intake, moderate permeability, and a high available water capacity. Their organic-matter content is low to high in the uneroded areas and low in eroded areas. Runoff is medium. These soils absorb moisture easily and release it readily to plants. They generally have a moderate intake rate, but this is somewhat lower in the eroded areas. A few of the soils tend to puddle, and this reduces the intake rate.

Most soils in this unit are easy to work. Water erosion is the principal hazard. The only irrigation method that is suited to these soils is the sprinkler system. Water should be applied at a low rate so that it infiltrates the soils and does not become the source of runoff and erosion.

These soils are suited to close-sown crops, such as small grains, alfalfa, and grass. Because of the extreme hazard of erosion, they are not suited to row crops. Terraces and grassed waterways help control erosion.

CAPABILITY UNIT IVs-1, IRRIGATED

The only soil in this unit is Sarpy silty clay, overwash, 0 to 2 percent slopes. This deep, excessively drained soil is on bottom lands of the Missouri River Valley. The surface layer is thin silty clay. The underlying material is fine sand. This soil is moderately alkaline throughout.

This soil has a slow water intake rate and permeability is rapid in the coarse underlying material. The available water capacity, organic-matter content, and natural fertility are low. Some areas are subject to ponding.

The slow intake rate and the low moisture retention of this soil are the main concerns of management. The sprinkler system is better for irrigating this soil than other methods. Land leveling, which is needed for furrow and border irrigation, could expose the sandy underlying material in some areas.

This soil is suited to the crops commonly grown in the county, especially corn and alfalfa. Applications of irrigation water should be rather frequent and light to maintain an adequate supply of moisture in the soil. Additions of commercial fertilizer and barnyard manure increase and help maintain fertility in this soil.

CAPABILITY UNIT IVs-12, IRRIGATED

The only soil in this unit is Sarpy fine sand, 2 to 11 percent slopes. This deep, excessively drained soil is on bottom lands of the Missouri River Valley. The underlying material is fine sand.

This soil has a very rapid water intake rate, rapid permeability, and a low available water capacity. Its organic-matter content and natural fertility are low. It is subject to severe blowing and is lacking in some important plant nutrients.

Soil blowing and low moisture retention are the main concerns of management of this soil. The only suitable irrigation method is the sprinkler system. Soil blowing can be controlled by using maximum amounts of crop residue as a surface mulch. Adequate fertilizer will help to insure production of enough crop residue to control the blowing and to improve fertility. Detailed soil tests should be made to determine the kind and amount of minor fertility elements that are needed.

Corn and alfalfa are better suited to this soil than most other crops. Close-sown crops, such as small grains and grass, are other crops that can be used. Crops that produce little residue, such as soybeans, are not suited to this soil.

Predicted yields

The predicted acre yields for the principal crops grown on soils of Dakota County are given in table 2. These predictions are based on average yields for seeded acres during the most recent 5-year period. They do not represent anticipated yields that might be obtainable in the future under a new and possilby different technology.

Yields for various crops were derived from information obtained from interviews with farmers, representatives of the Soil Conservation Service and Agricultural Extension Service, and others familiar with the soils and farming in the county. Yield information from the Agriculture Stabilization and Conservation Service and research data from Agricultural Experiment Stations were also used. Yield records, trends, research, and experience were taken into consideration.

Crop yields are influenced by many factors. Some of the most influential soil features are depth, texture, slope, and drainage. Also important are erosion, available water capacity, permeability, and fertility. Management practices such as the cropping pattern, timeliness of operations, plant population, and crop variety have an effect on crop yields. Weather is significant both on a day to day basis and for longer seasonal or yearly fluctuations. All of these were taken into account when preparing table 2.

Predicted yields are listed for dryland and irrigated management. These basically reflect soil differences and different responses to management practices.

A high level of management is used on most dryland farms in the county. Fertility is maintained and fertilizer or lime is applied at rates indicated by soil tests and field experiments. Crop residue is returned to the soil to improve tilth and to maintain or increase the organic-matter content. Suited varieties of seed are used, and plant populations are optimum. Weeds,

TABLE 2.—*Predicted average acre yields of principal crops under a high level of management*

[Absence of yield indicates that the crop is not suited to the soil or that it is grown only in small amounts]

Soil	Corn		Soybeans	Alfalfa (hay)	Oats	Tame Pasture
	Dryland	Irrigated	Dryland	Dryland	Dryland	Dryland
	Bu	*Bu*	*Bu*	*Tons*	*Bu*	*AUM* [1]
Albaton silty clay, 0 to 2 percent slopes	85	110	34	4.0	65	
Albaton silty clay, depressional, 0 to 1 percent slopes	75	110	25	3.5	60	
Albaton silty clay loam, 0 to 2 percent slopes	90	120	36	4.0	70	
Alluvial land						
Blake silty clay loam, 0 to 2 percent slopes	110	140	35	4.2	65	
Blencoe silty clay, 0 to 2 percent slopes	95	115	34	4.0	68	
Blyburg silt loam, 0 to 2 percent slopes	110	150	38	4.8	80	
Blyburg silt loam, 2 to 6 percent slopes	80	120	30	4.0	55	4.0
Blyburg silty clay loam, 0 to 2 percent slopes	105	140	38	4.2	75	
Blyburg silty clay, overwash, 0 to 2 percent slopes	90	115	35	3.9	65	
Calco silt loam, overwash, 0 to 2 percent slopes	85		35	4.0	45	
Calco silty clay loam, 0 to 2 percent slopes	100		40	4.0	50	
Crofton silt loam, 2 to 6 percent slopes, eroded	70		30	3.5	40	1.5
Crofton silt loam, 6 to 11 percent slopes, eroded	65			3.0	35	1.4
Crofton silt loam, 11 to 15 percent slopes						1.2
Crofton silt loam, 11 to 15 percent slopes, eroded	55			2.5	32	1.2
Crofton silt loam, 15 to 30 percent slopes						
Crofton silt loam, 15 to 30 percent slopes, eroded						
Forney silt loam, overwash, 0 to 2 percent slopes	110	135	40	4.3	75	
Forney silty clay, 0 to 2 percent slopes	70	110	28	4.5	70	
Forney soils, swales, 0 to 2 percent slopes	80	105	30			
Grable very fine sandy loam, 0 to 2 percent slopes	55	120	22	2.0	35	
Gullied land-Ida complex, 30 to 60 percent slopes						
Haynie silt loam, 0 to 2 percent slopes	100	150	35	4.2	65	
Ida silt loam, 11 to 17 percent slopes, eroded	60			2.5	36	1.5
Ida silt loam, 17 to 30 percent slopes						
Ida silt loam, 17 to 30 percent slopes, eroded						
Ida soils, 30 to 60 percent slopes						
Judson silty clay loam, 0 to 2 percent slopes	110	125	37	4.5	75	
Judson silty clay loam, 2 to 6 percent slopes	100	120	35	4.3	75	4.2
Kennebec silt loam, 0 to 2 percent slopes	110	125	40	4.3	65	
Kennebec silt loam, overwash, 0 to 2 percent slopes	100	125	35	4.0	50	
Luton silty clay, thin surface, 0 to 2 percent slopes	85	110	34	4.5	75	
Marsh						
Modale silt loam, 0 to 2 percent slopes	90	130	40	4.0	60	
Monona silt loam, 6 to 11 percent slopes	80		28	3.0	55	4.0
Monona silt loam, 11 to 17 percent slopes	68			2.0	50	2.3
Monona silt loam, 17 to 30 percent slopes						
Moody silty clay loam, 2 to 6 percent slopes	90		38	4.0	65	4.2
Moody silty clay loam, 6 to 11 percent slopes	85		30	3.3	62	4.0
Moody silty clay loam, 6 to 11 percent slopes, eroded	80		28	3.1	50	3.8
Moody-Nora silty clay loams, 11 to 15 percent slopes	78		25	3.1	50	3.8
Napier silt loam, 2 to 6 percent slopes	110	125	37	4.3	75	4.2
Napier silt loam, 6 to 11 percent slopes	90		30	4.0	62	3.0
Napier silt loam, 11 to 15 percent slopes	68			2.8	50	
Napier-Gullied land complex, 2 to 11 percent slopes						
Nora silt loam, 2 to 6 percent slopes, eroded	85		31	3.2	68	4.4
Nora silt loam, 6 to 11 percent slopes	70		28	3.0	55	3.5
Nora silt loam, 6 to 11 percent slopes, eroded	68		25	3.0	52	3.0
Nora silt loam, 11 to 15 percent slopes	65			2.8	50	2.8
Nora silt loam, 11 to 15 percent slopes, eroded	60			2.7	34	2.0
Nora silt loam, 15 to 30 percent slopes						
Omadi silt loam, 0 to 2 percent slopes	110	135	38	4.8	75	
Onawa silty clay, 0 to 2 percent slopes	85	110	35	4.2	65	
Owego silty clay, 0 to 2 percent slopes	82	105	32	4.0	60	
Percival silty clay, 0 to 2 percent slopes	65	110	25	3.0	53	
Sansarc-Nora complex, 11 to 30 percent slopes						
Sarpy fine sand, 2 to 11 percent slopes						
Sarpy loamy fine sand, 0 to 6 percent slopes	35	60	12	1.5	25	1.6
Sarpy silty clay, overwash, 0 to 2 percent slopes				2.5	60	
Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes	90		35	4.0	50	

[1] AUM is animal-unit-months, a term used to express the carrying capacity of pasture. It is the number of months during the grazing season that 1 acre will provide grazing for 1 animal unit (one cow, one horse, one mule, five hogs, or seven sheep) without damage to the pasture.

insects, and plant diseases are controlled. Under irrigation, water application is timely and in the proper amount. Water erosion and soil blowing are controlled Where needed for crop production, the soil is drained. Tillage, seeding, and cultivation practices are performed at the proper time and are adequate. The soils are protected from deterioration and used in accordance with their capacity.

Irrigation in Dakota County is used mainly to supplement natural rainfall. Many soils in the county are not irrigated. Only a small acreage of alfalfa hay, soybeans, and tame pasture is irrigated, and yield data on these crops are limited. Oats are not irrigated. Predicted yields under irrigation for these crops were omitted from table 2.

Irrigation water provides only a small or moderate increase in yield of crops grown on the fine-textured soils, such as Albaton, Forney, and Onawa soils. Increases in yields from application of irrigation water are more substantial, however, on the medium- and coarse-textured soils, such as Blyburg, Grable, Haynie, and Sarpy soils.

The table does not give any recommendations, and the yields given do not apply to specific farms or farmers. One of its best uses is to compare the productivity of one soil with that of another soil within the county.

Yields in any one year on a particular soil may vary considerably from the figures given. This can be caused by weather, sudden infestations of plant disease, insects, or other unpredictable hazards. By using long-time averages, it is possible to consider such hazards in arriving at the yield figures.

Management of the Soils for Range [3]

The acreage of range is very small in Dakota County. Generally, it is in small tracts in the Missouri River Valley that are not suitable for cultivation.

Various kinds of range produce different kinds and amounts of native grass. To properly manage range, a livestock farmer should know the different kinds of range sites on his land and the plants that can grow on each site. Management can then be used that will favor the growth of the best forage plants on each kind of land.

The interpretations for each range site in the county are in the technical guide which is on file in the local office of the Soil Conservation Service.

Management practices that maintain or improve the condition of the range are needed in all areas of range. Proper grazing use and deferred grazing are the two most important practices. Another practice that improves the range is establishing native grasses by seeding or reseeding either improved strains or wild strains. Farmers who want to reseed presently cropped land to grass can obtain technical help from the local office of the Soil Conservation Service. The kind of soil and the range site assigned to that soil determine the best seeding program. No care other than management of grazing is needed to maintain the forage composition.

[3] By PETER N. JENSEN, range conservationist, Soil Conservation Service.

Management of the Soils for Woodland and Windbreaks [4]

Native woodland in Dakota County is limited to narrow strips along the Missouri River and its tributaries and to the bluffs in the steep areas of Ida, Nora, and Napier soils and Gullied land. Much of this woodland is capable of producing commercial quantities of wood; but its value for esthetics, recreation, wildlife habitat, and watershed protection is even greater.

Eastern cottonwood, elm, hackberry, ash, willow, and other trees that tolerate wetness grow on the bottom lands. The trees in these areas have a greater potential for growth than those on the bluffs, but they have much less commercial value.

On the bluffs, the woodland is made up of bur oak, northern red oak, American basswood, black walnut, American elm, red elm, shagbark hickory, hackberry, green ash, ironwood, and Kentucky coffeetree. The understory includes Missouri gooseberry, trailing raspberry, and greenbrier.

Early settlers in Dakota County planted trees for protection, shade, and fenceposts. Through the years, landowners have continued to plant trees in windbreaks to protect their buildings and livestock. Native trees and shrubs contribute much to the natural beauty of the landscape, and they benefit wildlife by providing food and cover.

Windbreaks are needed to protect the farmsteads, livestock, and soil. They help to reduce home heating costs, control snow drifting, provide shelter for livestock, improve conditions for wildlife, and beautify the countryside (fig. 16).

Trees are not easily established in Dakota County, but observing the basic rules of tree culture can result in a high degree of tree survival. If healthy seedlings of suited species are maintained in a good condition and properly planted in a well prepared soil site, they can survive and grow well. They will require care after planting.

Management of windbreaks can be planned more effectively if soils are grouped according to those characteristics that affect the growth of trees. The soils of Dakota County have been assigned to eight windbreak suitability groups. The soils in each group are about the same in suitability for specified trees, potential productivity, and management requirements.

Table 3 gives the relative vigor and expected height, by windbreak group, of trees at 20 years of age that are suitable for windbreaks in the county. Detailed tree measurements were taken on soils of the major windbreak suitability groups.

The ratings for vigor in table 3 are based on observations of relative vigor and general condition of trees. A rating of *good* indicates that one or more of the following conditions generally apply: leaves (or needles) are normal in color and growth; small amounts of deadwood (top, branches, and twigs) may occur in the live crown; evidence of disease, insect,

[4] By JAMES W. CARR, JR., forester, Soil Conservation Service.

***Figure 16*—A young windbreak of cedar and pine designed to protect a feedlot from winter winds.**

and climatic damage is limited. A rating of *fair* indicates that one or more of the following conditions generally applies: leaves (or needles) are obviously abnormal in color and growth; substantial amounts of deadwood (top, branches, and twigs) occur within the live crown; evidence of moderate disease, insect, and climatic damage is obvious; current year's growth is obviously less than normal. A rating of *poor* indicates that one or more of the following conditions generally applies: leaves (or needles) are very abnormal in color and growth; very large amounts of deadwood (top, branches, and twigs) occur within the live crown; evi-

TABLE 3.—*Relative vigor and estimated height, by windbreak suitability group, of specified trees at 20 years of age*

[Group 6 and Group 10 are not included because the need for windbreaks on these soils is uncommon in Dakota County]

Trees	Group 1		Group 2		Group 3		Group 4		Group 5		Group 7	
	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height	Relative vigor	Average height
		Ft		*Ft*		*Ft*		*Ft*		*Ft*		*Ft*
Eastern redcedar	Good	25	Good	23	Good	23	Good	23	Good	20	Good	18
Ponderosa pine	Good	30	Poor	(1)	Good	31	Good	28	Good	25	Good	26
Green ash	Good	30	Good	29	Fair	29	Good	28	(2)	(2)	Fair	23
Hackberry	(2)	(2)	(2)	(2)	Fair	28	Good	26	(2)	(2)	Fair	17
Honeylocust	Good	38	Poor	35	Fair	31	Fair	36	(2)	(2)	Fair	17
Russian-olive	Poor	(1)	Poor	(1)	Fair	27	Fair	20	Fair	15	Fair	17
Bur oak	Good	27	(2)	(2)	(2)	(2)	Good	35	Good	20	(1)	(2)
Russian mulberry	Good	22	Fair	12	Fair	22	Fair	20	(2)	(2)	Fair	17
Eastern cottonwood	(2)	(2)	Fair	54	Fair	60	Poor	(1)	Poor	(1)	Fair	45

[1] Most of the trees are dead or dying.

[2] Sufficient data are not available.

dence of extensive disease, insect, and climatic damage is obvious; current year's growth is essentially negligible.

Conifers, such as redcedar and pine, are better suited to windbreak use than other kinds of trees. The measurements and high ratings in table 3 show that eastern redcedar and pine are the most reliable windbreak species. These trees hold their leaves through the winter, thereby giving maximum protection when it is most needed.

The table also shows that several broadleaf trees are well suited to windbreaks in Dakota County. The best broadleaf trees are green ash, honeylocust, and hackberry. Cotoneaster, lilac, and honeysuckle are the best shrubs. Eastern redcedar reach a mature height of 30 to 40 feet. Pine and broadleaf trees generally grow faster than redcedar, and they are somewhat taller at maturity.

The rate of growth in a windbreak varies widely in response to soil and moisture conditions, soil fertility, exposure, and arrangement of trees within the planting. Some trees grow faster than others. Some have an early fast growth but tend to die young. Eastern cottonwood, Siberian elm, and Russian-olive, for example, have early vigorous growth but are short lived if they spread to unwanted areas. Boxelder and mulberry commonly freeze back in severe winters, and green ash is susceptible to damage by borers.

A good windbreak should be designed for the soil in which it is to grow. Specific information on design, establishment, and care of a windbreak is available from the Soil Conservation Service and the Cooperative Extension Service in the county.

Following is a brief description of the windbreak suitability groups of Dakota County and a list of suitable trees and shrubs for windbreak planting in each group. To find the name of the soils in a group, refer to the "Guide to Mapping Units" at the back of the survey.

WINDBREAK SUITABILITY GROUP 1

This group consists of deep, nearly level to gently sloping soils on foot slopes and bottom lands. These soils range from somewhat poorly drained to well drained. The surface layer is mainly medium textured but ranges to moderately fine textured. In most soils the underlying material is stratified and ranges from medium textured to moderately fine textured, but in some soils it is fine sand or clay in the lower part. The available water capacity is moderate to high. Natural fertility ranges from low to high. These soils range from neutral to moderately alkaline in the surface layer.

These soils generally provide good sites for planting trees, and survival and growth are good. Competition for moisture from weeds and grass is the principal hazard. The following trees and shrubs are suitable for planting.

