USDA United States Department of Agriculture

Natural Resources Conservation Service

In cooperation with Minnesota Agricultural Experiment Station

Soil Survey of McLeod County, Minnesota

Part I

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How To Use This Soil Survey

This survey is divided into three parts. Part I includes general information about the survey area; descriptions of the general soil map units, detailed soil map units, and soil series in the area; and a description of how the soils formed. Part II describes the use and management of the soils and the major soil properties. This part may be updated as further information about soil management becomes available. Part III includes the maps.

On the **general soil map**, which is the color map preceding the detailed soil maps, the survey area is divided into groups of associated soils called general soil map units. This map is useful in planning the use and management of large areas.

To find information about your area of interest, locate that area on the map, identify the name of the map unit in the area on the color-coded map legend, then refer to the section **General Soil Map Units** in Part I of this survey for a general description of the soils in your area.

The **detailed soil maps** follow the general soil map. These maps can be useful in planning the use and management of small areas.

To find information about your area of interest, locate that area on the **Index to Map Sheets**, which precedes the soil maps. Note the number of the map sheet, and turn to that sheet.

Locate your area of interest on the map sheet. Note the map unit symbols that are in that area. Turn to the **Index to Map Units** in Part I of this survey, which lists the map units by symbol and name and shows the page where each map unit is described.

The **Summary of Tables** shows which table has data on a specific land use for each detailed soil map unit. See **Contents** for sections of this publication that may address your specific needs.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (formerly 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 November 1991. Soil names and descriptions were approved in March 1992. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1991. This survey was made cooperatively by the Natural Resources Conservation Service and the Minnesota Agricultural Experiment Station. Other assistance was provided by the Agricultural Extension Service, Minnesota Department of Natural Resources, and the Board of Water and Soil Resources. The survey was partially funded by the Legislative Commission for Minnesota Resources and by McLeod County. It is part of the technical assistance furnished to the McLeod County Soil and Water Conservation District.

All programs and services of the Natural Resources Conservation Service are offered on a nondiscriminatory basis, without regard to race, color, national origin, religion, sex, age, marital status, or handicap.

Cover: An area of the level to rolling Lester, Storden, and Cordova soils in McLeod County, Minnesota. Most areas of these soils are used as cropland. Contour stripcropping helps to control water erosion.

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Issued November 1997

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Foreword

This soil survey contains information that can be used in land-planning programs in McLeod County, Minnesota. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to ensure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Natural Resources Conservation Service.

William Hunt
State Conservationist
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Soil Survey of McLeod County, Minnesota

By James J. Murray, Natural Resources Conservation Service

Fieldwork by James J. Murray and Mark L. Perry, Natural Resources Conservation Service, and H. Gerald Floren, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Natural Resources Conservation Service, in cooperation with the Minnesota Agricultural Experiment Station

How This Survey Was Made

This survey was made to provide information about the soils and miscellaneous areas in the survey area. The information includes a description of the soils and miscellaneous areas and their location and a discussion of their suitability, limitations, and management for specified uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

The soils and miscellaneous areas in the survey area are in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind or segment of the landscape. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landscape, soil scientists develop a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientists to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Individual soils on the landscape commonly merge into one another as their characteristics gradually change. To construct an accurate map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

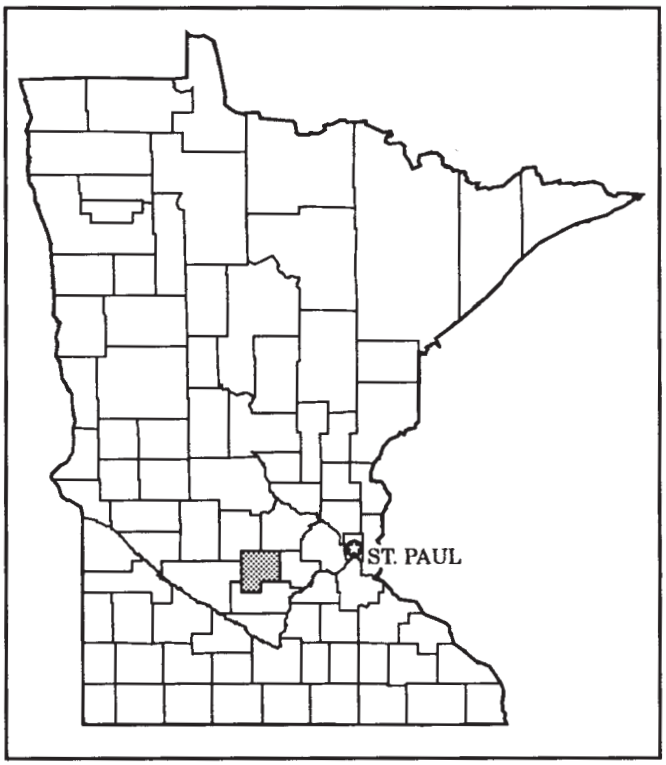
While a soil survey is in progress, samples of some of the soils in the area generally are collected for

laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

The descriptions, names, and delineations of the soils in this survey area do not fully agree with those of the soils in adjacent survey areas. Differences are the result of a better knowledge of soils, modifications in series concepts, or variations in the intensity of mapping or in the extent of the soils in the survey areas.



McLeod Co-MN (locator map)

Figure I-1.—Location of McLeod County in Minnesota.

General Nature of the Survey Area

McLeod County is in south-central Minnesota (fig. I-1). Glencoe is the county seat.

This soil survey updates the survey of McLeod County published in 1955 (USDA, 1955). It provides additional information and has larger maps, which show the soils in greater detail.

History and Development

For thousands of years, the area that includes McLeod County was inhabited by Indian tribes. The survey area was covered by a forest, which was known as the Big Woods, or by prairie. The Big Woods supported several species of trees, including basswood, maple, elm, American aspen or poplar, ironwood, butternut, oak, cottonwood, and boxelder (Shamla and others, 1975). The prairie, which supported mainly tall grasses, was west of the wooded area.

Exploration of the survey area took place in the 16th and 17th centuries. The area was claimed by France and Spain and was subsequently invaded by English fur trappers. In the Treaty of 1783, following the Revolutionary War, England ceded to the United States all land west of the Mississippi. The Sioux Indians relinquished claim to a large area of land west of the Mississippi through the Treaty of 1851. The area that is now McLeod County was originally a part of Carver County, which was created in 1855. The current boundaries of McLeod County were established on March 1, 1856.

The first pioneers to settle in the wilderness were mostly of English, Irish, and Scottish descent. Later, word of cheap land prices and abundant opportunity spread through Europe. A large migration to the area took place after 1870 (Shamla and others, 1975).

McLeod County was named for Martin McLeod, one

of the authors of the bill that established the county. Martin McLeod was a fur trader stationed at a trading post in Lac qui Parle. During his career as a trader, he became familiar with the Indian trails that crossed this part of central Minnesota. In 1855, Martin McLeod and J.H. Steven founded the city of Glencoe, which is the county seat. Glencoe was named for a valley in Scotland (Shamla and others, 1975).

Since the 1850's, the vegetation in McLeod County has been transformed from an open prairie and forested area to an intensively developed agricultural area. The early farmers' markets were limited by the routes of poorly constructed trails. Today, roads along most section lines provide transportation routes for agricultural products to local markets.

Two railroads serve McLeod County. U.S. Highway 212 and State Highways 7, 15, 22, and 261 run through the county. Airports are located in Glencoe, Hutchinson, and Winsted.

Farming

Wheat, corn, oats, potatoes, and wild hay cut from the prairie were the main crops produced by the first settlers. Corn, soybeans, and wheat for market and for livestock feed are still the principal crops. The acreage of corn, soybeans, wheat, and oats has decreased since 1986, mainly because of the increase in the acreage enrolled in agricultural programs that are designed to reduce surplus commodity crops and take highly erodible land out of production.

The number of cattle and calves, hogs, and feeder pigs has decreased since 1986, but the number of sheep and lambs has remained about the same. In 1989, there were 37,600 cattle and calves, 44,400 hogs and pigs, and 1,100 sheep and lambs in McLeod County (McLeod County Extension Service, 1990).

Dairying is an important enterprise in the county. Also, small but important acreages are used to grow specialty crops, mainly sweet corn and green peas. Canneries are located in the surrounding areas.

In 1982, McLeod County had 1,492 farms. There were 1,303 farms in the county in 1987. The average size of farms increased from 182 acres in 1982 to 198 acres in 1987 (McLeod County Extension Service, 1990).

Physiography, Drainage, and Geology

The materials that make up the landscape in McLeod County consist of Mesozoic and Paleozoic sedimentary strata, Pleistocene glacial deposits, and recent sediments.

The entire eastern part of the county is underlain by sedimentary strata deposited during the Paleozoic (Cambrian) Era (Matsch, 1972). The western part of McLeod County is underlain by sedimentary strata deposited during the Mesozoic (Cretaceous) period. These strata overlie igneous and metamorphic bedrock of the Precambrian Era (Sims and Austin, 1963).

Glacial sediments of the Pleistocene Epoch, which range from 300 to 500 feet thick, cover these bedrock formations throughout the county. As the glacier moved in a southeasterly direction from its source in the vicinity of the Winnipeg lowland, it gouged out bedrock to make yellow to gray, shale-rich, calcareous loamy till (Matsch, 1972). This till was deposited by the retreating Des Moines lobe of the Wisconsin glaciation about 10,000 years ago. The most strongly morainic topography is an end moraine in the northwestern part of the county, north of the city of Hutchinson. This moraine extends across the northern part of Acoma and Hutchinson Townships. The morainic system was the eastern margin of the late Wisconsin (Mankato) ice sheet, near where the Grantsburg lobe branches off from the Des Moines lobe (Thiel, 1944). In the southern part of the county, the topography descends to a ground moraine. Most of the material was left as a result of the melting ice and consists of till.

More than 10,000 years ago, rivers and streams coursed down glacial spillways as the glacier melted and released huge quantities of water. The valleys of the South Branch of the Crow River and Buffalo Creek and their tributaries were carved out as the base of these spillways cut down into the till. The water deposited its alluvium as sandy and gravelly material on flood plains along these waterways. Subsequent incision has left terraces along these waterways and in an outwash area in the eastern part of the county between the South Fork of the Crow River and Buffalo Creek. Sandy and gravelly material was also deposited in places on upland ridges and knolls. During more recent times, loamy and clayey alluvium several feet thick have accumulated on bottom land along these waterways. Also, organic accumulations of decomposed plants have formed in some depressions.

Climate

The three tables at the end of this section give climate data as recorded at Hutchinson during the period 1961 to 1990.

In winter, the average temperature is 15 degrees F and the average daily minimum temperature is 5 degrees. The lowest temperature on record, which occurred at Hutchinson on January 21, 1970, is -36 degrees. In summer, the average temperature is 70 degrees and the average daily maximum temperature is 82 degrees. The highest recorded temperature, which

occurred at Hutchinson on August 1, 1988, is 104 degrees.

Growing degree days are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (40 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation is about 26.6 inches. Of this, about 19.51 inches, or 73 percent, usually falls in April through September. The growing season for most crops falls within this period. The heaviest 1-day rainfall during the period of record was 4.5 inches at Hutchinson on August 26, 1967. Thunderstorms occur on about 38 days each year, and most occur in July.

The average seasonal snowfall is 35 inches. The greatest snow depth at any one time during the period of record was 52 inches. On an average, 15 days per year have at least 1 inch of snow on the ground. The heaviest 1-day snowfall on record was 15 inches.

The average relative humidity in midafternoon is about 59 percent. Humidity is higher at night, and the average at dawn is about 78 percent. The sun shines 69 percent of the time possible in summer and 51 percent in winter. The prevailing wind is from the northwest. Average windspeed is highest, 12 miles per hour, in April.

TEMPERATURE AND PRECIPITATION

(Recorded in the period 1961-90 at Hutchinson, Minnesota)

Month	Temperature						Precipitation				
				2 years in 10 will have--				2 years in 10 will have--			
	Average daily maximum	Average daily minimum	Average	Maximum temperature higher than--	Minimum temperature lower than--	Average number of growing degree days*	Average	Less than--	More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January-----	21.6	1.1	11.4	48	-29	0	0.65	0.17	1.03	2	7.8
February----	27.7	7.2	17.5	53	-26	2	.55	.17	.90	1	5.2
March-------	40.2	21.1	30.6	72	-13	39	1.62	.63	2.44	3	8.3
April-------	57.6	35.3	46.5	86	14	236	2.38	1.18	3.42	5	1.9
May---------	71.1	46.7	58.9	92	27	579	3.11	1.78	4.29	6	.0
June--------	80.0	56.3	68.2	97	40	838	4.37	2.08	6.34	7	.0
July--------	84.4	61.1	72.7	98	46	976	3.51	1.91	4.93	5	.0
August------	81.7	58.0	69.8	96	42	888	3.69	1.96	5.21	5	.0
September---	72.6	48.8	60.7	92	28	613	2.45	1.33	3.44	5	.0
October-----	60.8	37.8	49.3	84	19	305	2.02	.68	3.12	3	.3
November----	41.6	24.0	32.8	67	-6	46	1.40	.45	2.26	2	4.6
December----	25.6	8.0	16.8	50	-22	2	.85	.29	1.36	2	6.9
Yearly:											
Average---	55.4	33.8	44.6	---	---	---	---	---	---	---	---
Extreme---	104	-36	---	99	-31	---	---	---	---	---	---
Total-----	---	---	---	---	---	4,524	26.60	21.19	31.12	46	35.0

* A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (40 degrees F).

FREEZE DATES IN SPRING AND FALL

(Recorded in the period 1961-90 at Hutchinson, Minnesota)

Probability	Temperature		
	24 °F or lower	28 °F or lower	32 °F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	Apr. 21	May 6	May 17
2 years in 10 later than--	Apr. 17	Apr. 30	May 12
5 years in 10 later than--	Apr. 8	Apr. 19	May 1
First freezing temperature in fall:			
1 year in 10 earlier than--	Oct. 30	Sept. 28	Sept. 14
2 years in 10 earlier than--	Oct. 13	Oct. 2	Sept. 19
5 years in 10 earlier than--	Oct. 23	Oct. 11	Sept. 29

GROWING SEASON

(Recorded in the period 1961-90 at Hutchinson, Minnesota)

Probability	Daily minimum temperature during growing season		
	Higher than 24 °F	Higher than 28 °F	Higher than 32 °F
	Days	Days	Days
9 years in 10	165	148	128
8 years in 10	172	155	135
5 years in 10	187	170	150
2 years in 10	201	184	164
1 year in 10	209	192	172

General Soil Map Units

The general soil map in Part III of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, it consists of one or more major soils or miscellaneous areas and some minor soils or miscellaneous areas. It is named for the major soils or miscellaneous areas. The soils or miscellaneous areas making up one unit can occur in another but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils or miscellaneous areas can be identified on the map. Likewise, areas that are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

1. Clarion-Canisteo-Glencoe Association

Nearly level to rolling, well drained, poorly drained, and very poorly drained, loamy soils on moraines

Setting

Landform and position on the landform: Shoulders, back slopes, summits, rims of depressions, and closed depressions on moraines
Slope range: 0 to 12 percent

Composition

Percent of survey area: 5
Clarion and similar soils: 30 percent
Canisteo and similar soils: 25 percent
Glencoe and similar soils: 15 percent
Minor soils: 30 percent (fig. I-2)