Conifers—eastern redcedar, ponderosa pine, Austrian pine, Scotch pine, eastern white pine, Colorado blue spruce, Norway spruce.
Low broadleaf trees—Russian mulberry.
Medium to tall broadleaf trees—green ash, honeylocust, hackberry, bur oak, northern red oak, black walnut, sycamore.
Shrubs—honeysuckle, cotoneaster, lilac, chokecherry, skunkbush sumac, autumn-olive, Amur maple.

WINDBREAK SUITABILITY GROUP 2

This group consists of deep, nearly level soils on bottom lands. These soils range from somewhat poorly drained to poorly drained. The surface layer is moderately fine textured or fine textured except in areas that have an overwash of medium-textured material. The underlying material is stratified and ranges widely from fine sand to clay. The available water capacity in most soils of this group is moderate to high, but it is low in some soils. Natural fertility ranges from low to high. These soils are neutral to moderately alkaline in the surface layer. They have a wetness limitation because the fine-textured soil material is slowly permeable. Water ponds on the surface following rains. In depressions and swells, a water table is at a depth of 4 to 8 feet.

These soils generally provide good sites for planting trees. Survival and growth of trees are good, if the selected trees can tolerate occasional wetness. Establishing seedlings can be a concern in wet years. These soils shrink when dry, causing cracks to appear. This allows air to enter and dry out the roots of newly established plants. The abundant and persistent herbaceous vegetation that grows on this site is a concern of management when establishing trees. The following trees and shrubs are suitable for planting.

Conifers—eastern redcedar, Scotch pine, Austrian pine, Black Hills spruce.
Low broadleaf treees—Russian mulberry, diamond willow.
Medium to tall broadleaf trees—green ash, honeylocust, white willow, golden willow, eastern cottonwood, sycamore.
Shrubs—redosier dogwood, buffaloberry, chokecherry.

WINDBREAK SUITABILITY GROUP 3

This group consists of deep, nearly level to gently sloping soils on bottom lands. They are somewhat poorly drained to excessively drained. The surface layer ranges from sandy to silty and the underlying material from sandy to clayey. Available water capacity is low to high, and soil fertility is low. These soils are mildly alkaline to moderately alkaline in the surface layer.

These soils are suited to trees if soil blowing is prevented. Cultivation generally needs to be restricted to the tree rows. Drought and competition for moisture from grass and weeds are hazards. The following trees and shrubs are suitable for planting.

Conifers—eastern redcedar, ponderosa pine, Scotch pine, Austrian pine.
Low broadleaf trees—boxelder, Russian mulberry.
Tall broadleaf trees—honeylocust, green ash, eastern cottonwood.
Shrubs—honeysuckle, autumn-olive, skunkbush sumac.

WINDBREAK SUITABILITY GROUP 4

This group consists of deep, nearly level to strongly sloping soils on colluvial foot slopes and loess uplands. These soils are well drained. The surface layer and subsoil range from medium textured to moderately fine textured. The underlying material is medium textured in the more sloping soils and medium textured to moderately fine textured in the lower areas. The available water capacity is high. These soils are commonly neutral to mildly alkaline, but some eroded areas are moderately alkaline. Natural fertility commonly ranges from medium to high, but it is low in eroded areas.

These soils generally provide good sites for planting trees, and survival and fair growth of suited species are good. Erosion, drought, and competition for moisture from weeds and grass are the principal hazards. Lack of moisture, because of rapid runoff, reduces growth of trees on the steeper slopes. The following trees and shrubs are suitable for planting.

Conifers—eastern redcedar, ponderosa pine, Austrian pine, Scotch pine.
Low broadleaf trees—Russian mulberry, Russian-olive.
Tall broadleaf trees—green ash, hackberry, honeylocust, bur oak.
Shrubs—cotoneaster, honeysuckle, lilac, chokecherry, skunkbush sumac, autumn-olive, and Amur maple.

WINDBREAK SUITABILITY GROUP 5

This group consists of deep, gently sloping to strongly sloping soils on loess uplands. These soils are well drained, and they are calcareous at or near the surface. Erosion is a hazard because of the silty texture and slopes. The surface layer, transitional layer, and underlying material are medium textured and calcareous. The available water capacity is high. Since these soils are sloping and runoff is medium to rapid, the amount of moisture retained in the soil is low. Natural fertility is low. Reaction is moderately alkaline. Many areas are eroded.

These soils generally provide fair to poor sites for planting trees. Survival is fair, but growth is poor. Lack of adequate moisture and competition for moisture from weeds and grass are the principal hazards. Erosion is a hazard where cultivation is used to control weeds. Trees that tolerate a high content of lime do well on these soils. The following trees and shrubs are suitable for planting.

Conifers—eastern redcedar, ponderosa pine, Austrian pine.
Low broadleaf trees—Russian-olive.
Tall broadleaf trees—bur oak.
Shrubs—skunkbush sumac, autumn-olive.

WINDBREAK SUITABILITY GROUP 6

Forney soils, swales, 0 to 2 percent slopes, is the only soil in this group. This soil occurs in depressional or swalelike areas on bottom lands. The surface layer ranges from moderately fine textured to fine textured, and the underlying material is fine textured. Sand occurs within a depth of 40 inches in places. The available water capacity is high, and natural fertility is medium. This soil is moderately alkaline throughout. Plant growth is limited by the excessive wetness. Water ponds on the surface; the water table is generally within a depth of 6 feet. The soil is also subject to flooding.

This soil provides a fair site for planting trees. Survival and growth are good if the trees selected can tolerate wetness and occasional flooding. Establishment can be a concern during wet years. The abundant and persistent herbaceous and grass vegetation that grows on this site is a concern of management when establishing trees. The following trees and shrubs are suitable for planting.

Low broadleaf trees—diamond willow.
Tall broadleaf trees—eastern cottonwood, golden willow, white willow.
Shrubs—redosier dogwood, purple willow.

WINDBREAK SUITABILITY GROUP 7

Sarpy fine sand, 2 to 11 percent slopes, is the only soil in this group. This soil is deep, excessively drained, very gently sloping to moderately sloping, and on bottom lands. The surface layer and underlying material are coarse textured. This soil is moderately alkaline and calcareous. The available water capacity and natural fertility are low. Nearly all areas are hummocky or have a low, dunelike topography. There is considerable soil blowing and drifting of sand.

This soil provides poor sites for planting trees. Survival is poor, but growth is fair. After establishment, the roots of trees can penetrate into the lower layer where there is more moisture. Landshaping and mulching to reduce soil blowing are essential in establishing trees on this site. The following trees are suitable for planting.

Conifers—eastern redcedar, ponderosa pine, Scotch pine, Austrian pine.

WINDBREAK SUITABILITY GROUP 10

This group consists of soils and land types that have a wide range of characteristics. They are either excessively wet, frequently flooded, gullied, steep or very steep, shallow, or clayey. All of these characteristics make them unsuited to windbreak plantings.

The soils of this group are generally not suited to windbreak plantings of any kind, because their qualities and characteristics are unfavorable. In some areas, tolerant trees or shrubs can be planted for recreation and wildlife use or to establish a forest cover, but hand planting or other special practices are necessary.

Selection of Plants for Environmental Plantings [5]

Many plants are grown to provide attractive and satisfying places in which to live, work, and play. Trees, grasses, shrubs, or other plants are used to control erosion, reduce sediment, provide shade along streets and in parks, beautify lawns and homes, provide privacy, or reduce noise. They are also used for landscaping around factories, apartment houses, and school buildings.

In table 4, the soils of Dakota County are grouped according to the soil features or properties that limit the adaptation and use of a plant. The table is a general guide, and it suggests kinds of plants that are suitable for environmental plantings for the soil groups.

Color of foliage, flowering and fruiting characteristics, growth habits, and susceptibility to disease have

[5] By JAMES W. CARR, JR., forester, and ERVIN O. PETERSON, conservation agronomist, Soil Conservation Service.

TABLE 4.—*Environmental*

Soil groups, soil series, and map symbols	Trees suitable for—			Trees and shrubs suitable for—
	Shade	Ornamentals	Street borders	Critical areas
Group I. Soils that have no limitations. Plants should be climatically suited. Blyberg: Bc, BcC, Bd, Be Crofton: CfC2, CfD2, CfE, CfE2, CfF, CfF2 Grable: Gb Haynie: He Ida: IdE2, IdF, IdF2 Judson: Ju, JuC Kennebec: Ke, Ko Modale: Mk Monona: MnD, MnE, MnF Moody: MoC, MoD, MoD2, MpE Napier: NaC, NaD, NaE Nora: NoC2, NoD, NoD2, NoE, NoE2, NoF Omadi: Om Sarpy: ScC, So Waubonsie: Wu	Sugar maple, scarlet oak, silver maple, northern red oak, white oak, bur oak, hackberry, green ash, sycamore, American basswood, and black walnut.	Mountainash, paper birch, pin oak, Kentucky coffee-tree, ginkgo, golden-rain-tree, Austrian pine, eastern white pine, Scotch pine, blue spruce, Norway spruce, magnolia, flowering crabapple, American basswood, black cherry, concolor fir, and redbud.	Pin oak, thornless honeylocust, pyramidal linden, Norway maple, ironwood, little-leaf linden, and hackberry.	Roughleaf dogwood, smooth sumac, autumn-olive, Arnot bristly locust, periwinkle, winter-creeper euonymus, dwarf polygonum, and spreading juniper.
Group II. Soils that limit the choice of plants because runoff is rapid or very rapid. Ida: IeG	Bur oak, northern red oak, and scarlet oak.	Austrian pine, Scotch pine, juniper, green ash, and Russian-olive.	Thornless honey-locust, hackberry, green ash, and ironwood.	Smooth sumac, roughleaf dogwood, autumn-olive, Arnot bristly locust, and spreading juniper.
Group III. Soils that limit the choice of plants because they are sandy, droughty, and low in fertility. Sarpy: SbD	Silver maple, eastern cottonwood, sycamore, and scarlet oak.	Austrian pine, Scotch pine, ponderosa pine, and eastern white pine.	Thornless honeylocust and hackberry.	Autumn-olive, Arnot bristly locust, and spreading juniper.
Group IV. Soils that limit the choice of plants because they are wet. Albaton: Aa, Ab Blencoe: Bb Calco: Ca, Cb Forney: Fn, Fo, Fs Luton: Lu Onawa: On Owego: Ow Percival: Pe	Eastern cottonwood, green ash, hackberry, sycamore, American basswood, silver maple, red maple, swamp white oak, weeping willow, and black walnut.	Pin oak, paper birch, catalpa, mountain-ash, Scotch pine, Black Hills spruce, Kentucky coffee-tree, eastern hemlock, Austrian pine, and baldcypress.	Thornless honeylocust, littleleaf linden, pyramidal linden, and pin oak.	Redosier dogwood, roughleaf dogwood, autumn-olive, choke-cherry, and American plum.
Group V. Soils that severely limit the choice of plants. Onsite investigation is needed. Albaton: Ac Alluvial land: Ad Gullied land: GuG Marsh: Mh Napier: NgD Sansarc: SaF	----------	----------	----------	----------

been considered in table 4. For example, the American elm is suited to many different soils and was formerly used extensively as a shade tree. It is not listed in table 4, because it is susceptible to Dutch elm disease. Many horticultural varieties of plants that are also well suited to the climate of Dakota County are not included in the table. Information about suited horticultural varieties is generally available from local nurserymen.

Growth habits, shade tolerance, erosion control, and esthetic features determine the suitability and use of plants for various purposes and locations. Most plant-

planting guide

Trees and shrubs suitable for—Continued			Grasses suitable for—		
Wildlife food and cover	Hedges	Screens	Lawns	Roadsides and steep banks	Recreation areas
Autumn-olive, honeysuckle, American bittersweet, American cranberrybush, crabapple, winterberry euonymus, Washington hawthorn, Amur maple, skunkbush sumac, eastern redcedar, chokecherry, and snowberry.	Honeysuckle, cotoneaster, lilac, winged euonymus, privet, eastern hemlock, and viburnum.	Eastern redcedar, autumn-olive, honeysuckle, lilac, Austrian pine, Scotch pine, ponderosa pine, eastern white pine, Norway spruce, Amur maple, eastern hemlock, upright juniper, Oriental arborvitae, and Lombardy poplar.	Kentucky bluegrass, and perennial ryegrass.	Little bluestem, big bluestem, switchgrass, side-oats, grama, blue grama, bromegrass, perennial ryegrass, and crownvetch (legume).	Blue grama, buffalograss, tall fescue, Kentucky bluegrass, creeping red fescue, and perennial ryegrass.
Autumn-olive, crabapple, skunkbush, sumac, eastern redcedar, American plum, and Russian-olive.	Honeysuckle, cotoneaster, lilac, autumn-olive, Siberian peashrub, and Amur maple.	Eastern redcedar, autumn-olive, Austrian pine, ponderosa pine, upright juniper, and Russian-olive.	Blue grama, buffalograss, and Kentucky bluegrass.	Little bluestem, big bluestem, switchgrass, and crownvetch (legume).	Blue grama, buffalograss, and side-oats grama.
Austrian pine, Scotch pine, ponderosa pine, eastern white pine, American plum, eastern redcedar, and autumn-olive.	Lilac and cotoneaster.	Eastern redcedar, Rocky Mountain juniper, Austrian pine, ponderosa pine, Scotch pine, eastern white pine, and chokecherry.	Blue grama	Little bluestem, big bluestem, and switchgrass.	Blue grama, western wheatgrass, and tall fescue.
Redosier dogwood, autumn-olive, eastern redcedar, Oriental arborvitae, Scotch pine, buffaloberry, American elderberry, Virginia creeper, and Austrian pine.	Redosier dogwood, Amur maple, autumn-olive, and honeysuckle.	Eastern redcedar, Scotch pine, Austrian pine, autumn-olive, Lombardy poplar, Oriental arborvitae, buffaloberry, and Bolleana poplar.	Kentucky bluegrass	Reed canarygrass, and switchgrass.	Tall fescue.
----------	----------	----------	----------	Switchgrass and western wheatgrass.	Tall fescue and western wheatgrass.

ings can accomplish more than one useful purpose if suitable plants are selected. For example, some plants that have colorful foliage or fruit can be as useful for wildlife food and cover as they are for hedges, screens, erosion control, or beautification of the landscape.

Management of the Soils for Wildlife [6]

Wildlife populations are determined largely by the quality and quantity of vegetation which the land is capable of producing. Cover, food, and water, in

[6] By ROBERT O. KOERNER, biologist, Soil Conservation Service.

proper combination, are the three essential elements to wildlife abundance.

Topography plays a major role in determining wildlife numbers as do soil characteristics, such as fertility. Fertile soils produce more and better quality wildlife, both game and nongame species. The game species are primarily discussed here, although nongame species are becoming increasingly important. Improving the living conditions for the game species also benefits nongame species.

An appreciation of the natural environment by persons other than hunters and fishermen now has greater importance. This helps people to understand the relationship between plants, animals, and men and how all are dependent upon the soil.

In many cases, the soils rated highest for wildlife potential do not have the highest wildlife populations. This is not caused by the inability of soils to produce wildlife, but rather by many other factors such as hunting pressure, clean tillage, and improved harvesting methods. The potential still remains, and wildlife values can be enhanced with little cost and effort. Wildlife has a place in both rural and urban settings and needs to be considered when planning for optimum use of these areas.

Fish ponds that fill by runoff from fertile fields generally produce more pounds of fish than average because of the increased food production. Zooplankton and phytoplankton are microscopic animals and plants produced in fertile ponds. They provide food for larger aquatic animals such as frogs which, in turn, are used as food by fish.

Steep slopes and rough, irregular topography present hazards to livestock and are poorly suited to crops. In these areas, the natural undisturbed landscape can become escape cover for wildlife and provide a source of food. In many places where vegetation is lacking, it can be developed by planting flowering and fruiting trees and shrubs. Fencing to exclude livestock is an excellent way to encourage herbaceous and woody plant growth for wildlife winter cover.

Wetness, permeability, and the available water capacity are important soil characteristics to consider when selecting pond sites for wildlife and recreation.

In table 5, the principal soil associations, as shown on the general soil map, are evaluated for seven elements of wildlife habitat and for three kinds of wildlife. The habitat elements are grain and seed crops, domestic grasses and legumes, wild herbaceous plants, hardwood trees and shrubs, coniferous plants, wetland food and cover, and shallow water areas.

The three broad classes of wildlife in table 5 are defined as follows.

Openland wildlife.—Birds and mammals of cropland, pastures, meadows, lawns, and areas overgrown with grasses, herbs, shrubs, and vines. Examples are bobwhite quail, pheasant, mourning dove, meadowlark, killdeer, cottontail rabbit, and red fox.

Woodland wildlife.—Birds and mammals of wooded areas that contain either hardwood or coniferous trees and shrubs, or a mixture of both. Examples are wild turkey, ruffed grouse, thrushes, vireos, woodpecker, squirrel, gray fox, raccoon, and white-tailed deer.

Wetland wildlife.—Birds and mammals of swampy, marshy, or open water areas. Examples are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Kinds of wildlife by soil associations

In the Nora-Crofton-Moody association the soils have long, smooth slopes that are gently sloping to steep. Scattered trees and shrubs are in the lower parts of drainageways. Pheasant and bobwhite quail populations are low to moderate with approximately 10 to 100 birds per section. Deer and cottontail rabbits are scarce because of a lack of sufficient woody cover. Most of the soils are cultivated; there are very few idle or nonfarmed areas. The lack of winter cover is a limiting factor for wildlife.

The Moody-Judson-Crofton association has soils that are gently sloping to moderately sloping. There are a few scattered trees in draws and along fencerows. Nearly all the soils are cultivated. Some farmstead shelterbelts provide cover for wildlife. Pheasant population is moderate in this association with approximately 50 to 200 birds per section. There are also jackrabbits and cottontails. Deer are scarce. Bobwhite quail populations are low because of a lack of winter cover.

The Crofton-Nora-Napier association has moderately sloping to steep topography. Sizable blocks of deciduous trees such as bur oak, walnut, elm, ash, boxelder, and honeylocust are on many east-facing slopes. Drainageways and fencerows commonly have trees and shrubs. Also there are many odd areas that are not cultivated. This means better habitat for pheasant, quail, and rabbit. More deer are in this association because they move from the Missouri River Valley into cornfields to feed. Foxsquirrel, fox, and coyote are also in this association. Springs in this association supply water for wildlife. Clumps of native plum are along roadside ditches making escape cover and food for pheasants, bobwhite quail, and other kinds of wildlife.