Soil Properties and Qualities

Clarion
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Canisteo
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Glencoe
Drainage class: Very poorly drained
Parent material: Till
Surface texture: Clay loam

Minor Soils

- Harps and similar soils
- Nicollet and similar soils
- Storden and similar soils
- Webster and similar soils

2. Canisteo-Nicollet Association

Nearly level, poorly drained and moderately well drained, loamy soils on moraines

Setting

Landform and position on the landform: Rims of depressions, low summits, and back slopes on moraines
Slope range: 0 to 3 percent

Composition

Percent of survey area: 19
Canisteo and similar soils: 35 percent
Nicollet and similar soils: 30 percent
Minor soils: 35 percent (fig. I-3)

Soil Properties and Qualities

Canisteo
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Nicollet
Drainage class: Moderately well drained
Parent material: Till
Surface texture: Clay loam

Minor Soils

- Clarion and similar soils

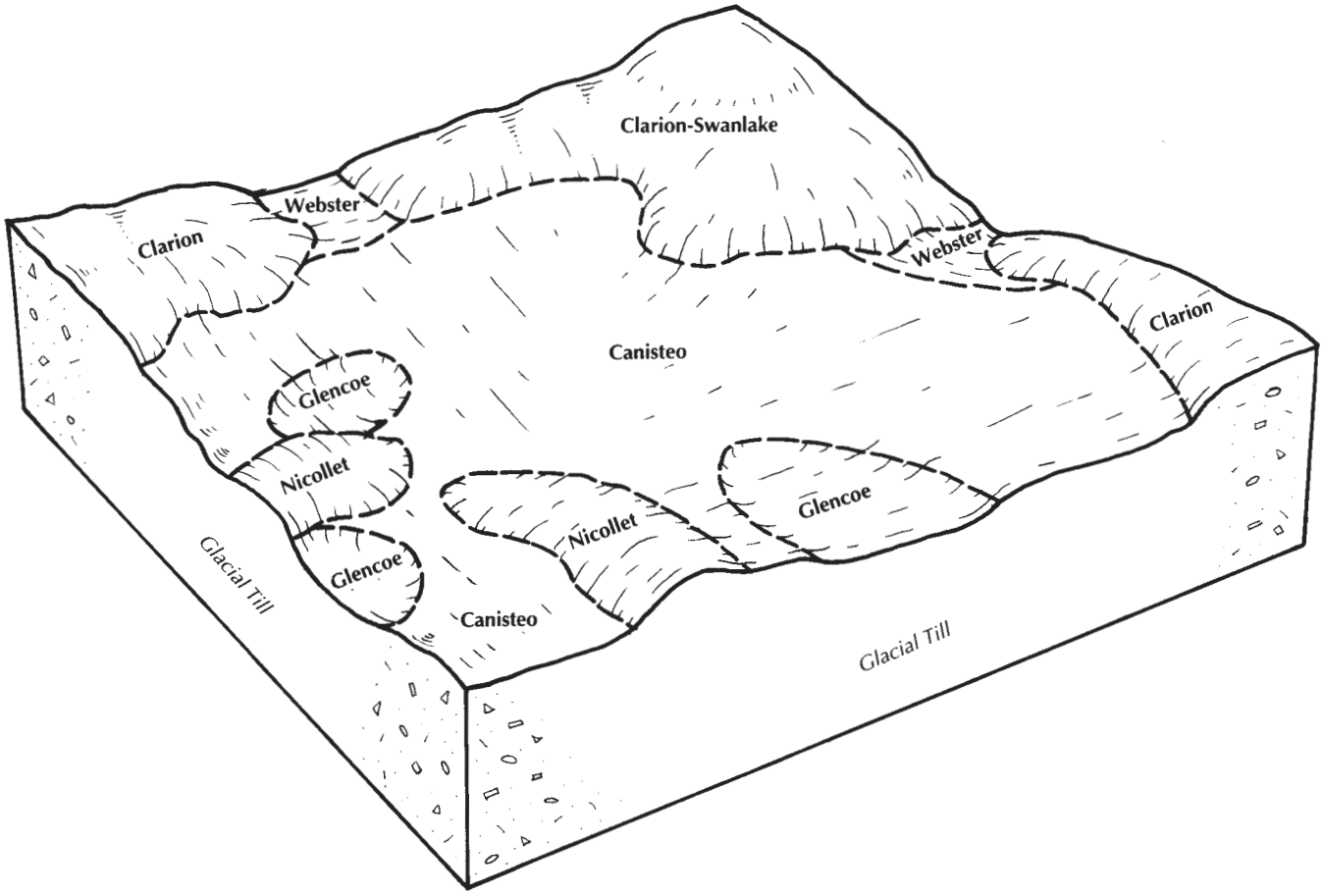


Figure I-2.—Typical pattern of soils and parent material in the Clarion-Canisteo-Glencoe association.

- Swanlake and similar soils
- Webster and similar soils
- Harps and similar soils
- Glencoe and similar soils
- Klossner and similar soils

3. Coland-Clarion-Hawick Association

Nearly level to hilly, poorly drained, well drained, and excessively drained, loamy soils on flood plains, moraines, and terraces

Setting

Landform and position on the landform: Low flood plains, back slopes, and shoulders on moraines and terrace treads and terrace risers on terraces
Slope range: 0 to 18 percent

Composition

Percent of survey area: 1

Coland and similar soils: 30 percent
Clarion and similar soils: 25 percent
Hawick and similar soils: 10 percent
Minor soils: 35 percent

Soil Properties and Qualities

Coland
Drainage class: Poorly drained
Parent material: Alluvium
Surface texture: Clay loam

Clarion
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Hawick
Drainage class: Excessively drained
Parent material: Glacial outwash
Surface texture: Coarse sandy loam