In the Omadi-Kennebec-Napier association are many long, wooded drainageways where silt washed from the uplands. The soils are suited to a wide variety of cover types and kinds of wildlife. All species of wildlife in this county use this association for food, water, or cover. Ash, willow, wildrose bushes, and many other herbaceous and woody plants are here. Any plants not growing naturally could be introduced if desired.

The Forney association is a unique area of poorly drained, nearly level, silty soils that are low in relative elevation. This association has only limited wildlife value because of a lack of adequate winter cover. It has some value to migrating waterfowl during seasons when the soils are ponded.

The Blyburg-Blencoe-Luton association is located on high bottom lands of the Missouri River Valley. It has value for providing food and cover for the wildlife that frequent the Haynie-Albaton-Onawa association that is adjacent to the Missouri River. The number of deer, as well as pheasants, squirrel, and bobwhite quail, is high where winter cover is available.

TABLE 5.—*Suitability of soils, by soil association, for wildlife habitat*

Soil association and soil series	Elements of wildlife habitat: Grain and seed crops	Domestic grasses and legumes	Wild herbaceous plants	Hardwood trees and shrubs	Coniferous plants	Wetland food and cover	Shallow-water areas	Habitat for—: Openland wildlife	Woodland wildlife	Wetland wildlife
Association 1:										
Nora	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Crofton	Fair	Good	Fair	Fair	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Moody	Good to fair.	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Association 2:										
Moody	Good to fair.	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Judson	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Crofton	Fair	Good	Fair	Fair	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Association 3:										
Crofton	Fair	Good	Fair	Fair	Good	Very poor.	Very poor.	Fair	Fair	Very poor.
Nora	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Napier	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Association 4:										
Omadi	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Kennebec	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Napier	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Association 5:										
Forney	Fair to poor.	Fair	Fair	Fair	Fair	Fair	Good	Fair	Fair	Fair.
Association 6:										
Blyburg	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Blencoe	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
Luton	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Fair.
Association 7:										
Haynie	Good	Good	Good	Good	Fair	Poor	Poor	Good	Fair	Poor.
Albaton	Fair	Fair	Good	Fair	Fair	Fair	Fair	Good	Fair	Fair.
Onawa	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Association 8:										
Ida (where slopes are 5 to 17 percent)	Fair	Fair	Fair	Fair	Good	Very poor:	Very poor.	Fair	Fair	Very poor.
Ida (where slopes are more than 17 percent)	Very poor.	Poor	Poor	Poor	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Monona	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

In the Haynie-Albaton-Onawa association are scattered areas of marsh useful for waterfowl. Duck hunting, fishing, and hiking are common in this association. Sauger, catfish, and carp are caught from the Missouri River. Hawks, owls, and other raptors are common as well as many kinds of shorebirds.

The Ida-Monona association has a good cover of trees on the steep and very steep bluffs. It offers excellent habitat for deer, squirrel, cottontail rabbit, and bobwhite quail.

In all of the associations mourning dove populations are high. Winter cover is the principal limiting factor. Wildlife habitat and wildlife populations can be increased by keeping livestock out of wooded drainageways and by leaving odd corners and fencerows in fields.

Engineering Uses of the Soils [7]

This section is useful to those who need information about soils used as structural material or as foundation upon which structures are built. Among those who can benefit from this section are planning commissions, town and city managers, land developers, engineers, contractors, and farmers.

Among properties of soils highly important in engineering are permeability, strength, compaction characteristics, soil drainage condition, shrink-swell potential, grain size, plasticity, and soil reaction. Also important are depth to the water table, depth to bedrock, and soil slope. These properties, in various degrees and combinations, affect construction and maintenance of roads, airports, pipelines, foundations for small buildings, irrigation systems, ponds and small dams, and systems for disposal of sewage and refuse.

Information in this section of the soil survey can be helpful to those who—

1. Select potential residential, industrial, commercial, and recreational areas.
2. Evaluate alternate routes for roads, highways, pipelines, and underground cables.
3. Seek sources of gravel, sand, or clay.
4. Plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for controlling water and conserving soil.
5. Correlate performance of structures already built with properties of the kinds of soil on which they are built, for the purpose of predicting performance of structures on the same or similar kinds of soil in other locations.
6. Predict the trafficability of soils for cross-country movement of vehicles and construction equipment.
7. Develop preliminary estimates pertinent to construction in a particular area.

Most of the information in this section is presented in tables 6, 7, and 8, which show, respectively, results of engineering laboratory tests on soil samples; several estimated soil properties significant in engineering; and interpretations for various engineering uses.

This information, along with the soil map and other parts of the publication, can be used to make interpretations in addition to those given in tables 7 and 8, and it can be used to make other useful maps.

This information, however, is not adequate for engineering design and does not eliminate need for further investigations at sites selected for engineering works, especially works that involve heavy loads or that require excavations to depths greater than those shown in the tables, generally depths greater than 6 feet. Also, inspection of sites, especially the small ones, is needed because many delineated areas of a given soil mapping unit may contain small areas of other kinds of soil that have strongly contrasting properties and different suitabilities or limitations for soil engineering.

Some of the terms used in this soil survey have special meaning to soil scientists. The Glossary defines many of these terms commonly used in soil science.

Engineering soil classification systems

The two systems most commonly used in classifying samples of soils for engineering are the Unified system (*10*) used by the SCS engineers, Department of Defense, and others, and the AASHO system (*1*) adopted by the American Association of State Highway Officials.

The Unified system is used to classify soils according to engineering uses for building material or for the support of structures other than highways. Soils are classified according to particle-size distribution, plasticity index, liquid limit, and content of organic matter. Soils are grouped into 15 classes. There are eight classes of coarse-grained soils that are subdivided on the basis of gravel and sand content. These are identified as GW, GP, GM, GC, SW, SP, SM, and SC. Six classes of fine-grained soils are subdivided on the basis of the plasticity index. Nonplastic classes are ML, MH, OL, and OH; plastic classes are CL and CH. There is one class of highly organic soils, Pt. Soils on the borderline between two classes are designated by symbols for both classes; for example, CL-ML.

The AASHO system is used to classify soils according to those properties that affect use in highway construction and maintenance. In this system, a soil is placed in one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. In group A–1 are gravelly soils of high bearing strength, or the best soils for subgrade (foundation). At the other extreme, in group A–7, are clay soils that have low strength when wet and that are the poorest soils for subgrade. Where laboratory data are available to justify a further breakdown, the A–1, A–2, and A–7 groups are divided as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As additional refinement, the engineering value of a soil material can be indicated by a group index number. Group indexes range from 0 for the best material to 20 or more for the poorest. The AASHO classification for tested soils, with group index numbers in parentheses, is shown in table 6; the estimated classification, without group index numbers, is given in table 7 for all soils mapped in the survey area.

Soil test data

Table 6 contains engineering test data for some of the major soil series in Dakota County. These tests were made to help evaluate the soils for engineering purposes. The engineering classifications given are based on data obtained by mechanical analyses and by tests to determine liquid limits and plastic limits. The mechanical analyses were made by combined sieve and hydrometer methods.

Liquid limit and plasticity index indicate the effect of water on the strength and consistence of soil material. As the moisture content of a clayey soil, from which the particles coarser than 0.42 millimeter have

[7] SYDNEY H. HAAKENSTAD, engineer, Soil Conservation Service, assisted in the preparation of this section.

been removed, is increased from a dry state, the material changes from a semisolid to a plastic state. If the moisture content is further increased, the material changes from a plastic to a liquid state. The plastic limit is the moisture content at which the soil material changes from the semisolid to plastic state; and the liquid limit, from a plastic to a liquid state. The plasticity index is the numerical difference between the liquid limit and the plastic limit. It indicates the range of moisture content within which a soil material is plastic. Liquid limit and plasticity index are estimated in table 7, but in table 6 the data on liquid limit and plasticity index are based on tests of soil samples.

Soil properties significant in engineering

Several estimated soil properties significant in engineering are given in table 7. These estimates are made by layers of representative soil profiles having significantly different soil properties. The estimates are based on field observations made in the course of mapping, on test data for these and similar soils, and on experience with the same kinds of soil in other counties. Following are explanations of some of the columns in table 7.

Depth to bedrock is the distance from the surface of the soil to a rock layer within the depth of observation. Depth to bedrock is not included in table 7, because all the soils in Dakota County lack bedrock within a depth of 5 feet, except the Sansarc soils which have clayey shale at a depth of 10 to 20 inches.

Depth to seasonal high water table is the distance from the surface of the soil to the highest level that ground water reaches in the soil in most years.

Soil texture is described in table 7 in the standard terms used by the Department of Agriculture. These terms are based on the percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil material that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the soil contains gravel or other particles coarser than sand, an appropriate modifier is added, as for example, "gravelly loamy sand." "Sand," "silt," "clay," and some of the other terms used in USDA textural classification are defined in the Glossary of this soil survey.

Tests to determine liquid limit and plasticity index measure the effect of water on the consistence of soil material as has been explained for table 6.

Permeability, as used here, is an estimate of the rate at which saturated soil would transmit water in a vertical direction under a unit head of pressure. It is estimated on the basis of those soil characteristics observed in the field, particularly structure, porosity, and texture. Lateral seepage or such transient soil features as plowpans and surface crusts are not considered.

Available water capacity is an estimate of the capacity of soils to hold water for use by most plants. It is defined here as the difference between the amount of water in the soil at field capacity and the amount at the wilting point of most plants.

Reaction refers to the acidity or alkalinity of a soil, expressed in pH values for a stated soil-solution mixture. The pH value and terms used to describe soil reaction are explained in the Glossary.

Shrink-swell potential refers to the relative change in volume to be expected of soil material with changes in moisture content; that is, the extent to which the soil shrinks as it dries out or swells when it gets wet. The extent of shrinking and swelling is influenced by the amount and kind of clay in the soil. Shrinking and swelling of soils may damage building foundations, roads, and other structures. Soils having *high* shrink-swell potential are the most hazardous. Shrink-swell potential is not indicated for organic soils or certain soils which shrink markedly on drying but do not swell quickly when rewetted.

Engineering interpretations of the soils

The estimated interpretations in table 8 are based on the engineering properties of soils shown in table 7, on test data for soils in this survey area and others nearby or adjoining, and on the experience of engineers and soil scientists with the soils of Dakota County. In table 8, ratings are used to summarize limitation or suitability of the soils for all listed purposes other than for pond-reservior areas, embankments, dikes, and levees, drainage of crops and pasture, irrigation, and terraces and diversions. For these particular uses, table 8 lists those soil features not to be overlooked in planning, installation, and maintenance.

Soil limitations are indicated by the ratings *slight, moderate,* and *severe. Slight* means that soil properties are generally favorable for the intended use, or in other words, limitations are minor and easily overcome. *Moderate* means that some soil properties are unfavorable but can be overcome or modified by special planning and design. *Severe* means that soil properties are so unfavorable and so difficult to correct or overcome as to require major soil reclamation, special designs, or intensive maintenance.

Soil suitability is rated by the terms *good, fair,* and *poor,* which have, respectively, meanings approximately parallel to the terms slight, moderate, and severe.

Sand and gravel are used in great quantities in many kinds of construction, but ratings of the soils as probable sources of these were not included in table 8 because most of the soils in Dakota County do not have sand or gravel within a depth of 5 feet. Grable, Percival, and Sarpy soils, however, are poor sources. Grable soils have poorly graded, fine-grained sand below a depth of 2 feet. Percival soils are a source of fine sand that is not suitable for most uses. Sarpy soils are a source of poorly graded fine sand that has a few aggregate-sized particles.

Following are explanations of some of the colums in table 8.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into natural soil. The soil material from a depth of 18 inches to 6 feet is evaluated. The soil properties considered are those that affect both absorption of effluent and construction and operation of the system. Properties that affect absorption are permeability, depth to water table or rock, and suscep-

TABLE 6.—*Engineering*

[Tests performed by the Nebraska Department of Roads in accordance with

Soil name and location	Parent material	Report No. S71-	Depth from surface	Specific gravity
			Inches	
Albaton silty clay: 400 feet west and 150 feet south of the NE. corner of SW¼ sec. 22, T. 29 N., R. 9 E. (Modal)	Clayey alluvium.	920 921	0–8 8–27	2.67 2.71
Blencoe silty clay: 100 feet north and 500 feet west of the SE. corner of sec. 13, T. 28 N., R. 8 E. (Modal)	Clayey and silty alluvium.	911 912	0–6 19–28	2.64 2.71
Blyburg silt loam: 400 feet west and 1,140 feet south of the NE. corner of sec. 2, T. 28 N., R. 8 E. (Modal)	Silty alluvium.	915 916	0–7 21–60	2.63 2.69
Crofton silt loam: 1,020 feet south and 200 feet west of the NE. corner of sec. 9, T. 27 N., R. 7 E. (Modal)	Loess.	927 928	0–6 15–60	2.72 2.72
Grable very fine sandy loam: 2,590 feet west and 1,000 feet north of the SE. corner of sec. 8, T. 27 N., R. 9 E. (Modal)	Loamy and sandy alluvium.	907 908	9–24 24–60	2.67 2.68
Haynie silt loam: 2,440 feet west and 100 feet north of SE. corner of sec. 1, T. 88 N., R. 48 W. (Modal)	Silty and loamy alluvium.	913 914	0–7 25–60	2.68 2.68
Kennebec silt loam, overwash: 720 feet north and 600 feet west of center of sec. 27, T. 28 N., R. 7 E. (Modal)	Silty alluvium.	924 925 926	0–6 16–30 30–60	2.63 2.64 2.65
Luton silty clay, thin surface: 1,220 feet east and 200 feet north of the SW. corner of sec. 6, T. 27 N., R. 9 E. (Modal)	Clayey alluvium.	917 918 919	0–7 17–35 41–60	2.63 2.74 2.73
Moody silty clay loam: 2,040 feet east and 216 feet south of the NW. corner of sec. 26, T. 28 N., R. 7 E. (Modal)	Loess.	929 930 931	0–7 16–29 38–50	2.64 2.71 2.72
Napier silt loam: 1,000 feet south and 150 feet west of the NE. corner of sec. 26, T. 28 N., R. 7 E. (Modal)	Silty alluvium.	932 933 934	0–7 17–30 38–60	2.64 2.68 2.69
Nora silt loam: 1,420 feet south and 100 feet west of the NE. corner of sec. 29, T. 28 N., R. 8 E. (Modal)	Loess.	922 923	0–7 19–33	2.63 2.68
Onawa silty clay: 1,200 feet south and 1,600 feet east of the NW. corner of sec. 25, T. 29 N., R. 8 E. (Modal)	Clayey and silty alluvium.	909 910	0–7 33–60	2.68 2.69

[1] Mechanical analyses according to the ASSHO Designation T 88-47(*1*). Results by this procedure may differ somewhat from results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHO procedure, the fine material is analyzed by the hydrometer method and the various grain-size fractions are calculated on the basis of all the material including that coarser than 2 millimeters in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method and the material coarser than 2 millimeters in diameter is excluded from calculations of grain-size fractions. The mechanical analyses used in this table are not suitable for use in naming textural classes of soil.

tibility to flooding. Slope is a soil property that affects difficulty of layout and construction and also the risk of soil erosion, lateral seepage, and downslope flow of effluent. Large rocks or boulders increase construction costs.

Sewage lagoons are shallow ponds constructed to hold sewage within a depth of 2 to 5 feet long enough for bacteria to decompose the solids. A lagoon has a nearly level floor and sides, or embankments, of compacted soil material. The assumption is made that the embankment is compacted to medium density and the pond is protected from flooding. Properties are consid-

test data

standard procedures of the American Association of State Highway Officials (AASHO) (*1*)]

Mechanical analysis [1]						Liquid limit	Plasticity index	Classification	
Percentage passing sieve—		Percentage smaller than—						AASHO [2]	Unified [3]
No. 60 (0.25 mm)	No. 200 (0.074 mm)	0.05 mm	0.02 mm	0.005 mm	0.002 mm				
						Percent			
-----------	100	99	96	79	65	78	48	A-7-5(31)	CH
-----------	100	99	99	83	71	84	56	A-7-6(32)	CH
100	99	97	77	54	44	59	33	A-7-6(21)	CH
[4] 99	98	96	75	20	13	34	6	A-4(8)	ML
100	92	80	29	12	9	31	3	A-4(8)	ML
100	97	87	32	13	10	30	2	A-4(8)	ML
100	99	92	58	34	27	42	19	A-7-6(12)	CL
100	99	94	56	30	23	42	20	A-7-6(12)	CL
100	66	35	17	12	9	24	[5] NP	A-4(6)	ML
100	15	9	6	4	4	NP	NP	A-2-4(—2)	SM
100	87	76	24	12	9	28	2	A-4(8)	ML
100	89	75	20	10	8	26	NP	A-4(8)	ML
-----------	100	94	58	26	18	48	19	A-7-6(13)	ML
-----------	100	94	58	30	21	46	20	A-7-6(13)	CL
100	99	92	53	28	22	42	17	A-7-6(11)	CL
-----------	100	99	92	66	52	72	43	A-7-6(28)	CH
-----------	100	99	97	78	65	91	64	A-7-6(32)	CH
100	99	98	94	79	64	87	60	A-7-6(32)	CH
100	99	94	63	38	30	46	19	A-7-6(13)	CL
100	99	94	64	38	32	49	25	A-7-6(16)	CL
100	99	93	54	31	27	42	20	A-7-6(12)	CL
100	99	92	58	30	24	42	16	A-7-6(11)	ML
100	99	92	61	33	28	46	22	A-7-6(14)	CL
-----------	100	93	60	33	29	42	20	A-7-6(12)	CL
100	99	93	55	32	28	44	19	A-7-6(12)	CL
[4] 99	98	92	56	34	28	43	20	A-7-6(13)	CL
100	99	96	85	66	52	68	41	A-7-6(26)	CH
100	96	89	44	21	15	31	6	A-4(8)	ML

[2] Based on AASHO Designation M 145-49(1).
[3] Based on the Unified Soil Classification System (*10*).
[4] 100 percent passes No. 10 sieve; 99 percent passes No. 40 sieve.
[5] NP means nonplastic.

ered that affect the pond floor and the embankment. Those that affect the pond floor are permeability, organic matter, and slope; and if the floor needs to be leveled, depth to bedrock becomes important. The soil properties that affect the embankment are the engineering properties of the embankment material, as interpreted from the Unified soil classification and the amount of stones, if any, that influence the ease of excavation and compaction of the embankment material.

Shallow excavations are those that require digging or trenching to a depth of less than 6 feet, as for example,

TABLE 7.—*Estimated soil properties*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in referring to other series that appear in the first column of this table.

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHO
	Ft	*In*			
Albaton:					
Aa	5–10	0–12	Silty clay loam	CL or CH	A–7
		12–60	Silty clay	CH	A–7
Ab	5–10	0–60	Silty clay	CH	A–7
Ac	[1] 2–4	0–60	Silty clay	CH	A–7
Alluvial land: Ad. Properties are too variable to be estimated.					
Blake: Ba	5–10	0–16	Silty clay loam	CL or CH	A–7
		16–31	Silt loam	ML	A–4
		31–60	Fine sandy loam and silt loam	ML or SM	A–4
Blencoe: Bb	5–10	0–15	Silty clay	CH	A–7
		15–24	Light silty clay	CH	A–7
		24–60	Silt loam	ML	A–4
Blyburg:					
Bc, BcC	5–10	0–15	Silt loam	ML	A–4
		15–60	Light silt loam	ML	A–4
Bd	5–10	0–12	Silty clay loam	CL	A–7
		12–60	Silt loam	ML	A–4
Be	[1] 5–10	0–10	Silty clay	CH	A–7
		10–20	Silty clay loam	CL	A–7
		20–60	Silt loam	ML	A–4
Calco:					
Ca	[1] 3–5	0–20	Silt loam	ML	A–4, A–5, or A–7
		20–60	Silty clay loam	CL	A–7
Cb	3–5	0–16	Silty clay loam	CL	A–7
		16–40	Silty clay loam	CL	A–7
		40–60	Silty clay loam	CL or CH	A–7
Crofton: CfC2, CfD2, CfE, CfE2, CfF, CfF2.	<10	0–60	Silt loam	CL	A–6 or A–7
Forney:					
Fn	5–10	0–17	Silt loam	ML	A–4
		17–28	Silty clay loam	CL or CH	A–7
		28–60	Silty clay	CH	A–7
Fo, Fs	[1] 3–5	0–11	Silty clay	CH	A–7
		11–60	Silty clay	CH	A–7
Grable: Gb	5–10	0–24	Very fine sandy loam	ML	A–4 or A–6
		24–60	Fine sand	SM or SP-SM	A–2
*Gullied land: GuG. For properties of Ida part, see Ida series. Properties of Gullied land are too variable to be estimated.					
Haynie: He	5–10	0–25	Silt loam	ML	A–4
		25–60	Very fine sandy loam	ML	A–4
Ida: IdE2, IdF, IdF2, IeG	>10	0–6	Silt loam	CL	A–6 or A–7
		6–60	Silt loam	CL	A–6 or A–7

significant in engineering

such mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for
The symbol > means more than; the symbol < means less than]

Percentage less than 3 inches passing sieve—		Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
No. 40 (0.42 mm)	No. 200 (0.074 mm)						
				In per hr	*In per in of soil*	*pH*	
100	95–100	45–55	25–40	0.2–0.6	0.21–0.23	7.9–8.4	High.
----------	100	75–85	45–60	0.06–0.2	0.10–0.13	7.9–8.4	High.
----------	100	70–85	45–60	0.06–0.2	0.11–0.13	7.9–8.4	High.
----------	100	70–85	45–60	0.06–0.2	0.11–0.13	7.9–8.4	High.
100	90–100	45–55	25–40	0.2–0.6	0.21–0.23	7.4–8.4	Moderate to high.
100	90–100	20–35	0–10	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
100	40–95	20–30	0–10	0.6–2.0	0.17–0.19	7.9–8.4	Low.
100	95–100	55–65	30–40	<0.06	0.12–0.14	6.6–7.3	High.
[2] 98–100	95–100	50–60	25–35	0.06–0.2	0.11–0.13	6.6–7.3	High.
100	90–100	30–40	0–10	0.6–2.0	0.20–0.22	----------	
100	90–100	25–35	0–10	0.6–2.0	0.22–0.24	6.6–8.4	Low.
100	90–100	20–30	0–10	0.6–2.0	0.17–0.22	7.9–8.4	Low.
100	90–100	41–50	25–35	0.2–0.6	0.21–0.23	6.6–8.4	Moderate.
100	90–100	20–40	0–10	0.6–2.0	0.20–0.22	7.9–8.4	Low.
----------	100	55–65	30–40	0.06–0.2	0.12–0.14	7.4–8.4	High.
100	90–100	41–50	25–40	0.2–0.6	0.18–0.20	7.4–8.4	Moderate to high.
100	90–100	20–40	0–10	0.6–2.0	0.20–0.22	7.9–8.4	Low.
100	95–100	35–45	5–15	0.6–2.0	0.22–0.24	7.9–8.4	Moderate.
100	95–100	40–50	20–30	0.2–0.6	0.18–0.20	7.9–8.4	Moderate to high.
100	95–100	41–50	15–25	0.2–0.6	0.21–0.23	7.9–8.4	Moderate to high.
100	95–100	41–50	20–30	0.2–0.6	0.18–0.20	7.9–8.4	Moderate to high.
100	95–100	45–55	25–40	0.2–0.6	0.18–0.20	7.9–8.4	Moderate to high.
100	95–100	35–50	15–25	0.6–2.0	0.20–0.24	7.9–8.4	Low to moderate.
100	90–100	25–35	0–10	0.6–2.0	0.22–0.24	6.6–7.8	Moderate.
100	95–100	45–55	25–40	0.2–0.6	0.18–0.20	7.9–8.4	Moderate to high.
----------	100	75–90	50–60	<0.06	0.10–0.12	7.9–8.4	High.
----------	100	70–85	45–55	<0.06	0.12–0.14	6.6–7.3	High.
----------	100	75–90	50–60	<0.06	0.10–0.13	7.4–8.4	High.
100	50–80	20–35	0–15	0.6–2.0	0.20–0.22	7.4–7.8	Low.
100	5–20	[3] NP	[3] NP	6.0–20.0	0.05–0.08	7.4–8.4	Low.
100	85–95	20–30	0–10	0.6–2.0	0.20–0.24	7.9–8.4	Low.
100	85–95	20–30	NP	0.6–2.0	0.17–0.19	7.9–8.4	Low.
100	95–100	35–50	15–30	0.6–2.0	0.22–0.24	7.9–8.4	Moderate.
100	95–100	30–50	11–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.

TABLE 7.—*Estimated soil properties*

Soil series and map symbols	Depth to seasonal high water table	Depth from surface	USDA texture	Classification	
				Unified	AASHO
	Ft	*In*			
Judson: Ju, JuC	[4] >10	0–30	Silty clay loam	ML or CL	A–6 or A–7
		30–60	Silty clay loam	CL or CH	A–7
Kennebec: Ke, Ko	5–10	0–30	Silt loam	ML or CL	A–7
		30–60	Silt loam	ML or CL	A–7
Luton: Lu	5–10	0–17	Silty clay	CH	A–7
		17–60	Silty clay	CH	A–7
Marsh: Mh. Properties are too variable to be estimated. Seasonal high water table is at a depth of 0 to 2 feet.					
Modale: Mk	[5] 5–10	0–25	Silt loam	CL–ML or CL	A–4 or A–6
		25–36	Silty clay loam	CL or CH	A–6 or A–7
		36–60	Silty clay	CH or CL	A–7
Monona: MnD, MnE, MnF	>10	0–15	Silt loam	CL or ML	A–6 or A–7
		15–40	Silt loam	CL or ML	A–6 or A–7
		40–60	Silt loam	CL or ML	A–6 or A–7
*Moody: MoC, MoD, MoD2, MpE. For properties of Nora part of MpE, see Nora series.	>10	0–11	Silty clay loam	CL or ML	A–7
		11–38	Silty clay loam	CH or CL	A–7
		38–60	Silt loam	CL	A–7
Napier: NaC, NaD, NaE, NgD. The properties of the Gullied land part of NgD are too variable to be estimated.	[6] >10	0–38	Silt loam	CL or ML	A–7
		38–60	Silt loam	CL	A–7
Nora: NoC2, NoD, NoD2, NoE, NoE2, NoF.	>10	0–13	Silt loam	CL	A–6 or A–7
		13–33	Silt loam and silty clay loam	CL	A–6 or A–7
		33–60	Silt loam	CL	A–6 or A–7
Omadi: Om	5–10	0–20	Silt loam	CL	A–6 or A–7
		20–60	Silt loam	CL	A–6 or A–7
Onawa: On	5–10	0–18	Silty clay	CH	A–7
		18–60	Silt loam	ML	A–4
Owego: Ow	5–10	0–11	Silty clay	CH	A–7
		11–22	Silt loam	ML	A–4
		22–60	Silty clay	CH	A–7
Percival: Pe	5–18	0–21	Silty clay and silty clay loam	CH	A–7
		21–60	Fine sand	SM or SP–SM	A–2
*Sansarc: SaF. For properties of Nora part, see Nora series.	>10	0–12	Clay loam or silty clay loam	CL or CH	A–7
		12–60	Clayey shale	CH	A–7
Sarpy:					
SbD	5–10	0–60	Fine sand	SM or SP–SM	A–2
ScC	5–10	0–14	Loamy fine sand	SM	A–2
		14–60	Fine sand	SM or SP–SM	A–2
So	5–10	0–12	Silty clay	CH	A–7
		12–60	Fine sand	SM or SP–SM	A–2
Waubonsie: Wu	5–10	0–21	Very fine sandy loam and loamy very fine sand.	SM	A–2
		21–38	Silty clay	CH	A–7
		38–60	Silt loam	CL–ML, ML or CL	A–4

[1] Subject to periodic flooding or overflow.
[2] 100 percent passes No. 10 sieve.
[3] NP means nonplastic.

significant in engineering—Continued

Percentage less than 3 inches passing sieve— No. 40 (0.42 mm)	No. 200 (0.074 mm)	Liquid limit	Plasticity index	Permeability	Available water capacity	Reaction	Shrink-swell potential
				In per hr	*In per in of soil*	*pH*	
100	95–100	35–50	11–25	0.6–2.0	0.18–0.20	6.1–6.5	Moderate.
100	95–100	41–60	20–35	0.6–2.0	0.18–0.20	6.6–7.8	High.
100	95–100	41–50	15–25	0.6–2.0	0.22–0.24	7.4–7.8	Moderate.
100	95–100	41–50	15–25	0.6–2.0	0.20–0.22	7.4–7.8	Moderate.
—	100	65–80	35–55	<0.06	0.12–0.14	6.6–7.3	High.
100	95–100	80–95	45–70	<0.06	0.10–0.13	7.9–8.4	High.
100	95–100	20–35	5–15	0.6–2.0	0.22–0.24	7.4–7.8	Moderate.
100	95–100	35–55	15–35	0.2–0.6	0.18–0.20	7.9–8.4	Moderate to high.
—	100	45–80	25–55	0.06–0.2	0.10–0.12	7.9–8.4	High.
100	95–100	35–50	11–25	0.6–2.0	0.22–0.24	6.1–7.3	Moderate.
100	95–100	35–50	11–25	0.6–2.0	0.20–0.22	6.6–7.8	Moderate.
100	95–100	35–50	11–25	0.6–2.0	0.20–0.22	7.4–8.4	Moderate.
100	95–100	41–50	15–25	0.6–2.0	0.21–0.23	6.1–6.5	Moderate.
100	95–100	45–55	20–30	0.2–0.6	0.18–0.20	6.1–7.3	Moderate to high.
100	95–100	41–45	15–25	0.6–2.0	0.20–0.22	6.6–7.8	Moderate.
100	95–100	41–50	15–25	0.6–2.0	0.20–0.24	6.6–7.3	Moderate.
100	95–100	41–25	15–25	0.6–2.0	0.20–0.22	6.6–7.3	Moderate.
100	95–100	35–50	15–25	0.6–2.0	0.22–0.24	6.6–7.3	Moderate.
[2] 98–100	95–100	35–50	15–25	0.6–2.0	0.18–0.22	6.6–8.4	Moderate.
100	95–100	35–45	15–25	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
—	100	30–45	11–20	0.6–2.0	0.22–0.24	6.6–8.4	Moderate.
100	95–100	30–45	11–20	0.6–2.0	0.20–0.22	7.9–8.4	Moderate.
100	95–100	60–80	35–50	0.06–0.2	0.12–0.14	7.9–8.4	High.
100	95–100	20–40	2–10	0.6–2.0	0.17–0.22	7.9–8.4	Low.
—	100	60–85	35–60	<0.06	0.12–0.14	7.4–7.9	High.
100	80–95	20–35	0–10	0.6–2.0	0.20–0.22	7.9–8.4	Low.
—	100	60–90	35–65	<0.06	0.10–0.12	7.9–8.4	High.
—	100	60–80	35–50	0.06–0.2	0.12–0.23	7.4–8.4	High.
100	8–20	NP	NP	6.0–20.0	0.05–0.07	7.9–8.4	Low.
100	85–95	40–65	20–35	0.06–0.2	0.17–0.23	7.9–8.4	High.
100	90–95	50–75	30–55	—	—	7.4–8.4	High.
100	5–20	NP	NP	6.0–20.0	0.05–0.09	7.4–8.4	Low.
100	15–25	<20	NP	6.0–20.0	0.10–0.12	7.4–7.8	Low.
100	5–20	NP	NP	6.0–20.0	0.05–0.08	7.9–8.4	Low.
—	100	60–80	35–50	0.06–0.2	0.12–0.14	7.9–8.4	High.
100	5–20	NP	NP	6.0–20.0	0.05–0.08	7.9–8.4	Low.
100	30–50	<20	NP	2.0–6.0	0.20–0.22	7.9–8.4	Low.
—	100	60–80	35–50	0.06–0.2	0.11–0.13	7.9–8.4	High.
100	80–95	20–30	0–10	0.6–2.0	0.20–0.22	7.9–8.4	Low.

[4] Some areas seeped.
[5] Water table may be perched.
[6] May be seeped in unit NaC.

TABLE 8.—*Interpretations of engineering*

[An asterisk in the first column indicates that at least one mapping unit in this series is made up of two or more kinds of soil. The soils in such to other series that appear in

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Albaton: Aa, Ab	Severe: slow permeability.	Slight where protected from flooding.	Severe: poorly drained; too clayey; can be used if soil material is dry to moist.	Severe: slow permeability; high shrink-swell potential.	Severe: if used as cover, soil material tends to shrink and crack.	Severe: slow permeability; high shrink-swell potential.
Ac	Severe: slow permeability; subject to flooding.	Severe: subject to flooding; high water table.	Severe: occasionally flooded; too clayey; high water table.	Severe: high water table; occasionally flooded.	Severe: occasionally flooded; high water table.	Severe: subject to flooding.
Alluvial land: Ad. Properties are too variable for specific interpretations to be made. Limitations are generally severe because flooding is frequent.						
Blake: Ba	Moderate: moderate permeability below a depth of 16 inches.	Moderate: permeability of soil material used as bottom of lagoon is too rapid for proper functioning of a lagoon.	Slight	Moderate: moderate shrink-swell potential below a depth of 16 inches; subject to frost action; slow permeability in upper 16 inches; needs surface drainage.	Slight: soil material is good for cover below a depth of 16 inches.	Moderate: moderate to high shrink-swell potential in upper 16 inches; subject to frost action.
Blencoe: Bb	Severe to slight: permeability is moderate below an approximate depth of 2 feet.	Moderate: permeability below an approximate depth of 2 feet is too rapid for proper functioning of a lagoon.	Slight	Severe in upper 2 feet: high shrink-swell potential. Slight below an approximate depth of 2 feet.	Slight to moderate: if used as cover, soil material from upper 2 feet may crack when dry, but soil material below an approximate depth of 2 feet can be used.	Severe: high shrink-swell potential and subject to frost action in upper 2 feet; poor surface drainage.
Blyburg: Bc, BcC, Bd	Slight	Moderate: permeability is too rapid for proper functioning of a lagoon.	Slight	Slight	Slight	Moderate: subject to frost action.

properties of the soils

mapping units may have different properties and limitations, and for this reason it is necessary to follow carefully the instructions for referring the first column of this table.]