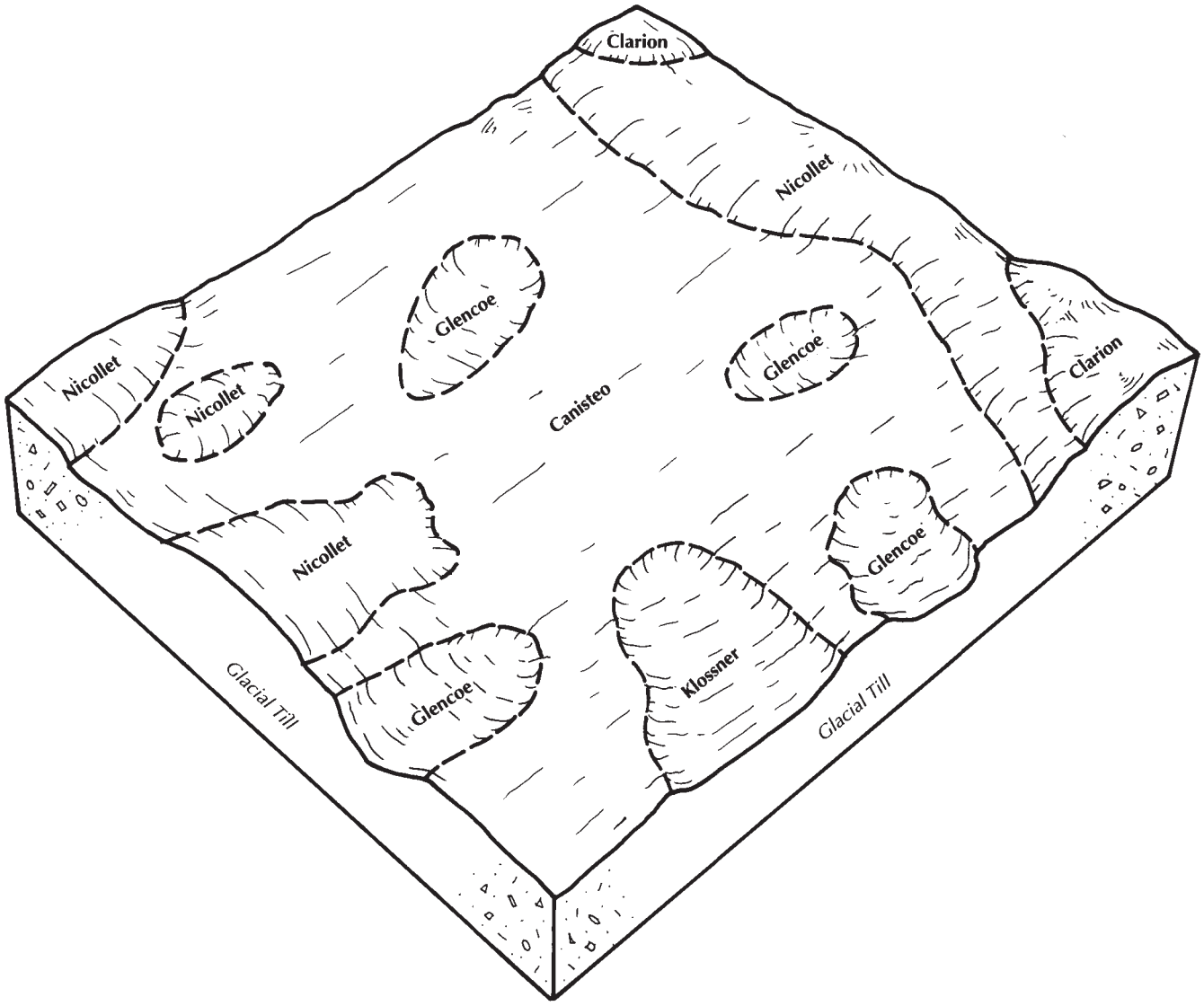


Figure I-3.—Typical pattern of soils and parent material in the Canisteo-Nicollet association.

Minor Soils

- Estherville and similar soils
- Millington and similar soils
- Hanlon and similar soils
- Kalmarville and similar soils
- Mayer and similar soils
- Udorthents and gravel pits in open excavations

4. Canisteo-Glencoe-Cokato Association

Nearly level to undulating, poorly drained, very poorly drained, and well drained, loamy soils on moraines

Setting

Landform and position on the landform: Summits and rims of depressions, closed depressions, and shoulders and back slopes on moraines

Slope range: 0 to 6 percent

Composition

Percent of survey area: 5
Canisteo and similar soils: 40 percent
Glencoe and similar soils: 15 percent
Cokato and similar soils: 10 percent
Minor soils: 35 percent

Soil Properties and Qualities

Canisteo

Drainage class: Poorly drained

Parent material: Till
Surface texture: Clay loam

Glencoe
Drainage class: Very poorly drained
Parent material: Colluvium and till
Surface texture: Clay loam

Cokato
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Minor Soils

- Cordova and similar soils
- Le Sueur and similar soils
- Lester and similar soils
- Muskego and similar soils
- Klossner and similar soils

5. Cokato-Canisteo-Cordova Association

Nearly level to rolling, well drained and poorly drained, loamy soils on moraines

Setting

Landform and position on the landform: Shoulders, back slopes, summits, rims of depressions, and foot slopes on moraines
Slope range: 0 to 12 percent

Composition

Percent of survey area: 19
Cokato and similar soils: 30 percent
Canisteo and similar soils: 25 percent
Cordova and similar soils: 10 percent
Minor soils: 35 percent (fig. I-4)

Soil Properties and Qualities

Cokato
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Canisteo
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Cordova
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Minor Soils

- Blue Earth and similar soils
- Le Sueur and similar soils
- Lester and similar soils
- Klossner and similar soils

6. Cokato-Storden-Muskego Association

Nearly level to very steep, well drained and very poorly drained, loamy and mucky soils on moraines

Setting

Landform and position on the landform: Summits, shoulders, back slopes, and lake basins on moraines
Slope range: 0 to 40 percent

Composition

Percent of survey area: 8
Cokato and similar soils: 25 percent
Storden and similar soils: 20 percent
Muskego and similar soils: 20 percent
Minor soils: 35 percent (fig. I-5)

Soil Properties and Qualities

Cokato
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Storden
Drainage class: Well drained
Parent material: Till
Surface texture: loam

Muskego
Drainage class: Very poorly drained
Parent material: Organic materials and coprogenous earth
Surface texture: Muck

Storden
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Minor Soils

- Canisteo and similar soils
- Glencoe and similar soils
- Le Sueur and similar soils
- Lester and similar soils
- Cordova and similar soils

7. Estherville-Coland-Biscay Association

Nearly level to undulating, somewhat excessively drained and poorly drained, loamy soils on terraces and low flood plains

Setting

Landform and position on the landform: Terrace treads and terrace risers on terraces and low flood plains

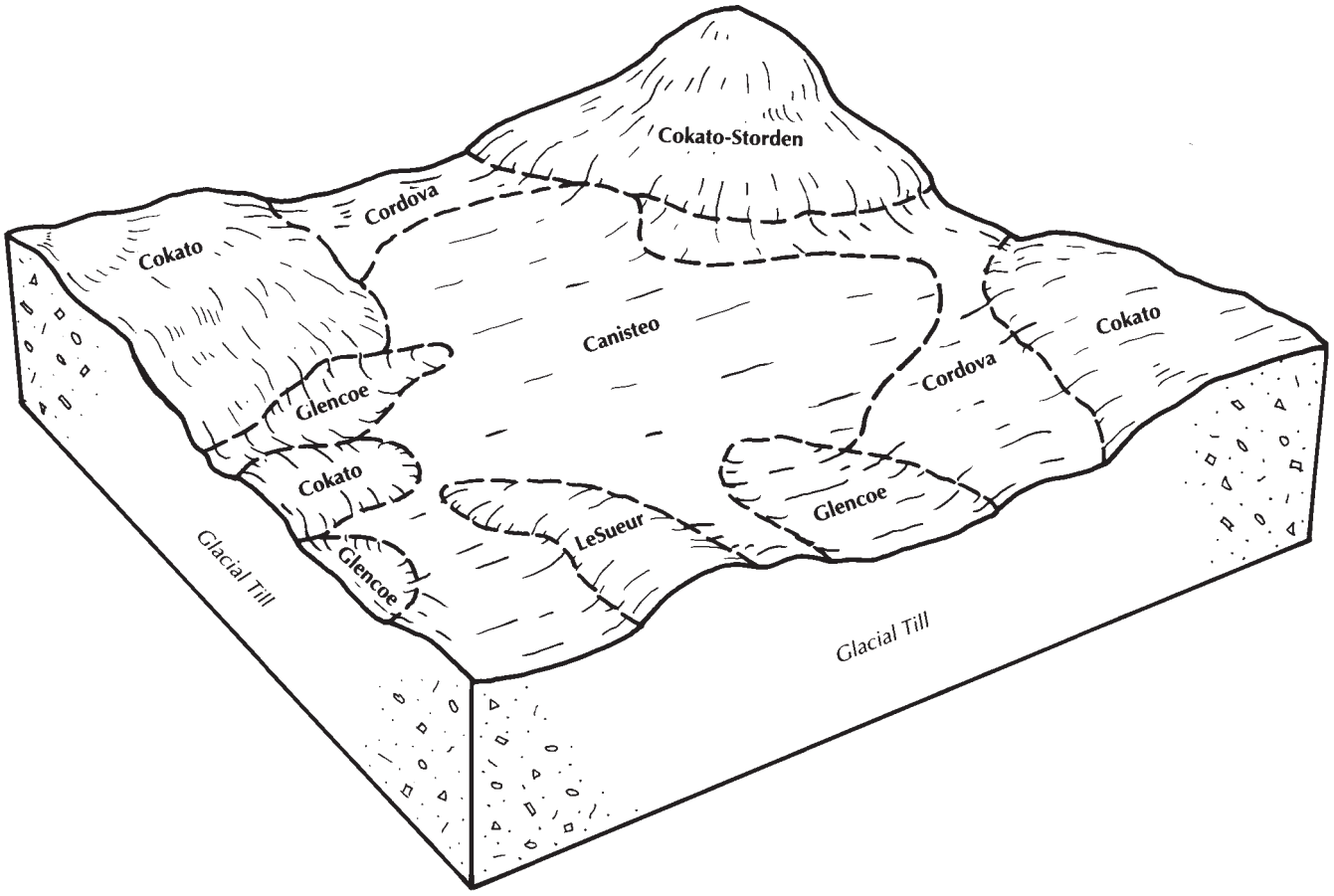


Figure I-4.—Typical pattern of soils and parent material in the Cokato-Canisteo-Cordova association.