Suitability as source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crops and pasture	Irrigation	Terraces and diversions
Poor: high shrink-swell potential; high susceptibility to frost action.	Poor: poor workability; slow permeability.	Slow permeability; may be used for dugouts.	Low permeability of compacted soil; poor compaction characteristics; high shrink-swell potential.	Ponded areas common; slow permeability.	Moderate available water capacity; adequate surface drainage necessary; very slow intake rate.	Not needed; nearly level.[2]
Poor: high shrink-swell potential; high susceptibility to frost action.	Poor: poor workability; slow permeability.	Slow permeability; may be used for dugouts.	Low permeability of compacted soil; poor compaction characteristics; high shrink-swell potential; high water table.	Slow permeability; occasionally flooded; high water table.	Moderate available water capacity; adequate surface drainage necessary; very slow intake rate.	Not needed; nearly level.[2]
Fair: moderate shrink-swell potential; subject to frost action.	Fair: upper 16 inches has poor workability.	Permeability is moderately slow in upper part and moderate in lower part; nearly level.	Low permeability for compacted soil; good workability below a depth of 16 inches.	Poor surface drainage; moderate permeability below a depth of about 2 feet.	High available water capacity; slow intake rate.	Not needed; nearly level.[2]
Poor in upper 2 feet; high shrink-swell potential; high susceptibility to frost action. Fair below an approximate depth of 2 feet.	Poor: too clayey in upper 2 feet. Good below a depth of 2 feet.	Permeability is very slow in upper part and moderate below a depth of 2 feet; nearly level.	Low permeability for compacted soil; poor workability in upper 2 feet.	Clayey in upper 2 feet; outlets for surface drainage difficult to obtain in many places.	High available water capacity; very slow intake rate; adequate surface drainage necessary.	Not needed; nearly level.[2]
Fair: subject to frost action.	Good to fair	Because of the moderate permeability, there is seldom any storage of liquid; nearly level.	Fair compaction characteristics; good workability.	Good internal drainage.	High available water capacity; moderate intake rate.	Not needed; nearly level.[2]

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Be	Slight. Severe where subject to flooding.	Moderate. Severe where subject to flooding; moderate permeability.	Moderate: subject to flooding in places.	Moderate: moderate shrink-swell potential; subject to frost action; subject to flooding in places.	Moderate: soil material is good for cover; subject to flooding in some places.	Moderate: subject to frost action; subject to flooding in places.
Calco: Ca	Severe: seasonal water table; subject to flooding; moderately slow permeability.	Severe: subject to flooding.	Moderate to severe: subject to flooding.	Severe: subject to flooding.	Severe: subject to flooding; soil material is good for cover.	Severe: moderate to high shrink-swell potential; subject to frost action; subject to flooding.
Cb	Severe: seasonal water table; moderately slow permeability.	Moderate: seasonal water table.	Severe: poorly drained; seasonal high water table.	Severe: poorly drained; surface drainage needed in places; check depth to water table before beginning construction.	Severe: seasonal high water table; poorly drained; site is good if depth to water table is greater than 10 feet, soil material is fair for cover.	Severe: moderate to high shrink-swell potential; subject to frost action.
Crofton: CfC2, CfD2, CfE, CfE2, CfF, CfF2.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 7 percent. Severe where slopes are more than 7 percent. Moderate permeability.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are 8 to 15 percent. Severe where slopes are more than 15 percent; low to moderate frost action potential; subject to consolidation if wetted and loaded.	Slight where slopes are less than 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent; subject to water erosion; subject to frost action.
Forney: Fn, Fo, Fs.	Severe: very slow permeability.	Slight where protected from flooding. Severe where not protected from flooding.	Severe: subject to flooding in some places; too clayey.	Severe: moderate to high shrink-swell potential; subject to flooding in some places.	Severe: subject to flooding in some areas; if used as cover, soil material may crack when dry.	Severe: moderate to high shrink-swell potential; subject to frost action.
Grable: Gb	Slight where protected from flooding; rapid permeability in underlying soil; danger of pollution of ground water.	Severe: rapid permeability in underlying soil.	Moderate: sandy in lower part.	Slight	Severe: rapid permeability in underlying soil.	Slight: erodible cut and fill slopes.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crops and pasture	Irrigation	Terraces and diversions
Fair: moderate to high shrink-swell potential; subject to frost action; compaction control needed.	Fair to poor: too clayey.	Permeability is moderately slow in upper part and moderate below a depth of 16 inches.	Fair to good compaction characteristics; low permeability for compacted soil.	Good internal drainage; subject to flooding or ponding in some areas; outlets for drainage difficult to obtain.	High available water capacity; very slow intake rate.	Not needed; nearly level.[2]
Fair to poor: moderate to high shrink-swell potential; subject to flooding.	Fair to poor: fair in upper 2 feet; subject to flooding.	Moderately slow permeability; subject to flooding.	Good workability; subject to flooding.	Poorly drained; seasonal high water table; moderately slow permeability.	High available water capacity; seasonal high water table; slow intake rate.	Not needed; nearly level.[2]
Fair to poor: fair above an approximate depth of 3 feet; poor workability below a depth of 3 feet.	Fair: approximately 3 feet of material available.	Moderately slow permeability below a depth of 3 feet.	Good workability above a depth of 3 feet.	Poorly drained; seasonal high water table; moderately slow permeability.	High available water capacity; seasonal high water table; slow intake rate.	Not needed; nearly level.[2]
Fair erodibility of slopes; subject to frost action.	Fair to poor: low fertility.	Moderate permeability; favorable storage potential if seepage decreased.	Fair to good workability; foundation drains necessary in places; requires close compaction control in places; erodibility of slopes; subject to consolidation upon wetting and loading; low permeability for compacted soil.	Good internal drainage; runoff excessive.	High available water capacity; moderate intake rate; high erodibility of slopes.	Erodible: steep and irregular slopes make alinement difficult; potential siltation of channels.
Poor: high shrink-swell potential; subject to frost action; poor workability.	Poor: too clayey.	Very slow permeability; nearly level.	Low permeability for compacted soil; poor compaction characteristics.	Ponded areas common; subject to overflow; clayey; outlets for surface drainage difficult to obtain.	Moderate available water capacity; adequate surface drainage necessary; very slow intake rate.	Not needed; nearly level.[2]
Fair to good: erodible if exposed on embankments; narrow moisture range for satisfactory compaction.	Fair in upper 2 feet. Poor below depth of 2 feet; too sandy; low fertility.	Rapid permeability in substratum; high seepage; nearly level.	Medium permeability for compacted soil; susceptible to seepage because water table is deeper than 5 feet.	Well drained to somewhat excessively drained; fine sand below depth of 2 feet.	Moderate available water capacity; moderate intake rate; fine sand at an approximate depth of 2 feet.	Not needed; nearly level.[2]

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
*Gullied land: GuG. Properties of Gullied land are too variable for interpretations to be made. Limitations are severe for most uses because of very steep slope and severe erosion. For interpretations of Ida part, see Ida series.						
Haynie: He	Slight	Moderate: moderate permeability.	Slight	Slight if protected from flooding. Severe if subject to flooding.	Slight to moderate: possible ground water contamination.	Moderate to severe: erodible cut or fill slopes; subject to frost action.
Ida: IdE2, IdF, IdF2, IeG.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent.	Severe: excessive slopes; moderate permeability.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent: subject to consolidation where wetted and loaded.	Slight where slopes are less than 15 percent. Moderate where slopes are 15 to 25 percent. Severe where slopes are more than 25 percent: good cover soil.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent: erodible slopes.
Judson: Ju, JuC	Moderate: moderate permeability.	Moderate: moderate permeability.	Slight	Moderate: moderate shrink-swell potential.	Slight	Slight to moderate: subject to frost action.
Kennebec: Ke, Ko	Slight: severe when flooding is a hazard.	Moderate: moderate permeability; severe if not protected from flooding.	Severe: subject to flooding.	Severe: subject to flooding; moderate potential for frost action.	Severe: occasional flooding; good cover soil.	Severe: subject to flooding and frost action.
Luton: Lu	Severe: very slow permeability.	Slight	Severe: too clayey; poorly drained.	Severe: high shrink-swell potential.	Severe: poor cover soil.	Severe: high shrink-swell potential; poor workability.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crops and pasture	Irrigation	Terraces and diversions
Fair: erodible on slopes; needs compaction control.	Good	Moderate permeability; nearly level topography.	Medium to low permeability for compacted soil; fair compaction characteristics; subject to seepage in foundation area.	Well drained; good surface drainage; moderate permeability.	High available water capacity; moderate intake rate.	Not needed; nearly level.[2]
Fair to poor: erodible slopes; borrow areas may be steep; needs compaction control.	Poor to fair: less than 8 inches thick; low fertility.	Moderate permeability; favorable storage potential.	Low permeability for compacted soil; fair compaction characteristics; requires close control; erodible on slopes; foundation drains may be necessary.	Well drained; good surface drainage; runoff excessive.	Excessive slopes; highly erodible; high available water capacity; moderate intake rate.	Soil features favorable for construction where slopes are less than 17 percent; slopes greater than 17 percent are too steep for construction; highly erodible.
Fair to poor: moderate shrink-swell potential; subject to frost action; needs compaction control.	Fair: high fertility; too clayey.	Moderate permeability.	Low permeability of compacted soil; fair compaction characteristics.	Moderate permeability; subject to runoff from higher lying areas.	High available water capacity; slow intake rate; erodible on slopes.	Slopes erodible; soil features favorable for construction.
Fair to poor: moderate shrink-swell potential; high organic matter content; subject to frost action; needs compaction control.	Good	Moderate permeability; nearly level topography; subject to flooding.	Low permeability for compacted soil; fair compaction characteristics.	Moderate permeability; subject to occasional flooding.	High available water capacity; moderate intake rate.	Not needed; nearly level.[2]
Poor: high shrink-swell potential; poor workability.	Poor: too clayey.	Very slow permeability; nearly level topography.	Low permeability for compacted soil; poor compaction characteristic; difficult to work, water table at depth of 2 feet or less.	Ponded in places; adequate surface drainage outlets are available; very slow permeability.	Moderate available water capacity; very slow intake rate.	Not needed; nearly level.[2]

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Marsh: Mh	Severe: water table at depth of 2 feet or less.	Severe: water table at depth of 2 feet or less.	Severe: water table at depth of 2 feet or less.	Severe: water table at depth of 2 feet or less.	Severe: water table at depth of 2 feet or less.	Severe: water table at depth of 2 feet or less.
Modale: Mk	Severe: slow permeability below depth of 3 feet.	Slight	Moderate to severe, depending on moisture content of soil; too clayey below depth of 3 feet.	Moderate: high shrink-swell potential below approximate depth of 2 feet.	Moderate: difficult to work in substratum where wet; good cover soil in top 2 feet.	Moderate: high shrink-swell potential in substratum; subject to frost action.
Monona: MnD, MnE, MnF.	Slight if less than 8 percent slopes. Moderate if 8 to 15 percent slopes. Severe if slopes of more than 15 percent.	Severe: strong slopes; moderate permeability.	Moderate where slopes are less than 15 percent. Severe if slopes are more than 15 percent; good sidewall stability where soil is dry.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent.	Slight where slopes are less than 15 percent. Moderate if slopes are less than 25 percent. Severe if more than 25 percent.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent; erosion by water can be damaging; subject to frost action.
*Moody: MoC, MoD, MoD2, MpE. For interpretations of the Nora part of unit MpE, see the Nora series.	Severe: moderately slow permeability in approximately upper 3 feet.	Moderate where slopes are less than 7 percent. Severe where slopes are more than 7 percent; moderate permeabilty.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent; good sidewall stability when soil is dry.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent; subject to frost action; subject to shrinking and swelling.	Slight to moderate: top 12 inches of soil good for cover. CH soil cracks in places where dry.	Moderate to severe; moderate to high shrink-swell potential; subject to frost action; erodible by water.
Napier: NaC, NaD NaE, NgD. Properties of Gullied land part of unit NgD are too variable for interpretations to be made.	Slight where slopes are less than 8 percent. Moderate where slopes are of more than 8 percent.	Moderate where slopes are less than 7 percent. Severe where slopes are more than 7 percent.	Slight where slopes are less than 8 percent. Moderate where slopes are more than 8 percent; good for stability in dry soil.	Moderate: subject to frost action.	Slight to moderate: subject to local runoff from adjoining higher areas during heavy rains; good cover soil.	Moderate: moderate shrink-swell potential; subject to frost action; erodibility on steeper slopes.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crops and pasture	Irrigation	Terraces and diversions
Poor: very poorly drained; water table at depth of 2 feet or less.	Poor: very poorly drained; water table at depth of 2 feet or less.	Water table at depth of 2 feet or less; nearly level.	----------------	Water table at depth of 2 feet or less.	Not suited; water table at depth of 2 feet or less.	Not suited; water table at depth of 2 feet or less.
Fair in upper part; poor below depth of 2 feet: high shrink-swell potential; subject to frost action below depth of 2 feet; poor compaction characteristics.	Good in upper 2 feet.	Slow permeability below depth of 2 feet; nearly level topography.	Low permeability for compacted soil; poor workability.	Very slow permeability in substratum.	High available water capacity; moderate intake rate in upper 2 feet.	Not needed; nearly level.[2]
Fair: moderate shrink-swell potential; subject to frost action; good workability.	Good----------	Moderate permeability; erodible slopes.	Low permeability for compacted soil; subject to consolidation upon wetting and loading; erodible slopes.	Moderate permeability; some slopes limit the use of the soil.	High available water capacity; subject to excessive erosion on slopes; moderate intake rate.	Soil features favorable for construction where slopes are less than 17 percent. Unfavorable where slopes are more than 17 percent; steep and highly susceptible to water erosion.
Fair to poor: moderate to high shrink-swell potential; fair workability; needs close borrow area and compaction concontrol.	Fair: too clayey.	Moderate permeability.	Low permeability: fair permeability below approximate depth of 3 feet.	Some slopes may affect desired use; erodible by water; moderate permeability at depth of 1 to 3 feet.	High available water capacity; subject to excessive erosion on slopes; slow intake rate.	Soil features favorable for construction.
Fair to poor: moderate shrink-swell potential; plastic index can exceed 15; high in organic matter to a depth of 2 feet or more.	Good----------	Moderate permeability.	Low to medium permeability for compacted soil; high organic matter content in upper part; subject to excessive consolidation upon wetting and loading.	Subject to water erosion and siltation; moderate permeability.	High available water capacity; subject to excessive erosion on slopes; moderate intake rate.	Soil features favorable for construction.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Nora: NoC2, NoD, NoD2, NoE, NoE2, NoF.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent; moderate permeability.	Moderate where slopes are less than 7 percent. Severe where slopes are more than than 7 percent; moderate permeability.	Slight where slopes are less than 8 percent; moderate where 8 to 15 percent slopes; severe if slopes are more than 15 percent; cuts are stable when soil is dry.	Moderate where slopes are less than 15 percent. Severe where slopes are more than 15 percent; subject to consolidation when wetted and loaded; subject to frost action.	Slight where slopes are less than 15 percent. Moderate where slopes are 15 to 25 percent. Severe if slopes more than 25 percent; good cover soil.	Moderate where slopes are less than 15 percent. Severe where slopes are over 15 percent moderate; subject to frost action; erodibility of slopes.
Omadi: Om	Moderate: moderate permeability; water table at depth of 5 to 10 feet.	Moderate: moderate permeability.	Slight to moderate, depending on inplace soil moisture.	Severe: subject to frost action; subject to flooding in places.	Moderate: subject to flooding; good cover soil.	Moderate to severe: subject to frost action.
Onawa: On	Moderate: subject to flooding in some areas; slow permeability in upper 1½ feet of depth.	Moderate: moderate permeability below depth of 2 feet. Subject to flooding in some areas.	Moderate to severe, depending on soil moisture and depth to water table; subject to flooding in some areas.	Severe: high shrink-swell potential in upper 1.5 feet of soil; poor surface drainage; subject to frost action.	Moderate to severe: subject to flooding in some areas; check depth to water table before selecting site; good cover soil below a depth of 1.5 feet.	Severe: high shrink-swell potential in upper 1.5 feet; subject to frost action; poor surface drainage.
Owego: Ow	Severe: very slow permeability but moderate permeability in less clayey layer at a depth of 20 inches.	Slight: some seepage in thin silty layer at 20 inches.	Severe: poor to somewhat poorly drained; too clayey; moisture content of soil will determine ease of excavation and stability of trenches and walls.	Moderate: high shrink-swell potential; poor surface drainage; slow internal drainage of the soil.	Severe: poor cover soil; will crack when dry.	Severe: high shrink-swell potential; poor workability; subject to frost action.
Percival: Pe	Moderate to severe: slow permeability to a depth of 2 feet; rapid permeability.	Severe: rapid permeability below a depth of about 2 feet.	Severe: subject to caving below a depth of 2 feet; seepage into excavations can be expected.	Severe: high shrink-swell potential in upper part; subject to flooding; subject to frost action; check depth to water table for proposed construction.	Severe: subject to flooding in some places; rapid permeability in the lower part; possible contamination of ground water; poor cover soil in top 2 feet.	Severe: high shrink-swell potential in upper 2 feet; subject to flooding and frost action.
*Sansarc: SaF. For interpretations of the Nora part, see the Nora series.	Severe: slow permeability; steep slopes; shale at depth of 10 to 20 inches.	Severe: excessive slopes; shale at depth of 10 to 20 inches.	Severe: clayey shale at a depth of about 20 inches; steep slope.	Severe: high shrink-swell potential; difficult to work; slope; shale at depth of 10 to 20 inches.	Severe: limited depth to clayey shale; slope; no cover soil available in this soil.	Severe: high shrink-swell potential; steep slopes; shale at depth of 10 to 20 inches.

properties of the soils—Continued

Suitability as source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crops and pasture	Irrigation	Terraces and diversions
Fair: moderate shrink-swell potential; erodibility of slopes; subject to frost action; good workability with compaction control.	Fair: too clayey.	Moderate permeability.	Fair to good workability; medium to low permeability for compacted soil; subject to consolidation upon wetting and loading; requires close control; needs foundation drains in places.	Subject to water erosion; moderate permeability.	High available water capacity; subject to excessive erosion on slopes; moderate intake rate.	Irregular relief causes difficulty in layout and construction in places; high erodibility by water.
Fair to poor: fair workability; depth limited by moisture; subject to frost action.	Good	Moderate permeability.	Medium to low permeability for compacted soil; high susceptibility to seepage in foundation in some areas.	Seasonal water at depth of 5 to 10 feet; moderate permeability.	High available water capacity; moderate intake rate.	Not needed; nearly level.[2]
Poor: in upper 2 feet; too clayey; fair below depth of 2 feet; wet in borrow areas; compaction control difficult in places because of two types of soil.	Poor: in upper 2 feet; too clayey; good below a depth of 2 feet; too wet in places for borrow areas.	Slow permeability in upper 2 feet; moderate permeability below a depth of 2 feet; nearly level topography.	Low permeability for compacted soil; subject to seepage in foundation area below a depth of 1.5 feet.	Slow permeability in upper part; moderate permeability in lower part; outlets for drainage difficult to obtain.	High available water capacity; very slow intake rate.	Not needed; nearly level.[2]
Poor: high shrink-swell potential; subject to frost action; poor workability.	Poor: too clayey; poorly drained.	Very slow permeability; nearly level topography.	Low permeability for natural and compacted soil; poor compaction characteristics; difficult to work.	Ponded in places; adequate outlets are not available in places; very slow permeability.	Moderate available water capacity; very slow intake rate.	Not needed; nearly level.[2]
Poor to fair: high clay content to a depth of 2 feet; sand below 2 feet; erodible where exposed on embankments.	Poor: high clay content; sand below depth of 2 feet.	Rapid permeability below depth of about 2 feet; nearly level topography.	Low permeability of compacted soil from upper 2 feet; rapid permeability in fine sand layers below 2 feet; soil difficult to mix.	Slowly permeable in upper part; water table at depth of 5 to 8 feet in low areas.	Low available water capacity; very slow intake rate.	Not needed; nearly level.[2]
Poor: about 20 inches to clayey shale; high shrink-swell potential; steep slopes.	Poor: too clayey; less than 8 inches thick.	Slow permeability; banks subject to sliding.	High shrink-swell potential; clayey shale at shallow depth; may be difficult to compact if shale is fragmental.	Very slow permeability; steep slopes; rapid surface drainage.	Not suitable; shallow soil; high clay content; steep slopes.	Shallow depth to clayey shale; steep slopes.