Slope range: 0 to 6 percent

Composition

Percent of survey area: 6
Estherville and similar soils: 30 percent
Coland and similar soils: 25 percent
Biscay and similar soils: 10 percent
Minor soils: 35 percent (fig. I-6)

Soil Properties and Qualities

Estherville
Drainage class: Somewhat excessively drained
Parent material: Glacial outwash
Surface texture: Loam

Coland
Drainage class: Poorly drained
Parent material: Alluvium
Surface texture: Clay loam

Biscay
Drainage class: Poorly drained
Parent material: Glacial outwash
Surface texture: Clay loam

Minor Soils

- Millington and similar soils
- Hanlon and similar soils
- Kalmarville and similar soils
- Mayer and similar soils
- Udorthents and gravel pits in open excavations

8. Clarion-Canisteo-Storden Association

Nearly level to very steep, well drained and poorly drained, loamy soils on moraines

Setting

Landform and position on the landform: Back slopes and summits, rims of depressions, and shoulders on moraines
Slope range: 0 to 40 percent

Composition

Percent of survey area: 5

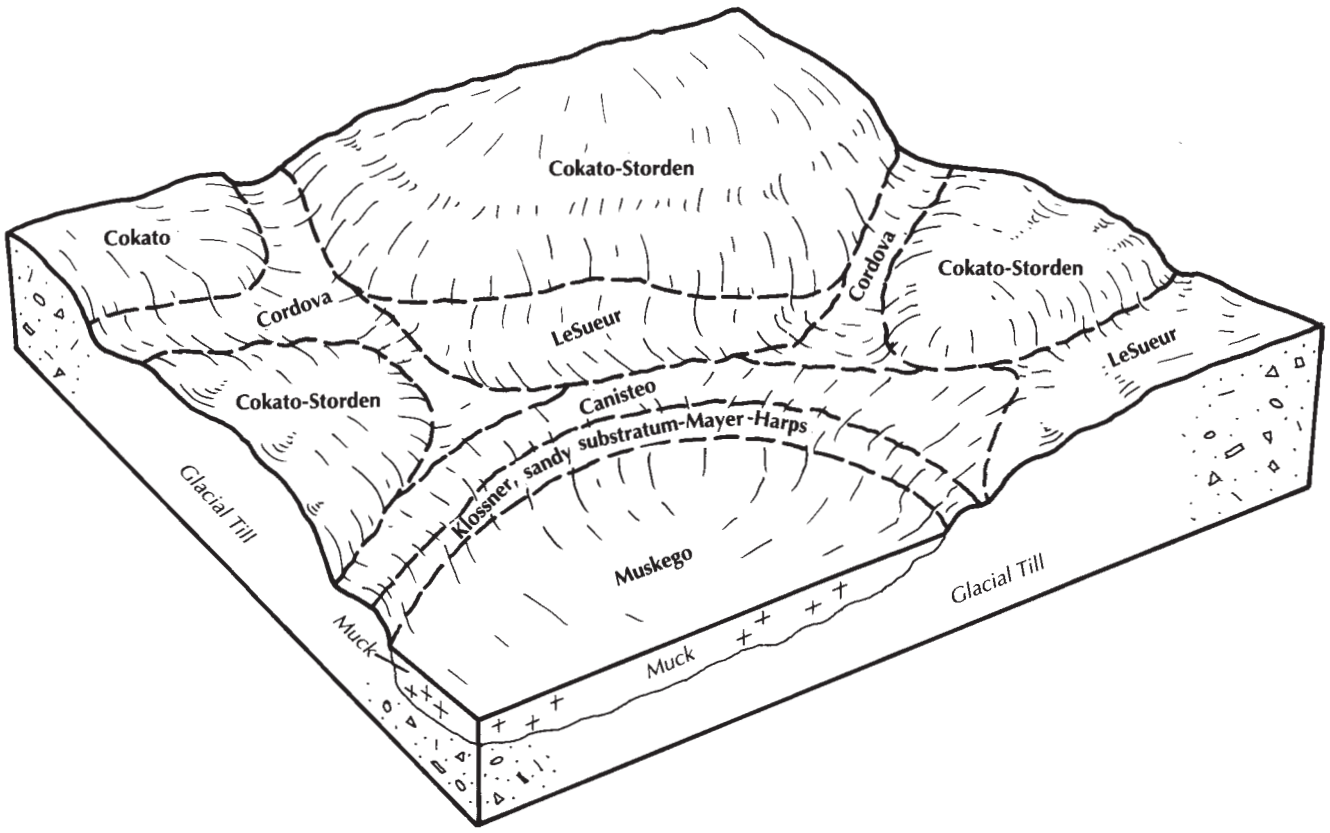


Figure I-5.—Typical pattern of soils and parent material in the Cokato-Storden-Muskego association.

Clarion and similar soils: 30 percent
Canisteo and similar soils: 25 percent
Storden and similar soils: 10 percent
Minor soils: 35 percent

Soil Properties and Qualities

Clarion
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Canisteo
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Storden
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Minor Soils

- Glencoe and similar soils
- Nicollet and similar soils
- Webster and similar soils
- Estherville and similar soils

9. Clarion-Harps-Glencoe Association

Nearly level to rolling, well drained, poorly drained, and very poorly drained, loamy soils on moraines

Setting

Landform and position on the landform: Shoulders, back slopes, and summits, rims of depressions, and closed depressions on moraines
Slope range: 0 to 12 percent

Composition

Percent of survey area: 13
Clarion and similar soils: 30 percent
Harps and similar soils: 25 percent
Glencoe and similar soils: 15 percent
Minor soils: 30 percent (fig. I-7)