TABLE 8.—*Interpretations of engineering*

Soil series and map symbols	Degree and kind of limitation for—					
	Septic tank absorption fields	Sewage lagoons	Shallow excavations	Dwellings without basements	Sanitary landfill [1]	Local roads and streets
Sarpy: SbD, ScC, So.	Severe: risk of contaminating ground water. Slight where protected from flooding.	Severe: very rapid permeability.	Severe: low sidewall stability.	Severe: subject to flooding in some areas. Moderate where slopes are more than 8 percent.	Severe: risk of contaminating ground water; rapid permeability.	Moderate: subject to flooding in places; good foundation for fills; good bearing capacity if sand is confined.
Waubonsie: Wu	Severe: very slow to slow permeability below depth of about 2 to 3 feet.	Slight where lagoon bottom is in contact with CH soil.	Slight: check depth to water table before excavating.	Moderate: subject to frost action and seepage.	Moderate: check depth to water table before selecting site; good cover soil below depth of 3 feet and above depth of 2 feet.	Moderate: subject to erosion by soil blowing and water.

[1] Onsite study is needed of the deep underlying strata, the water table, and the hazards of aquifer pollution and drainage into ground water in landfills deeper than 5 or 6 feet.

excavations for pipelines, sewer lines, phone and power transmission lines, basements, open ditches, and cemeteries. Desirable soil properties are good workability, moderate resistance to sloughing, gentle slopes, absence of rock outcrops or big stones, and freedom from flooding or a high water table.

Dwellings, as rated in table 8, are not more than three stories high and are supported by foundation footings placed in undisturbed soil. The features that affect the rating of a soil for dwellings are those that relate to capacity to support load and resist settlement under load and those that relate to ease of excavation. Soil properties that affect capacity to support load are wetness, susceptibility to flooding, density, plasticity, texture, and shrink-swell potential. Those that affect excavation are wetness, slope, depth to bedrock, and content of stones and rocks.

Sanitary landfill is a method of disposing of refuse in dug trenches. The waste is spread in thin layers, compacted, and covered with soil throughout the disposal period. Landfill areas are subject to heavy vehicular traffic. Some soil properties that affect suitability for landfill are ease of excavation, hazard of polluting ground water, and trafficability. The best soils have moderately slow permeability, withstand heavy traffic, and are friable and easy to excavate. Unless otherwise stated, the ratings in table 8 apply only to a depth of about 6 feet, and therefore limitation ratings of *slight* or *moderate* may not be valid if trenches are to be much deeper than that. For some soils, reliable predictions can be made to a depth of 10 or 15 feet, but regardless of that, every site should be investigated before it is selected.

Local roads and streets, as rated in table 8, have an all-weather surface expected to carry automobile traffic all year. They have a subgrade of underlying soil material; a base consisting of gravel, crushed rock, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. These roads are graded to shed water and have ordinary provisions for drainage. They are built mainly from soil at hand, and most cuts and fills are less than 6 feet deep.

Soil properties that most affect design and construction of roads and streets are the load-supporting capacity and stability of the subgrade and the workability and quantity of cut and fill material available. The AASHO and Unified classifications of the soil material, and also the shrink-swell potential, indicate traffic-supporting capacity. Wetness and flooding affect stability of the material. Slope, depth to hard rock, content of stones and rocks, and wetness affect ease of excavation and amount of cut and fill needed to reach an even grade.

Road fill is soil material used in embankments for roads. The suitability ratings reflect (1) the predicted performance of soil after it has been placed in an embankment that has been properly compacted and provided with adequate drainage and (2) the relative ease of excavating the material at borrow areas.

Topsoil is used for topdressing an area where vegetation is to be established and maintained. Suitability is affected mainly by ease of working and spreading the soil material, as in preparing a seedbed; natural fertility of the material, or the response of plants when fertilizer is applied; and absence of substances toxic to

properties of the soils—Continued

Suitability as source of—		Soil features affecting—				
Road fill	Topsoil	Pond reservoir areas	Embankments, dikes, and levees	Drainage of crops and pasture	Irrigation	Terraces and diversions
Good: severe erodibility where exposed on embankments and cut slopes.	Poor: too sandy; low fertility.	Rapid permeability; nearly level topography.	Medium permeability of compacted soil; fair to good compaction characteristics; subject to seepage if foundation becomes saturated.	Rapid permeability.	Low available water capcity; very rapid intake rate.	Not needed; nearly level.[2]
Fair in top 1.5 to 2 feet: soil below depth of 1.5 to 2 feet is too clayey; substratum below depth of 3 or 4 feet contains less clay.	Good to depth of about 1.5 to 2 feet; poor below as soil is too clayey.	Nearly level topography; slow permeability below depth of 2 to 3 feet.	Medium to low permeability for compacted soil; fair to good compaction characteristic in upper 2 feet; fair to poor below 2 feet; soils difficult to mix.	Slow permeability from a depth of 2 to 3 feet; top 1 to 1.5 feet is erodible by wind and water.	High available water capacity; moderate intake rate; slow permeability in clayey layer.	Not needed; nearly level.[2]

[2] Some areas are benefited by diversions on adjoining higher soils.

plants. Texture of the soil material and its content of stone fragments are characteristics that affect suitability, but also considered in the ratings is damage that will result at the area from which topsoil is taken.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for pond reservoir areas have low seepage, which is related to their permeability and depth to fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material resistant to seepage and piping and of favorable stability, shrink-swell potential, shear strength, and compactibility. Presence of stones or organic material in a soil are among factors that are unfavorable.

Drainage of crops and pasture is affected by permeability, texture, and structure; depth to claypan, rock, or other layers that influence rate of water movement; depth to the water table; slope; stability in ditchbanks; susceptibility to stream overflow; salinity or alkalinity; and availability of outlets for drainage.

Irrigation of a soil is affected by slope; susceptibility to stream overflow, water erosion, or soil blowing; soil texture; content of stones; accumulations of salts and alkali; depth of root zone; rate of water intake at the surface; permeability of soil layers below the surface layer and in fragipans or other layers that restrict movement of water; amount of water held available to plants; and need for drainage or depth to water table or bedrock.[8]

[8] Further information on use of soils for irrigation is in the publication "Irrigation Guide for Nebraska," Soil Conservation Service, 1971.

Terraces and diversions are embankments or ridges constructed across the slope to intercept runoff so that it soaks into the soil or flows slowly to a prepared outlet. Features that affect suitability of a soil for terraces are uniformity and steepness of slope; depth to bedrock or other unfavorable material; presence of stones; permeability; and resistance to water erosion, soil slipping, and soil blowing. A soil suitable for these structures provides outlets for runoff and is not difficult to vegetate.

How the Soils of Dakota County Were Formed and How They Are Classified

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of soils in Dakota County. The second explains the system of soil classification currently used and places each soil series in the classes of that system.

Factors of Soil Formation

Soil is produced by soil-forming processes acting on materials deposited or accumulated by geologic agents. The characteristics of the soil at any given point are determined by (1) the physical and mineralogical composition of the parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and

(5) the length of time the forces of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that is formed and, in exteme cases, determines it almost entirely. Finally, time is needed for changing the parent material into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Generally, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

Parent material is the unconsolidated mass from which a soil forms. It determines the chemical and mineralogical composition of the soil. The soils of Dakota County formed in alluvium, sedimentary bedrock, and loess. A few outcrops of sandstone and glacial till are exposed in the bluffs or on the slopes of deeply entrenched drainageways. The largest area of these materials is in the vicinity of Homer, along Wigle and Fiddlers Creeks.

Approximately 54 percent of the soils of Dakota County formed in Peoria loess. Peoria loess is the yellowish-brown, wind-deposited material that consists mainly of silt particles but also has clay and sand in smaller amounts. The loess contains no pebbles or stones but has numerous lime concretions that have formed since it was deposited. Ida, Monona, Crofton, Nora, and Moody soils formed in loess of the uplands. These soils are friable to very friable and express varying degrees of development. Depth to calcareous, undeveloped loess varies with the soils. Loess soils provide an unrestricted rooting zone for plants. They have a high available water capacity and are generally well aerated.

Alluvium is the parent material for soils on bottom lands in the county. About 45 percent of the soils in the county formed in alluvium of different origins and age. The largest area of alluvial soils is in the Missouri River Valley. Alluvium consists of sediment deposited by water along major streams and in narrow upland drainageways. It varies widely in texture because of differences in the materials from which it originally came and the manner in which it was deposited. Soils of 17 series formed in alluvium in Dakota County. Some of the alluvial material, the local part, was transported for only a short distance and retains many of the characteristics of the soils from which it was washed. Judson and Napier soils are good examples of soils that formed in this kind of alluvium.

Alluvium on the Missouri River bottom lands originated from sources mainly outside the county. Some of this alluvium has been in place long enough to be affected by other soil forming processes. Blencoe, Blyburg, Calco, Forney, and Luton soils formed in this kind of alluvium. These soils have a greater accumulation of organic matter, are less stratified, and show more soil development than soils that formed in younger alluvium.

Albaton, Blake, Haynie, Forney, Modale, Onawa, Owego, and Percival soils formed in the most recent alluvium. This alluvium and the soils that formed from it vary widely in texture. Albaton soils formed entirely in clayey alluvium. Sarpy soils formed in sandy alluvium. Many soils, such as those in the Grable, Modale, and Waubonsie series, formed in layers of differing and contrasting textures.

Graneros Shale, Greenhorn Limestone, and Dakota Sandstone are exposed in some places. The Sansarc soils developed from the Graneros Shale formation. This formation is soft, of sedimentary rock origin, and of Cretaceous age. The Sansarc soils occur in the vicinity of Homer. Dakota Sandstone crops out along the bluffs north of Homer. Soils that formed from the limestone and sandstone were not recognized in Dakota County.

Glacial till is not parent material for any of the soils in Dakota County; however, it occurs as outcrops. The glacial till is from the Kansan glaciation and is firm, calcareous clay loam that contains pebbles and boulders. Associated with the till are pockets of sand in a few areas. The till areas are small and are shown on the detailed soil map by a standard symbol for glacial till.

Climate

Dakota County has a midcontinental climate characterized by wide seasonal variations. A nearly uniform climate prevails throughout the county, although there is some variation in rainfall from north to south.

Climatic changes have an interrelationship with other soil-forming factors in developing soils of the county. The influence of the general climate is modified, however, by local conditions in or near the developing soil. For example, on Ida or Crofton soils that have steep slopes, much of the water runs off the surface. This results in a warmer and drier microclimate than in nearby areas where the slope is not so steep. Soils that tend to pond water, such as those of the poorly drained Forney series, are colder and wetter than the adjacent, moderately well drained Blyburg soils. Soils that have north- and east-facing slopes tend to be cooler and more moist than those that have south-facing slopes, and they are also more likely to be more deeply leached of lime and to support natural stands of trees.

Soil micro-organisms have a temperature range in which they are most active, and this determines the rate organic matter is decomposed to form humus. Weathering of parent material by water and air is activated by changes in temperature. As a result of weathering, changes caused by both physical and chemical actions take place. Rainfall influences the formation of the soils through its effect on the amount of vegetation that grows and on the leaching process in soils.

Plant and animal life

Plants, animals, micro-organisms, earthworms, and other organisms are active in soil-forming processes. The kind of plants and animals that live in and on the soil are affected in turn, by the climate, the parent material, relief, and the age of the soil.

Tall grasses were the dominant vegetation in Dakota County at the time of settlement. Trees covered only a small area, mainly along the bluffs, along major streams, and in areas along the Missouri River. Trees therefore have had only slight influence on soil formation. Trees are presently most common on the steep and very steep soils in the bluff area that borders the Missouri River Valley. They are common in the Gullied land-Ida complex. Some of these stands have been in place long enough to have caused slight, but noticeable, changes in the soils. Trees growing on alluvial soils, such as Sarpy and Albaton soils and Alluvial land, have not had enough time to have had any influence on soil formation.

Grasses have been more important than trees in the formation of the soils on uplands, such as Nora, Moody, and Monona soils. Each year the grasses developed new growth above ground, and their fibrous root systems grew in the upper few feet of the soil. In time an upper layer, moderately high in content of organic matter, formed in the soils. This decayed organic matter helps to develop good structure and tilth in the soil. It also brings plant elements to the soil surface. This process of redistribution keeps the soils productive and plants growing. The decomposition of organic material forms various organic acids that, in solution, hasten the leaching processes of soils and thus aid soil formation.

Organisms have an important role in the formation of soils. Worms and small burrowing animals aid in mixing the soil material with organic matter. This speeds up soil formation and helps make the soil more friable and aerated. Micro-organisms also play an important part in soil formation. There are many kinds of micro-organisms which use plant material residue as food. These micro-organisms break down the residue to humus. When they die, the micho-organisms become an available form of nitrogen for plants.

Man changes soil mainly by causing accelerated erosion. Less obvious are chemical changes in the soil brought about by additions of lime and fertilizer or changes in microbial activity and organic matter content brought about by returning crop residue to the soil.

Relief

The landscape in the uplands of Dakota County is dominantly gently sloping to very steep. The bottom lands are nearly level or depressional. Sandy areas on bottom lands are moderately sloping in a few areas. Through its effect upon drainage, aeration, and erosion, relief is an important factor in the formation of soils.

Even in soils that formed in the same parent material, the influence of relief is seen in the color, thickness, and horizonation of the soils. The gradient, shape, direction, and length of slope influence the amount of moisture in the soil. The steeper the topography, the less moisture is able to penetrate through the soil. As water moves through the soil, it leaches certain elements into lower horizons. Such soils as Ida soils, that formed on steep and very steep landscapes and have medium to rapid runoff, have lime near the surface and little soil development. In Moody soils, which formed in areas not so steep, lime is deeper and horizon development is more evident.

In Dakota County, soils on north- and east-facing slopes have a thicker surface layer and show more profile development. Soils on south- and west-facing slopes receive more sunlight and have warmer temperatures. This increases micro-organism activity and accelerates the rate of decomposition of organic matter. Erosion is also greater on these soils. Water erosion removes soil material faster than horizons can form in some soils.

Relief affects the color of the subsoil through its effect on drainage and soil aeration. For example, the subsoil of a Nora soil, which has good internal drainage, generally is brownish because iron compounds are well distributed throughout the horizon and are well oxidized. The subsoil of soils that have restricted internal drainage are poorly aerated and are generally grayish and may be mottled. Examples are the Forney or Luton soils. Soils like the nearly level Albaton soils are likely to be wet because of slow runoff or a moderately high water table. Where they occur, in poorly drained areas, decay of organic matter is slow or incomplete, and soil formation is slow.

Time

Time enables the factors of relief, climate, and plant and animal life to bring about the formation of soils from the parent material. Where parent material has been in place or exposed for only a short time, the factors of soil formation have not had time to act on the soil material. Examples of mature soils are those of the Moody and Monona series, which have well-developed subsoils and are leached of lime.

The younger, immature soils have not had time to develop such definite subsoil horizons or, in many instances, the soluble calcium carbonate has not been leached from their upper layers. Examples of these are the Albaton and Haynie soils, which formed in recent alluvium. Further examples are the overwash phase of Kennebec soils on bottom land that still receives deposition and the Crofton and Ida soils that have moderately steep slopes where erosion is removing the soil at a faster rate than the soils can develop.

The degree of profile development depends on the intensity of the different soil-forming factors, on the length of time they have been active, and on the nature of the parent material. Differences in the length of time that geologic materials have been in place are therefore commonly reflected in the distinctness of horizons in the soil profile.

Classification of the Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those used in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are placed in broad classes to facilitate study and comparison in large areas, such as countries and continents.

The system of soil classification currently used was adopted by the National Cooperative Soil Survey in 1965. Because this system is under continual study, readers interested in developments of the current system should refer to the latest literature available (*4*, *7*).

The current system of classification has six categories. Beginning with the broadest, these categories are order, suborder, great group, subgroup, family, and series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped together. The same property or subdivisions of that property may be used in several different categories. In table 9, the soil series of Dakota County are placed in three categories of the current system. The classification is current as of March 1974. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. Three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is named with a word of three or four syllables ending in *sol* (Moll-i-sol).

SUBORDER. Each order is divided into suborders using those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than are the orders.

TABLE 9.—*Soils classified according to the current system of classification*

Series	Family	Subgroup	Order
Albaton	Fine, montmorillonitic (calcareous), mesic	Vertic Fluvaquents	Entisols.
Blake [1]	Fine-silty, mixed (calcareous), mesic	Aquic Udifluvents	Entisols.
Blencoe [1]	Clayey over loamy, montmorillonitic, mesic	Aquic Hapludolls	Mollisols.
Blyburg	Coarse-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Calco	Fine-silty, mixed (calcareous), mesic	Cumulic Haplaquolls	Mollisols.
Crofton	Fine-silty, mixed (calcareous), mesic	Typic Ustorthents	Entisols.
Forney [1]	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Grable	Coarse-silty over sandy or sandy-skeletal, mixed (calcareous), mesic.	Typic Udifluvents	Entisols.
Haynie	Coarse-silty, mixed (calcareous), mesic	Typic Udifluvents	Entisols.
Ida	Fine-silty, mixed (calcareous), mesic	Typic Udorthents	Entisols.
Judson	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Kennebec	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Luton [1]	Fine, montmorillonitic, mesic	Vertic Haplaquolls	Mollisols.
Modale [1]	Coarse-silty over clayey, mixed (calcareous), mesic	Aquic Udifluvents	Entisols.
Monona	Fine-silty, mixed, mesic	Typic Hapludolls	Mollisols.
Moody [1]	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Napier	Fine-silty, mixed, mesic	Cumulic Hapludolls	Mollisols.
Nora [1]	Fine-silty, mixed, mesic	Udic Haplustolls	Mollisols.
Omadi	Fine-silty, mixed, mesic	Fluventic Hapludolls	Mollisols.
Onawa [1]	Clayey over loamy, montmorillonitic (calcareous), mesic	Mollic Fluvaquents	Entisols.
Owego [1]	Fine, montmorillonitic (calcareous), mesic	Fluvaquentic Haplaquolls	Mollisols.
Percival	Clayey over sandy or sandy-skeletal, montmorillonitic (calcareous), mesic.	Aquic Udifluvents	Entisols.
Sansarc [1]	Clayey, montmorillonitic (calcareous), mesic, shallow	Typic Ustorthents	Entisols.
Sarpy	Mixed, mesic	Typic Udipsamments	Entisols.
Waubonsie	Coarse-loamy over clayey, mixed, (calcareous), mesic	Aquic Udifluvents	Entisols.

[1] These soils are taxadjuncts. The reasons for excluding them from the series with which they are here identified are as follows:

Blake.—The surface layer is darker than defined in the range for the series.

Blencoe.—The clayey upper material is thinner and the depth to carbonates is shallower than defined in the range for the series.

Forney.—These soils are more stratified and are shallower to carbonates than defined in the range for the series.

Luton.—The A horizon is thinner and the depth to carbonates is shallower than defined in the range for the series.

Modale.—These soils lack a sufficient change in texture within a thickness of 5 inches to meet the definition of strongly contrasting textures, and they have a darker A horizon than defined in the range for the series.

Moody, mapping unit MoD2.—The A horizon is lighter colored and thinner than defined in the range for the series.

Nora, mapping units NoC2, NoD2, and NoE2.—The A horizon is lighter colored and thinner than defined in the range for the series.

Onawa.—The mottles are darker colored than defined in the range for the series.

Owego.—The upper clayey layers are thinner and the underlying material lacks the mottles as defined in the range for the series.

Sansarc.—These soils are in an area of higher rainfall, have less clay in the A horizon, and have browner colors in the C horizon than defined in the range for the series.

The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper part of the solum; cracking of soils caused by a decrease in soil moisture; and fine stratification. The names of suborders have two sylables. The last syllable indicates the order. An example is *Aquoll* (Aqu, meaning water or set, and *oll,* from Mollisol).

GREAT GROUP. Soil suborders are separated into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed and those that have pans that interfere with growth of roots, movement of water, or both. Some features used are soil acidity, soil climate, soil composition, and soil color. The names of great groups have three or four syllables and are made by adding a prefix to the name of the suborder. An example is Haplaquoll (*Hapl,* meaning simple horizons, *aqu* for wetness or water, and *oll,* from Mollisol).

SUBGROUP. Great groups are subdivided into subgroups, one representing the central (typic) segment of the group, and other called intergrades that have properties of the group and also one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, suborder, or order. The names of subgroups are derived by placing one or more adjectives before the name of the great group. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY. Soil families are separated within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils that are used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name consists of a series of adjectives preceding the subgroup name. The adjectives are the class names for texture, mineralogy, and so on, that are used to differentiate families. An example is the coarse-loamy, mixed, mesic family of Typic Haplaquolls.

Mechanical and Chemical Analysis

Samples from soil profiles were collected for mechanical and chemical analysis by the Soil Conservation Service, Soil Survey Laboratory in Lincoln, Nebraska. Soils of the Crofton, Luton, Moody, Monona, and Nora series were sampled in nearby counties. These data are recorded in Soil Survey Investigations Report Number 5 (*9*). Ida and Napier soils were sampled in counties in Iowa. This data is recorded in Soil Survey Investigations Report Number 3 (*8*).

This information is useful to soil scientists in classifying soils and developing concepts of soil genesis. It is also helpful in estimating available water capacity, susceptibility to soil blowing, fertility, tilth, and other practical aspects of soil management.

Environmental Factors Affecting Soil Use

This section was prepared mainly for those not familiar with Dakota County. Among the environmental factors affecting the use of soils in the county are geology, relief, climate, water supply, and natural vegetation. Other factors include transportation facilities and the manufacturing and business services of agriculture.

Geology

The oldest geologic materials exposed in the county are of Cretaceous age. They are Greenhorn Limestone, Graneros Shale, and Dakota Sandstone (*2*). They crop out in the bluff areas near the town of Homer and in isolated areas along the deeply dissected bluffs. Dakota Sandstone is of economic importance as a source of water for domestic use and for livestock. Soils of the Sansarc series formed in material weathered from Graneros Shale.

Continental glaciers of the Nebraska and Kansas stage (*3*) entered the county from the northeast. They covered rocks of Cretaceous age with glacial debris, which is a heterogenous mass of sand, clay, silt, and some gravel and boulders. Because loess was deposited over the glacial material, glacial till is at the surface in only a few places where drainage entrenchment and erosion have removed the overlying loess. No soils in Dakota County formed in glacial till.

Peoria Loess has a high content of silt and a low content of sand. It is the material in which nearly all soils on the uplands formed. After the loess was deposited, the landscape was eroded to form the present topography, which consists of ridges that alternate with narrow valleys. Soils of the Crofton, Ida, Monona, Moody, and Nora series formed in Peoria Loess.

The narrow stream valleys of the upland drainageways consist primarily of local silty alluvium on foot slopes and bottom lands. Soils of the Napier and Judson series formed in this material.

The bottom lands on the Missouri River Valley have alluvial deposits that originated from many areas outside the county. This is reflected in the wide range of material in which the soils developed. Albaton, Forney, Luton, and Owego soils formed in alluvium that is mainly fine textured. Calco soils formed in moderately fine textured alluvium. Blyburg, Grable, Haynie, Kennebec, and Omadi soils formed in alluvium that is mainly medium textured. Sarpy soils formed in alluvium that is mainly coarse textured. Blake, Blencoe, Modale, Onawa, Percival, and Waubonsie soils formed in alluvium of varied and mixed textures.

Relief and Drainage

Dakota County consists of two main topographic areas. The loess-covered uplands, including the bluff area that borders the Missouri River Valley, lie in the northern part of Nebraksa's rolling hills and make up about 55 percent of the county. The other 45 percent consists of Missouri River bottom lands and valleys of creeks that head in the uplands

The south-central part of the county has less relief than any other part of the uplands. Drainageways in this area have low gradients and are not deeply entrenched. The rest of the uplands, particularly the bluff area, is strongly dissected, and nearly all drainageways have steep gradients and entrenched channels.

The difference between the lowest and highest elevation in the county is about 450 feet. The lowest elevation, at the southeast corner of the county on the Missouri River, is 1,070 feet above sea level. The highest elevation, near the southwest corner of the county, is 1,520 feet. The average elevation over most of the Missouri River bottom lands is about 1,110 feet. The elevation of South Sioux City is 1,106 feet above sea level, of Dakota City is 1,102, of Emerson is 1,426, of Hubbard is 1,157, and of Jackson is 1,124 feet.

Most of Dakota County is drained by the Missouri River and its tributaries. Elk, Pigeon, and Omaha Creeks flow into the Missouri River within the county. These creeks are fed by many smaller streams, springs, and intermittent drainageways that divide the upland part of the county. They flow in a northeasterly direction. As they enter the Missouri River bottom lands, Pigeon and Omaha Creeks flow easterly and southeasterly. Elk, Pigeon, and Omaha Creeks are confined to constructed channels, the bottoms of which are at about the same elevation as the surrounding land. Elk and Pigeon Creeks drain all of the west, north, and central part of the uplands. Omaha Creek drains the southern part, except for a narrow area along the Dakota-Thurston County line in the southwestern corner that drains southeasterly to Logan Creek in Thurston County.

The Missouri River bottom lands are nearly flat but are broken in places by depressions, oxbows, and old channels. Northeast of Hubbard, on the north side of Pigeon Creek, there is a large depressed area, and north of Crystal Lake, there are some sand ridges.

Large dams on the Missouri River have greatly reduced flooding of the valley bottom lands. The reduced flooding and the straightening of the river channel have improved drainage in some areas. Some lakes that were in oxbows of the river have been drained, either partly or entirely, and the soil is presently farmed. Only Crystal and Blyburg Lakes remain. Crystal Lake is larger and is used as a recreation area.

The higher bottom lands of the Missouri River Valley were at one time subject to flooding by creeks and drainageways of the uplands. These streams deposited sediment that filled lakes and low areas. Drainage districts were organized, and floodwaters are now confined to channels. Flood protection and the drying up of shallow lakes have helped improve soil drainage. Nearly all drainageways in the county have some problems associated with flooding.

Climate [9]

The climate of Dakota County is typical of the interior of a large continent. Summers are warm and winters are cold; precipitation is moderate. Temperature and precipitation vary considerably from year to year largely because of the location, movement, and interaction of large-scale weather systems.

Temperature and precipitation data are given in table 10, and the probabilities of freezing temperatures are shown in table 11. These data are based on records kept at Homer, Nebraska, and nearby Sioux City, Iowa. They are believed to be representative of Dakota County, but minimum temperatures on calm clear nights frequently vary, as do showers over short distances.

About three-quarters of the annual precipitation falls during the warm half of the year, April through September. In an average year, precipitation amounting to 0.01 inch or more falls on 97 days, and amounts of 0.10 inch or more fall on 48 days. Heavy precipitation, amounting to 0.50 inch or more, occurs on an average of 18 days per year, and 14 of these days are in the warm half of the year when the potential for soil erosion is high. Once a year, rainfall amounts of 1.0 inch in 30 minutes, 1.3 inches in an hour, 1.5 inches in 3 hours, 2.1 inches in 12 hours, or 2.5 inches in 24 hours should be expected.

As spring begins, precipitation is continuous, slow accumulating, and well distributed. By the end of spring and in summer, most of the precipitation is from erratic showers and thunderstorms. A few of the thunderstorms are severe and are accompanied by torrential rains, hail, damaging winds, or, on rare occasions, a tornado.

Average annual snowfall adds up to about 32 inches and accounts for approximately 10 percent of the annual precipitation. The first snow, amounting to an inch or more, generally falls late in November, but snow has fallen late in September. Snowfall is often accompanied by brisk north winds, which can whip the snow into sizable drifts.

Dry topsoil and ample subsoil moisture are the optimum combination during crop planting, but variations from this optimum are frequent. It is difficult to provide the desired 1 inch of moisture per week for growing corn if moisture is lacking in the subsoil at the beginning of the growing season. The chances are 2 in 5 of receiving a weekly rainfall of 1 inch in June but only 1 in 4 late in July and in all of August.

Since 1890, when records were first kept, the temperature at Sioux City has ranged from 111° F, on July 11, 1939, to 35° below zero, on January 12, 1912. In an average year, the temperature drops to about 19° below zero and rises to 100° or higher. Temperatures above 90° are too high for optimum growth of corn. They occur on an average of 34 days per year but have occurred on as many as 70 days, in 1936, and on as few as 3 days, in 1915. Freezing temperatures occur on an average of 152 days per year. The growing season generally lasts about 160 days.

The free water that evaporates from shallow lakes averages 38 inches a year, and 78 percent of this evaporates in May through October.

[9] By MORRIS S. WEBB, JR., climatologist for Nebraska, National Weather Service, U.S. Department of Commerce.

TABLE 10.—*Temperature and precipitation*

[Data from Sioux City, Woodbury County, Iowa, unless otherwise noted]

Month	Temperature: Average daily maximum [1]	Temperature: Average daily minimum [1]	Temperature: Two years in 10 will have at least 4 days with—[2] Maximum temperature equal to or higher than—	Temperature: Two years in 10 will have at least 4 days with—[2] Minimum temperature equal to or lower than—	Precipitation: Average monthly total [3]	Precipitation: One year in 10 will have—[3] Equal to or less than—	Precipitation: One year in 10 will have—[3] Equal to or more than—	Precipitation: Days with 1 inch or more of snow cover	Precipitation: Average depth of snow on days with snow cover
	° F	*° F*	*° F*	*° F*	*Inches*	*Inches*	*Inches*	*Number*	*Inches*
January	28	9	49	−12	0.5	0.2	0.8	22	5
February	32	13	54	−11	1.0	.1	2.3	15	5
March	44	25	65	3	1.3	.5	2.4	12	6
April	60	38	81	20	2.3	1.3	3.5	(4)	3
May	72	50	89	34	3.7	1.7	5.9		
June	81	60	96	45	4.5	2.7	6.5		
July	87	64	97	51	3.4	1.5	5.7		
August	84	62	96	49	2.8	1.2	4.9		
September	76	53	94	35	2.8	.6	5.9		
October	64	41	84	24	2.0	.3	4.2	(4)	2
November	46	27	69	7	1.0	.1	2.2	2	3
December	33	15	55	−10	.7	.2	1.9	13	3
Year	59	38	[5] 100	[6] −19	26.0	19.5	32.2	64	5

[1] Data based on period 1890–1971.
[2] Data based on period 1948–63.
[3] Data from Homer, Dakota County, based on period 1946 to May 1972.
[4] Less than half a day.
[5] Average annual highest temperature for the period 1949–71.
[6] Average annual lowest temperature for the period 1949–71.

TABLE 11.—*Probabilities of specified temperatures in spring and fall*

[All data from Sioux City, Iowa]

Probability	Dates for given probability and temperature [1]: 16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
1 year in 10 later than	April 6	April 12	April 21	April 26	May 15
2 years in 10 later than	March 31	April 6	April 14	April 21	May 8
5 years in 10 later than	March 20	March 27	April 6	April 13	April 28
Fall:					
1 year in 10 earlier than	November 1	October 27	October 16	September 30	September 27
2 years in 10 earlier than	November 5	October 30	October 23	October 8	October 1
5 years in 10 earlier than	November 13	November 6	November 2	October 20	October 9

[1] Based on temperatures in a standard National Weather Service thermometer shelter at a height of approximately 5 feet above the ground and in a representative exposure. Lower temperatures exist at times nearer the ground and in local areas subject to extreme air drainage. The dates in this table are based on the period 1949–71.

Water Supply

Water for domestic use and for livestock is available from wells throughout most of the county. In the western part of the county, well water comes from pockets of sand and gravel in or at the base of glacial till. In the bluff area, water in wells 75 to 350 feet deep comes from the sandstone of the Dakota Formation. The water is usable but is very hard. In some places, sulfates or chlorides give the water an unpleasant taste. Good-quality water is obtained from shallow wells, generally less than 50 feet deep, in the narrow stream valleys and on the Missouri River bottom lands. Farm ponds and streams are used to supplement wells for watering livestock.

Wells that supply water for irrigation can be developed in the alluvium of the Missouri River Valley, but test drilling is necessary to locate the most favorable sites. The quality of the water generally is good, the pumping lift is not excessive, and recharge is adequate to prevent rapidly declining water levels. On the bottom lands of the Missouri River Valley there is potential for expanding irrigation, but in the uplands the potential for developing irrigation wells is limited.

Natural Vegetation

The original native vegetation in Dakota County was principally tall grasses. The most important grasses were big bluestem, little bluestem, switchgrass, and indiangrass. Swamp grasses and rushes grew in sizable marshlike areas. The composition of the vegetation varied with the drainage characteristics of the areas.

Woodlands cover approximately 5 percent of the county. They occur on bluffs, along streams, and in and along old channels of the Missouri River. The largest area is in the bluffs along the Missouri River Valley. The common tree species in this area are red elm, black oak, hackberry, black walnut, white elm, bur oak, and basswood. The underbrush is sumac, dogwood, and ironwood. The low bottoms along streams of the narrow upland drainageways support a fairly dense growth of elm, ash, oak, cottonwood, and willow. Cottonwood, willow, elm, and box elder are along the abandoned channels of the Missouri River, and a fairly dense growth of small willows is along the alluvial flood plains.

Cultural Features

Among the transportation facilities in the county are one railroad line that enters the county from the south along Omaha Creek and continues north to South Sioux City, one that enters the county near the town of Emerson, and a third line that follows Otter and Elk Creeks. These railroads provide service to the county from South Sioux City, Nebraska, and Sioux City, Iowa. State highways 9, 12, 35, and 110 and federal highways 20, 73, and 77 are the main roads to markets. All the rural mail routes are graveled. A small airport is near South Sioux City, and a larger one is nearby in Sioux City, Iowa.

The towns of South Sioux City and Dakota City are the largest markets and shopping centers in the county. Other towns are well distributed throughout the county. They are Emerson, Homer, Hubbard, and Jackson. Most of the industries in the county are related to purchasing, processing, and selling farm-related products. Meatpacking, feedmills, and an alfalfa-dehydrating mill, concrete products, and farm-machinery plants are some of the common industries. There are grain elevators in nearly all towns of Dakota County, and these handle most of the locally grown grains that are marketed.

Outdoor recreation is provided by Crystal Lake and the Omadi Bend State Recreation Area and by many recreation areas along the Missouri River. Offering recreation opportunities in the uplands are the Basswood Ridge special use area and, near South Sioux City, golf courses and the Atokad racetrack.

Trends in Farming and Soil Use

Farming has been the most important enterprise in Dakota County since the county was settled. Fattening beef cattle in drylots and raising hogs, along with farm-related industries, provide part of the income of people of Dakota County. These enterprises have not grown as much in this county as they have in adjoining counties because many rural residents supplement their farm income with off-the-farm employment.

According to the Nebraska Agricultural Statistics reports, in the period 1957 to 1970, the number of hogs increased from 24,060 to 34,900, the number of beef cattle increased from 18,260 to 28,250, and the number of milk cows decreased from 2,670 to 1,050. A large number of cattle are shipped in for fattening.

Corn is by far the most important crop grown in the county. In 1957, 2,381,670 bushels were harvested from 50,850 acres, and 101,910 bushels of irrigated corn were harvested from 1,290 acres. In 1969, 2,914,500 bushels were harvested from 43,500 acres and 145,500 bushels from 1,500 acres.

Soybeans have shown a large increase as an important cash-grain crop. In 1957, there were 100,440 bushels harvested from 3,720 acres. By 1970 production increased to 382,800 bushels on 17,400 acres.

Production of oats has decreased considerably. In 1957, 647,520 bushels were harvested on 20,920 acres, but by 1970 production was down to 395,600 bushels on only 9,200 acres. Oats are planted as a nurse crop when legumes are seeded.

Alfalfa hay has decreased slightly because of its need in the cropping sequence. In 1957, there were 30,060 tons of hay harvested from 13,070 acres. By 1970, production decreased to 25,200 tons harvested from 9,000 acres. A large acreage of alfalfa grown on the bottom lands is dehydrated. Alfalfa grown on the uplands is used for hay.

There are a few acres of potato and small vegetable gardens, and the produce from these is sold locally. Popcorn is a minor crop. A few acres of legumes are harvested for seed.

The number of farms in the county, according to the Census of Agriculture, decreased from 540 in 1964 to 454 in 1969.

The trend is towards larger sized operating units. Average size of farms was 146 acres in 1964, and this gradually increased to 394 in 1969. The average cost per acre of farmland varies with the kind of soil. Farmland has decreased from 155,245 acres in 1964 to 143,292 acres in 1969. Much farm acreage near South Sioux City and Dakota City has gone to highway, housing, and industrial use.

Cash-grain farms are by far the most important type of farm operation in Dakota County. But nearly all farms have some livestock. In 1969, 214 farms in the county were operated by full owners, 120 by part owners, and 120 by tenants.

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Glossary

Alluvium. Soil material, such as sand, silt, or clay, that has been deposited on land by streams.