Soil Properties and Qualities

Clarion
Drainage class: Well drained
Parent material: Till

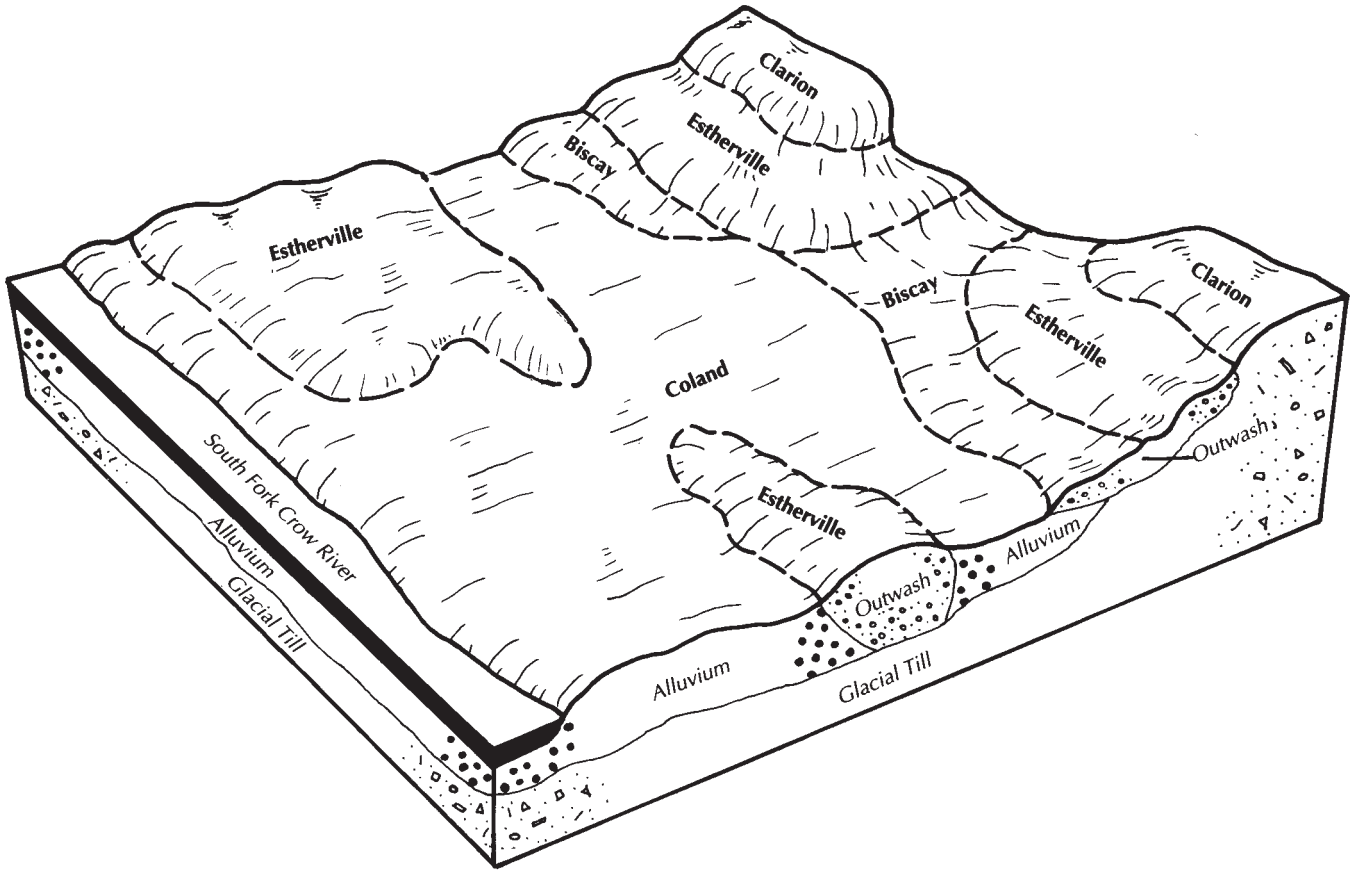


Figure I-6.—Typical pattern of soils and parent material in the Estherville-Coland-Biscay association.

Surface texture: Loam

Harps
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Glencoe
Drainage class: Very poorly drained
Parent material: Colluvium and till
Surface texture: Clay loam

Minor Soils

- Canisteo and similar soils
- Nicollet and similar soils
- Storden and similar soils
- Webster and similar soils
- Swanlake and similar soils

10. Harps-Clarion-Nicollet Association

Nearly level to undulating, poorly drained, well drained, and moderately well drained, loamy soils on moraines

Setting

Landform and position on the landform: Rims of depressions, summits, and back slopes on moraines
Slope range: 0 to 6 percent

Composition

Percent of survey area: 6
Harps and similar soils: 40 percent
Clarion and similar soils: 15 percent
Nicollet and similar soils: 10 percent
Minor soils: 35 percent

Soil Properties and Qualities

Harps
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

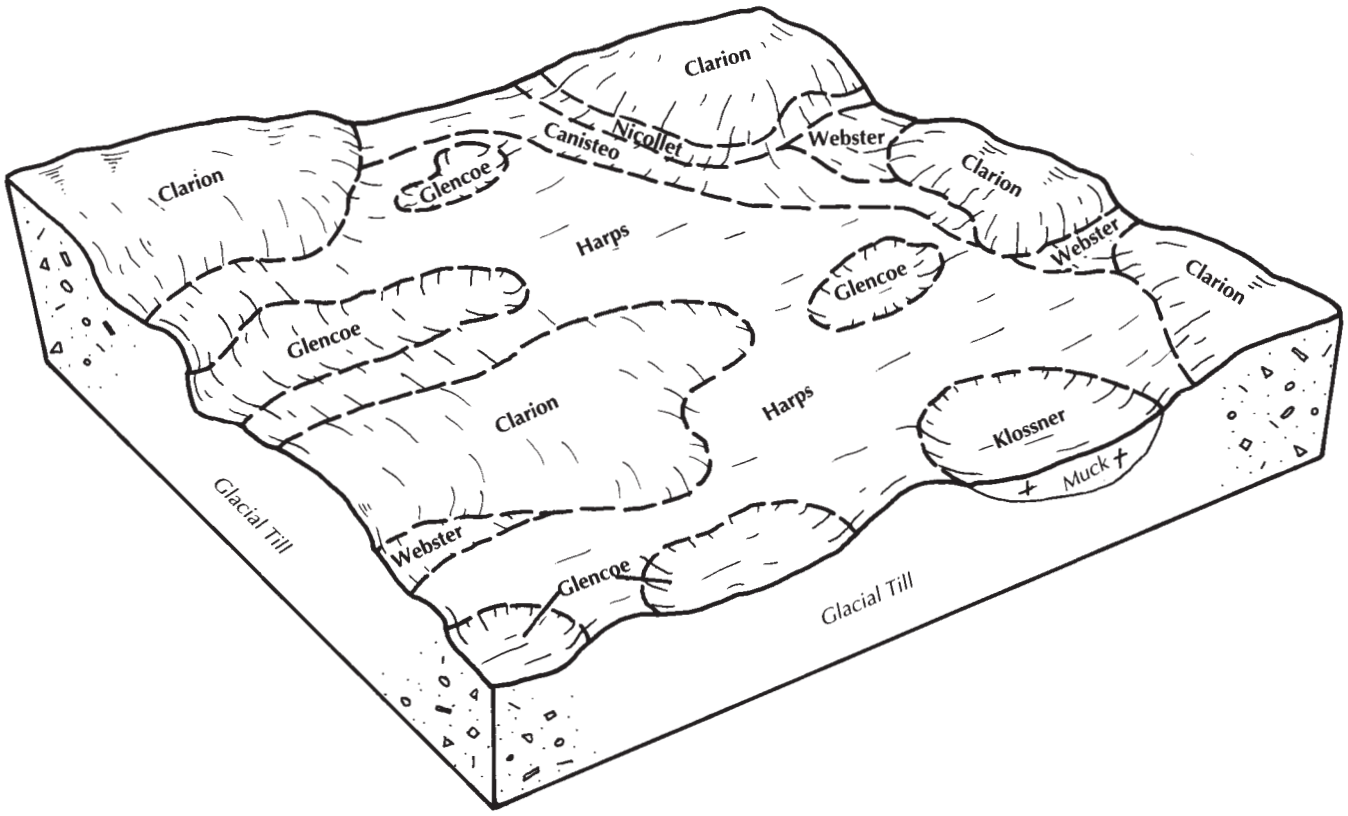


Figure I-7.—Typical pattern of soils and parent material in the Clarion-Harps-Glencoe association.