Available water capacity. The capacity of soils to hold water available for use by most plants, commonly defined as the difference between the percentage of soil water at field capacity and the percentage at the wilting point of most plants. This difference multiplied by the bulk density and divided by 100 gives a value in surface inches of water per inch depth of soil. In this survey, the classes of available water capacity for a 60 inch profile or to a limiting layer are:

Very low	0 to 3 inches
Low	3 to 6 inches
Moderate	6 to 9 inches
High	more than 9 inches

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (often with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Colluvium. Soil material, rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrations of compounds, or of soil grains cemented together. The composition of some concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are examples of material commonly found in concretions.

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

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

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

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

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

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

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

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

Cemented.—Hard and brittle; little affected by moistening.

Contour farming. Plowing, cultivating, planting, and harvesting in rows that are at right angles to the natural direction of the slope or that are parallel to terrace grade.

Depth, soil. The total thickness of weathered soil material over mixed sand and gravel or bedrock. In this survey the classes of soil depth used are.

Very shallow	0 to 10 inches
Shallow	10 to 20 inches
Moderately deep	20 to 40 inches
Deep	more than 40 inches

Diversion, or diversion terrace. A ridge of earth, generally a terrace, that is built to divert runoff from its natural course and, thus, to protect areas downslope from the effects of such runoff.

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

Excessively drained soils are commonly very porous and rapidly permeable and have a low water-holding capacity.

Somewhat excessively drained soils are also very permeable and are free from mottling throughout their profile.

Well-drained soils are nearly free from mottling and are commonly of intermediate texture.

Moderately well drained soils commonly have a slowly permeably layer in or immediately beneath the solum. They have uniform color in the A and B horizons and mottling in the lower B and the C horizons.

Somewhat poorly drained soils are wet for significant periods but not all the time, and some soils commonly have mottling at a depth below 6 to 16 inches.

Poorly drained soils are wet for long periods and are light gray and generally mottled from the surface downward, although mottling may be absent or nearly so in some soils.

Very poorly drained soils are wet nearly all the time. They have a dark-gray or black surface layer and are gray or light gray, with or without mottling, in the deeper parts of the profile.

Dryfarming. Production of crops that require some tillage in a subhumid or semiarid region, without irrigation. Usually involves use of periods of fallow, during which time enough moisture accumulates in the soil to allow production of a cultivated crop.

Eolian soil material. Earthy parent material accumulated through wind action; commonly refers to sandy material in dunes or to loess in blankets on the surface.

Erosion. The wearing away of the land surface by wind (sandblast), running water, and other geological agents.

Fallow. Cropland left idle in order to restore productivity, mainly through accumulation of water, nutrients, or both. Summer fallow is a common stage before cereal grain in regions of limited rainfall. The soil is tilled for at least one growing season to control weeds, to aid decomposition of plant residues, and to encourage the storage of moisture for the succeeding grain crop.

Fertility, soil. The quality of a soil that enables it to provide compounds, in adequate amounts and in proper balance, for the growth of specified plants, when other growth factors such as light, moisture, temperature, and the physical condition of the soil are favorable.

Flood plain. Nearly level land, consisting of stream sediments, that borders a stream and is subject to flooding unless protected artifically.

Genesis, soil. The manner in which a soil originates. Refers especially to the processes initiated by climate and organisms that are responsible for the development of the solum, or true soil, from the unconsolidated parent material, as conditioned by relief and age of landform.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Green manure (agronomy). A crop grown for the purpose of being turned under in an early stage of maturity or soon after maturity for soil improvement.

Horizon, soil. A layer of soil, approximately parallel to the surface, that has distinct characteristics produced by soil-forming processes. These are the major horizons:

O horizon.—The layer of organic matter on the surface of a mineral soil. This layer consists of decaying plant residues.

A horizon.—The mineral horizon at the surface or just below an O horizon. This horizon is the one in which living organisms are most active and therefore is marked by the accumulation of humus. The horizon may have lost one or more of soluble salts, clay, and sesquioxides (iron and aluminum oxides).

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or some combination of these; (2) by prismatic or blocky structure; (3) by redder or stronger colors than the A horizon; or (4) by some combination of these. Combined A and B horizons are usually called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The weathered rock material immediately beneath the solum. In most soils this material is presumed to be like that from which the overlying horizons were formed. If the material is known to be different from that in the solum, a Roman numeral precedes the letter C.

Immature soil. A soil lacking clearly defined horizons because the soil-forming forces have acted on the parent material only a relatively short time since it was deposited or exposed.

Intake rate. The average rate that water enters the soil under irrigation. Most soils have a faster initial rate which slows with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending upon the net irrigation application. The rate of water intake in inches per hour is expressed thus:

Very rapid	more than 3.0
Rapid	1.5 to 3.0
Moderate	0.5 to 1.5
Slow	0.3 to 0.5
Very slow	less than 0.3

Leaching. The removal of soluble materials from soils or other material by percolating water.

Legume. A member of the legume or pulse family (*Leguminosae*), one of the most important and widely distributed plant families. Includes many valuable forage species, such as peas, beans, peanuts, clover, alfalfa, sweet clover, lespedeza vetch, and kudzu. Practically all legumes are nitrogen-fixing plants, and many of the herbaceous species are used as cover and green-manure crops. Even some of the legumes that have no forage value (crotalaria and some lupines) are used for soil improvement. Other legumes are locust, honeylocust, redbud, mimosa, wisteria, and many tropical plants.

Lime. Chemically, lime is calcium oxide (CaO), but its meaning has been extended to include all limestone-derived materials applied to neutralize acid soil. Agricultural lime can be obtained as ground limestone, hydrated lime, or burned lime, with or without magnesium minerals. Basic slag, oystershells, and marl also contain calcium.

Loess. Fine-grained material, dominantly of silt-sized particles, that has been deposited by wind.

Mature soil. Any soil with well-developed soil horizons having characteristics produced by the natural processes of soil formation and in near equilibrium with its present environment.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineralogical, and biological properties of the various horizons, and their thickness and arrangement in the soil profile.

Mottling, soil. Irregularly marked with spots of different colors that vary in number and size. Mottling in soils usually indicates poor aeration and lack of drainage. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distint,* and *prominent.* The size measurements are these: *fine,* less than 5 millimeters (about 0.2 inch) in diameter along the greatest dimensions; *medium,* ranging from 5 millimeters to 15 millimeters (about 0.2 to 0.6 inch) in diameter along the greatest dimension; and *coarse,* more than 15 millimeters (about 0.6 inch) in diameter along the greatest dimension.

Mulch. A natural or artificially applied layer of plant residue or other material on the surface of the soil. Mulches are generally used to help conserve moisture, control temperature, prevent surface compaction or crusting, reduce runoff and erosion, improve soil structure, or control weeds. Common mulching materials are wood chips, plant residue, sawdust, and compost.

Munsell notation. A system for designating color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with a hue of 10YR, a value of 6, and a chroma of 4.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. Disintegrated and partly weathered rock from which soil has formed.

Ped. An individual natural soil aggregate, such as a crumb, a prism, or a block, in contrast to a clod.

pH value. A numerical means for designating acidity and alkalinity in soils. A pH value of 7.0 indicates precise neutrality; a higher value, alkalinity; and a lower value, acidity.

Permeability. The quality of a moist soil that enables water or air to move through it. In this survey, permeability applies to that part of the soil below the Ap horizon or equivalent layer and to a depth of 60 inches, or to bedrock at a shallower depth. Where there is a change of two or more permeability classes within a short vertical distance, the classes and depths will be stated. Classes of soil permeability in inches of water per hour are as follow:

Class	Inches per hour
Very slow	less than 0.06
Slow	0.06 to 0.2
Moderately slow	0.2 to 0.6
Moderate	0.6 to 2.0
Moderately rapid	2.0 to 6.0
Rapid	6.0 to 20.0
Very rapid	more than 20.0

Profile, soil. A vertical section of the soil through all its horizons and extending into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is precisely neutral in reaction because it is neither acid nor alkaline. An acid, or "sour," soil is one that gives an acid reaction; an alkaline soil is one that is alkaline in reaction. In words, the degrees of acidity or alkalinity are expressed thus:

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Runoff (hydraulics). The part of the precipitation upon a drainage area that is discharged from the area in stream channels. The water that flows off the land surface without sinking in is called surface runoff; that which enters the ground before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Sand. Individual rock or mineral fragments in a soil that range in diameter from 0.05 to 2.0 millimeters. Most sand grains consist of quartz, but they may be of any mineral composition. The texture class name of any soil that contains 85 percent or more sand and not more than 10 percent clay.

Silt. Individual mineral particles in a soil that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). Soil of the silt texture class is 80 percent or more silt and less than 12 percent clay.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur as the base of slip surfaces on relatively steep slopes and in swelling clays, where there is marked change in moisture content.

Slope. The degree of deviation of a surface from the horizontal, usually expressed in percent or degrees. In this survey, the following slope classes are recognized:

Nearly level	0 to 2 percent
Gently sloping	2 to 6 percent
Moderately sloping	6 to 11 percent
Strongly sloping	11 to 15 percent
Steep	15 to 30 percent
Very steep	30 to 60 percent

Soil. A natural, three-dimensional body on the earth's surface that supports plants and that has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Solum. The upper part of a soil profile, above the parent material, in which the processes of soil formation are active. The solum in mature soil includes the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristic of the soil are largely confined to the solum.

Stratified. Composed of, or arranged in, strata or layers, such as stratified alluvium. The term is confined to geological material. Layers in soils that result from the processes of soil formation are called horizons; those that are inherited from the parent material are called strata.

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

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

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it may soak into the soil or flow slowly to a prepared outlet without harm. Terraces in fields are generally built so they can be farmed. Terraces intended mainly for drainage have a deep channel that is maintained in permanent sod.

Terrace (geological). An old alluvial plain, ordinarily flat or undulating, bordering a river, lake, or the sea. Stream terraces are frequently called second bottoms, as contrasted to flood plains, and are seldom subject to overflow. Marine terraces were deposited by the sea and are generally wide.

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

Topsoil. A presumed fertile soil or soil material, or one that responds to fertilization, ordinarily rich in organic matter, used to topdress roadbanks, lawns, and gardens.

Underlying material. Weathered soil material immediately beneath the solum. In this survey, the C horizon of a soil.

Upland (geology). Land consisting of material unworked by water in recent geologic time and lying, in general, at a higher elevation than the alluvial plain or stream terrace. Land above the lowlands along rivers.

Water table. The highest part of the soil or underlying rock material that is wholly saturated with water. In some places an upper, or perched, water table may be separated from a lower one by a dry zone.

GUIDE TO MAPPING UNITS

For a full description of a mapping unit, read both the description of the mapping unit and that of the soil series to which the mapping unit belongs. Information about the use and management of each soil is given in the description of the capability unit and windbreak suitability group, pages 56 and 57, to which it is assigned. Other information is given in tables as follows:

Acreage and extent, table 1, page 10.
Predicted yields, table 2, page 53.
Engineering uses of the soils, tables 6, 7, and 8, pages 64 through 70.

Map symbol	Mapping unit	Page	Capability unit Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Windbreak suitability group Number
Aa	Albaton silty clay loam, 0 to 2 percent slopes	11	IIIw-2	43	IIIw-1	51	2
Ab	Albaton silty clay, 0 to 2 percent slopes	11	IIIw-1	42	IIIw-1	51	2
Ac	Albaton silty clay, depressional, 0 to 1 percent slopes	11	Vw-1	46	-----	--	10
Ad	Alluvial land	11	Vw-7	46	-----	--	10
Ba	Blake silty clay loam, 0 to 2 percent slopes	12	I-1	39	I-3	48	1
Bb	Blencoe silty clay, 0 to 2 percent slopes	13	IIw-1	40	IIw-1	49	2
Bc	Blyburg silt loam, 0 to 2 percent slopes	13	I-1	39	I-6	48	1
BcC	Blyburg silt loam, 2 to 6 percent slopes	13	IIe-1	40	IIIe-6	51	1
Bd	Blyburg silty clay loam, 0 to 2 percent slopes	14	I-1	39	I-3	48	1
Be	Blyburg silty clay, overwash, 0 to 2 percent slopes	14	IIw-1	40	IIw-1	49	2
Ca	Calco silt loam, overwash, 0 to 2 percent slopes	14	IIw-4	41	IIw-4	50	2
Cb	Calco silty clay loam, 0 to 2 percent slopes	15	IIw-4	41	IIw-3	50	2
CfC2	Crofton silt loam, 2 to 6 percent slopes, eroded	16	IIIe-9	42	IIIe-6	51	5
CfD2	Crofton silt loam, 6 to 11 percent slopes, eroded	16	IVe-9	45	IVe-6	52	5
CfE	Crofton silt loam, 11 to 15 percent slopes	16	IVe-9	45	-----	--	5
CfE2	Crofton silt loam, 11 to 15 percent slopes, eroded	16	IVe-9	45	-----	--	5
CfF	Crofton silt loam, 15 to 30 percent slopes	16	VIe-9	46	-----	--	10
CfF2	Crofton silt loam, 15 to 30 percent slopes, eroded	16	VIe-9	46	-----	--	10
Fn	Forney silt loam, overwash, 0 to 2 percent slopes	17	IIw-2	41	IIw-2	49	2
Fo	Forney silty clay, 0 to 2 percent slopes	18	IIIw-1	42	IIIw-1	51	2
Fs	Forney soils, swales, 0 to 2 percent slopes	18	IIIw-1	42	IIIw-1	51	6
Gb	Grable very fine sandy loam, 0 to 2 percent slopes	18	IIs-5	40	IIs-6	49	1
GuG	Gullied land-Ida complex, 30 to 60 percent slopes	19	VIIe-7	48	-----	--	10
He	Haynie silt loam, 0 to 2 percent slopes	20	I-1	39	I-6	48	1
IdE2	Ida silt loam, 11 to 17 percent slopes, eroded	21	IVe-9	45	-----	--	5
IdF	Ida silt loam, 17 to 30 percent slopes	21	VIe-9	46	-----	--	10
IdF2	Ida silt loam, 17 to 30 percent slopes, eroded	21	VIe-9	46	-----	--	10
IeG	Ida soils, 30 to 60 percent slopes	21	VIIe-9	48	-----	--	10
Ju	Judson silty clay loam, 0 to 2 percent slopes	22	I-1	39	I-3	48	1
JuC	Judson silty clay loam, 2 to 6 percent slopes	22	IIe-1	40	IIIe-3	50	4
Ke	Kennebec silt loam, 0 to 2 percent slopes	23	I-1	39	I-6	48	1
Ko	Kennebec silt loam, overwash, 0 to 2 percent slopes	23	IIw-3	41	IIw-6	50	1
Lu	Luton silty clay, thin surface, 0 to 2 percent slopes	24	IIIw-1	42	IIIw-1	51	2
Mh	Marsh	24	VIIIw-7	48	-----	--	10
Mk	Modale silt loam, 0 to 2 percent slopes	25	I-1	39	I-6	48	1
MnD	Monona silt loam, 6 to 11 percent slopes	25	IIIe-1	42	IVe-6	52	4
MnE	Monona silt loam, 11 to 17 percent slopes	25	IVe-1	44	-----	--	4
MnF	Monona silt loam, 17 to 30 percent slopes	26	VIe-1	46	-----	--	10
MoC	Moody silty clay loam, 2 to 6 percent slopes	26	IIe-1	40	IIIe-3	50	4
MoD	Moody silty clay loam, 6 to 11 percent slopes	27	IIIe-1	42	IVe-3	51	4
MoD2	Moody silty clay loam, 6 to 11 percent slopes, eroded	27	IIIe-8	42	IVe-3	51	4
MpE	Moody-Nora silty clay loams, 11 to 15 percent slopes	27	IVe-1	44	-----	--	4
NaC	Napier silt loam, 2 to 6 percent slopes	28	IIe-1	40	IIIe-6	51	4

Map symbol	Mapping unit	Page	Capability unit: Dryland Symbol	Dryland Page	Irrigated Symbol	Irrigated Page	Windbreak suitability group Number
NaD	Napier silt loam, 6 to 11 percent slopes-----------	28	IIIe-1	42	IVe-6	52	4
NaE	Napier silt loam, 11 to 15 percent slopes----------	28	IVe-1	44	-----	--	4
NgD	Napier-Gullied land complex, 2 to 11 percent slopes---	28	VIIe-7	48	-----	--	--
	Napier soil------------------------------------	--	-----	--	-----	--	4
	Gullied land-----------------------------------	--	-----	--	-----	--	10
NoC2	Nora silt loam, 2 to 6 percent slopes, eroded------	29	IIIe-8	42	IIIe-6	51	4
NoD	Nora silt loam, 6 to 11 percent slopes-------------	29	IIIe-1	42	IVe-6	52	4
NoD2	Nora silt loam, 6 to 11 percent slopes, eroded-----	30	IIIe-8	42	IVe-6	52	4
NoE	Nora silt loam, 11 to 15 percent slopes------------	30	IVe-1	44	-----	--	4
NoE2	Nora silt loam, 11 to 15 percent slopes, eroded----	30	IVe-8	45	-----	--	4
NoF	Nora silt loam, 15 to 30 percent slopes------------	30	VIe-1	46	-----	--	10
Om	Omadi silt loam, 0 to 2 percent slopes-------------	31	I-1	39	I-6	48	1
On	Onawa silty clay, 0 to 2 percent slopes------------	32	IIw-1	40	IIw-1	49	2
Ow	Owego silty clay, 0 to 2 percent slopes------------	33	IIIw-1	42	IIIw-1	51	2
Pe	Percival silty clay, 0 to 2 percent slopes---------	33	IIw-1	40	IIw-1	49	2
SaF	Sansarc-Nora complex, 11 to 30 percent slopes------	34	VIs-4	46	-----	--	--
	Sansarc soil-----------------------------------	--	-----	--	-----	--	10
	Nora soil--------------------------------------	--	-----	--	-----	--	4
SbD	Sarpy fine sand, 2 to 11 percent slopes------------	35	VIs-7	48	IVs-12	52	7
ScC	Sarpy loamy fine sand, 0 to 6 percent slopes-------	36	IVs-7	45	IIIs-11	51	3
So	Sarpy silty clay, overwash, 0 to 2 percent slopes--	36	IVs-2	45	IVs-1	52	2
Wu	Waubonsie very fine sandy loam, loamy substratum, 0 to 2 percent slopes----------------------------	37	IIs-6	40	IIs-8	49	3

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