Clarion
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Nicollet
Drainage class: Moderately well drained
Parent material: Till
Surface texture: Clay loam

Minor Soils

- Canisteo and similar soils
- Glencoe and similar soils
- Klossner and similar soils
- Swanlake and similar soils

11. Lester-Cordova Association

Nearly level to rolling, well drained and poorly drained, loamy soils on moraines

Setting

Landform and position on the landform: Back slopes, shoulders, summits, and foot slopes on moraines
Slope range: 0 to 12 percent

Composition

Percent of survey area: 12
Lester and similar soils: 35 percent
Cordova and similar soils: 30 percent
Minor soils: 35 percent

Soil Properties and Qualities

Lester
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Cordova
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Minor Soils

- Canisteo and similar soils
- Blue Earth and similar soils
- The ponded Klossner and Muskego soils and similar soils
- Le Sueur and similar soils

12. Cokato-Cordova Association

Nearly level to rolling, well drained and poorly drained, loamy soils on moraines

Setting

Landform and position on the landform: Back slopes, shoulders, summits, and foot slopes on moraines
Slope range: 0 to 12 percent

Composition

Percent of survey area: 1
Cokato and similar soils: 40 percent
Cordova and similar soils: 30 percent
Minor soils: 30 percent

Soil Properties and Qualities

Cokato
Drainage class: Well drained
Parent material: Till
Surface texture: Loam

Cordova
Drainage class: Poorly drained
Parent material: Till
Surface texture: Clay loam

Minor Soils

- Canisteo and similar soils
- Blue Earth and similar soils
- The ponded Klossner and Muskego soils and similar soils
- Le Sueur and similar soils

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Formation and Classification of the Soils

This section relates the soils in the survey area to the major factors of soil formation and describes the system of soil classification.

Formation of the Soils

Soils form by the action of soil-forming processes on material deposited or accumulated by geologic forces. The characteristics of the soil in a given area are determined by the composition of the parent material, the climate under which the soil material has accumulated, the plant and animal life on and in the soil, the relief, or lay of the land, and the length of time that the forces of soil formation have acted on the soil material. Climate and plant and animal life, chiefly plants, act upon the parent material. The type of parent material and its resistance to weathering determine the kind and degree of soil development. Relief modifies the effect of climate, which in turn influences plant material. Time is needed for changes to occur in the parent material. The amount of time needed depends on the intensity of soil development. All five factors of soil formation are interrelated. When one factor changes, changes in the other four factors result. The following paragraphs relate the factors of soil formation to the soils in the survey area.

Climate

The climate is essentially uniform throughout the survey area, but local variations in climate are caused by differences in relief and aspect. South- and west-facing slopes, for example, tend to be slightly drier and warmer than north- and east-facing slopes.

Climatic changes have been responsible for the formation and melting of glaciers, the deposition of sediments, the evolution of topography, and the growth cycles of plants and animals. The present climate has been relatively constant for the past few thousand years. It is a continental climate characterized by long, cold winters and hot summers. Freezing of the soil during the winter slows the soil-forming processes. Alternate freezing and thawing help to disintegrate parent materials, and frost heave can mix the soil material.

Climate and fires determined the growth of prairie or forest vegetation. The prairie soils in the survey area have a dark surface layer because they were covered by grasses. Prairie vegetation and cool temperatures promote the accumulation of organic matter. Forest vegetation promotes leaching, and thus the soils that formed under trees tend to be more acid than the soils that formed under prairie vegetation.

Rainfall affects the leaching of lime. The thickness of the solum is commonly determined by the depth to which free lime has been leached.

Living Organisms

The process of soil formation begins as plants begin to grow on the freshly deposited parent material. Plant roots loosen soil and release minerals in the underlying material. As the plants decay, organic matter and plant nutrients are returned to the soil. Most of the western part of McLeod County supported prairie vegetation. The soils have a thick, dark surface layer and are neutral to moderately alkaline. The rest of the county and areas along the rivers and lakes supported forest vegetation. Soils that formed under forest vegetation, such as Lester and Le Sueur soils, have a lighter colored surface layer than the prairie soils and are neutral to moderately acid.

Earthworms, ants, and other burrowing animals help to transform and translocate organic material and mix the upper few feet of the soil. Human activities also influence soil formation. Farming has increased the action of some soil-forming processes. In fields where the soil is exposed to the air and wind, the oxidation of organic matter is accelerated. Accelerated erosion of the surface layer has taken place on some steeply sloping soils, and areas below these slopes have received deposits of eroded material. Artificial drainage, which lowers the water table in wet soils, management decisions that change soil fertility, and changes in the types of vegetation planted also affect soil formation.

Topography

Each type of topographic position—summit, side slope, foot slope, toe slope, or drainageway—affects soil formation. Different kinds of soil form in different locations on the landscape. In areas where relief is relatively pronounced, much of the rainfall runs off the hillsides and plant growth is restricted. The lack of water movement through the soil limits the leaching of carbonates and the translocation of clay particles. Soils in rolling or hilly areas show less distinct horizon development than soils in the more level areas. Storden soils, for example, are weakly developed. In areas of these soils, erosional sediments are carried downslope by runoff. These sediments affect not only the soils from which they have been removed but also the areas where the sediment is deposited. The runoff infiltrates at the base of sloping soils. Thus, the soils in these areas generally have developed more distinct horizons. Delft and Hamel soils formed in such colluvial sediments. They have a thicker dark surface soil than the soils in areas upslope and are more fertile.

Topographic position also affects soil drainage. Delft and Webster soils, which are in concave drainageways, are poorly drained and have a seasonal high water table at a depth of 1 to 3 feet. In contrast, Clarion and Lester soils are on convex side slopes. These soils are well drained and have a water table at a much greater depth than the soils in concave positions.

Parent Material

The soils in McLeod County formed in several kinds of parent material, mainly of glacial origin. The most common parent material in the survey area is till. The till was deposited by ice as an unsorted mixture of clay, silt, sand, pebbles, and rocks. The till in this survey area was deposited about 10,000 years ago. It covers about 85 percent of the county. Canisteo, Clarion, Lester, Nicollet, and Webster soils formed in till.

Glacial outwash, which is modified till, was deposited by meltwater from the retreating glacial ice. This material is mainly in meltwater channels and on terraces along streams and rivers and, in places, on ridges and knolls in the uplands. The soils in these areas formed in loamy surface material over sandy and gravelly deposits. Biscay, Estherville, and Wadena soils are examples.

Alluvial material is deposited on sides of valleys and on most of the flood plains along rivers and streams. The soils in these areas formed in loamy or clayey deposits. The material is continually deposited as the streambanks constantly cut and fill. In most cases the soils that formed in alluvial material are much younger than the soils that formed in other kinds of parent material. Coland, Delft, Millington, Spillville, and Zook soils are examples.

After the deposition of glacial sediments, organic soils, such as Klossner and Muskego soils, formed in the accumulation of decomposed plants in depressions.

Time

Time is required for climate and biological activity to affect parent material. In areas that are stable, conditions are favorable for soil development and mature profiles have developed. Mature soils, such as Clarion and Lester soils, have a well developed surface layer and subsoil. In unstable areas, the soils are poorly developed and have only a thin surface layer over the parent material. Storden and Swanlake soils are examples. Soils that formed in alluvium along streams, such as Millington soils, are also weakly developed. Fresh deposits of alluvium are added almost annually. This recurring deposition prevents the formation of distinct horizons and mature profiles.

The soils in McLeod County are geologically young compared to soils in southeastern and southwestern Minnesota. The last glaciation left the survey area about 10,000 years ago.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (USDA, 1975). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. The classification and extent of the soils in this survey area are shown in the tables "Classification of the Soils" and "Acreage and Proportionate Extent of the Soils," which are at the end of this section. The categories of classification are defined in the following paragraphs.

ORDER. Eleven soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic

horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Endoaquolls (*Endo*, meaning within, plus *aquolls*, the suborder of the Mollisols that has an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Endoaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Generally, the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, thickness of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine-loamy, mixed, mesic Typic Endoaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Arkton	Fine-loamy, mixed, mesic Aquic Hapludolls
Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Endoaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Endoaquolls
Clarion	Fine-loamy, mixed, mesic Typic Hapludolls
Cokato	Fine-loamy, mixed, mesic Typic Argiudolls
Coland	Fine-loamy, mixed, mesic Cumulic Endoaquolls
Cordova	Fine-loamy, mixed, mesic Typic Argiaquolls
Cosmos	Fine, montmorillonitic, mesic Vertic Epiaquolls
Crippin	Fine-loamy, mixed, mesic Aquic Hapludolls
Delft	Fine-loamy, mixed, mesic Cumulic Endoaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Endoaquolls
Hamel	Fine-loamy, mixed, mesic Typic Argiaquolls
Hanlon	Coarse-loamy, mixed, mesic Cumulic Hapludolls
Harps	Fine-loamy, mesic Typic Calciaquolls
Hawick	Sandy, mixed, mesic Entic Hapludolls
Hoopeston	Coarse-loamy, mixed, mesic Aquic Hapludolls
Kalmarville	Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents
Kilkenny	Fine, montmorillonitic, mesic Mollic Hapludalfs
Klossner	Loamy, mixed, euic, mesic Terric Medisaprists
Lester	Fine-loamy, mixed, mesic Mollic Hapludalfs
Le Sueur	Fine-loamy, mixed, mesic Aquic Argiudolls
Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Endoaquolls
Millington	Fine-loamy, mixed (calcareous), mesic Cumulic Endoaquolls
Muskego	Coprogenous, euic, mesic Limnic Medisaprists
Nicollet	Fine-loamy, mixed, mesic Aquic Hapludolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Vertic Endoaquolls
Rolfe	Fine, montmorillonitic, mesic Typic Argialbolls
Shandep	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed, mesic Typic Eutrochrepts
Strout	Fine, montmorillonitic, mesic Vertic Hapludolls
Swanlake	Fine-loamy, mixed, mesic Typic Calciudolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
Udorthents	Udorthents
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Endoaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Vertic Endoaquolls

ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
27B	Dickinson fine sandy loam, 1 to 6 percent slopes	330	0.1
35	Blue Earth mucky silty clay loam	608	0.2
39A	Wadena loam, 0 to 2 percent slopes	275	*
39B	Wadena loam, 2 to 6 percent slopes	290	*
41A	Estherville loam, 0 to 2 percent slopes	4,210	1.3
41B	Estherville loam, 2 to 6 percent slopes	2,800	0.9
86	Canisteo clay loam	2,800	0.9
94B	Terril loam, 2 to 6 percent slopes	295	*
102B	Clarion loam, 2 to 6 percent slopes	13,690	4.2
106B	Lester loam, 2 to 6 percent slopes	14,070	4.3
109	Cordova clay loam	8,665	2.7
112	Harps clay loam	7,300	2.2
113	Webster clay loam	3,680	1.1
114	Glencoe clay loam	5,157	1.6
118	Crippin loam	2,060	0.6
130	Nicollet clay loam	27,675	8.6
134	Okoboji silty clay loam	525	0.2
238B	Kilkenny clay loam, 2 to 6 percent slopes	240	*
239	Le Sueur loam	4,715	1.4
247	Linder loam	585	0.2
255	Mayer loam	4,420	1.4
269	Millington clay loam, occasionally flooded	270	*
313	Spillville loam, occasionally flooded	255	*
327B	Dickman sandy loam, 1 to 6 percent slopes	240	*
336	Delft clay loam	505	0.2
362	Millington loam, frequently flooded	550	0.2
386	Okoboji mucky silty clay loam	575	0.2
392	Biscay clay loam	5,005	1.5
414	Hamel loam	2,505	0.8
517	Shandep clay loam	430	0.1
525	Muskego muck	7,653	2.4
539	Klossner muck	8,066	2.5
611C	Hawick coarse sandy loam, 4 to 12 percent slopes	270	*
887B	Clarion-Swanlake complex, 2 to 6 percent slopes	14,720	4.6
920B	Clarion-Estherville complex, 2 to 6 percent slopes	835	0.2
920C2	Clarion-Storden-Estherville complex, 6 to 12 percent slopes, eroded	1,600	0.5
920D2	Clarion-Storden-Estherville complex, 12 to 18 percent slopes, eroded	240	*
921C2	Clarion-Storden complex, 6 to 12 percent slopes, eroded	6,620	2.0
944B	Lester-Storden-Estherville complex, 2 to 6 percent slopes	770	0.2
945B	Lester-Storden complex, 2 to 6 percent slopes	10,150	3.1
945C2	Lester-Storden complex, 6 to 12 percent slopes, eroded	10,530	3.2
956	Canisteo-Glencoe complex	66,677	20.6
960D2	Storden-Clarion complex, 12 to 18 percent slopes, eroded	2,110	0.6
960F	Storden-Clarion complex, 18 to 40 percent slopes	305	*
978	Cordova-Rolfe complex	3,700	1.1
1016	Udorthents, loamy	460	0.1
1030	Udorthents-Pits, gravel, complex	975	0.3
1075	Klossner-Muskego complex, ponded	12,707	3.9
1080	Klossner-Okoboji-Glencoe complex, ponded	6,299	1.9
1084	Hanlon-Kalmarville complex, frequently flooded	815	0.2
1091	Klossner, sandy substratum-Harps-Mayer complex	980	0.3
1092	Harps-Glencoe complex	22,200	6.9
1095	Zook silty clay loam, frequently flooded	385	0.1
1159B	Strout-Arkton complex, 2 to 6 percent slopes	60	*
1193	Cosmos silty clay	80	*
1204B	Cokato loam, 2 to 6 percent slopes	6,400	2.0
1207B	Cokato-Le Sueur complex, 1 to 6 percent slopes	700	0.2
1213B	Cokato-Storden complex, 2 to 6 percent slopes	2,300	0.7
1213C2	Cokato-Storden complex, 6 to 12 percent slopes, eroded	800	0.2
1228	Hoopeston-Le Sueur complex	375	0.1

See footnote at end of table.

ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
1229B	Cokato-Storden-Estherville complex, 2 to 6 percent slopes	270	*
1833	Coland clay loam, occasionally flooded	1,035	0.3
1834	Coland clay loam, frequently flooded	5,740	1.8
1901B	Lester-Le Sueur complex, 1 to 6 percent slopes	1,448	0.4
	Water	10,500	3.2
	Total	323,500	100.0

* Less than 0.1 percent.

Soil Series and Detailed Soil Map Units

In this section, arranged in alphabetical order, each soil series recognized in the survey area is described. Each series description is followed by descriptions of the associated detailed soil map units.

Characteristics of the soil and the material in which it formed are identified for each soil series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the "Soil Survey Manual" (USDA, 1993). Many of the technical terms used in the descriptions are defined in "Soil Taxonomy" (USDA, 1975). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units on the detailed soil maps in Part III of this survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions in this section, along with the maps, can be used to determine the suitability and potential of a unit for specific uses. They also can be used to plan the management needed for those uses. More information about each map unit is given in Part II of this survey.

A map unit delineation on the detailed soil maps represents an area on the landscape and consists of one or more soils or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils or miscellaneous areas. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils and miscellaneous areas are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some "included" areas that belong to other taxonomic classes.

Most included soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, inclusions. They may or may not be mentioned in the map unit description. Other included soils and miscellaneous areas, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, inclusions. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. The included areas of contrasting soils or miscellaneous areas are mentioned in the map unit descriptions. A few included areas may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of included areas in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into segments that have similar use and management requirements. The delineation of such landscape segments on the map provides sufficient information for the development of resource plans, but if intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit. The principal hazards and limitations to be considered in planning for specific uses are described in Part II of this survey.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying layers, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying layers. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the

basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Lester loam, 2 to 6 percent slopes, is a phase of the Lester series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are called complexes. A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Harps-Glencoe complex is an example.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example.

The table "Acreage and Proportionate Extent of the Soils" in Parts I and II of this survey gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of Tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils or miscellaneous areas.

Arkton Series

Drainage class: Moderately well drained
Permeability: Moderately slow
Landform: Moraines
Parent material: Till
Slope range: 2 to 6 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Arkton clay loam, in an area of Strout-Arkton complex, 2 to 6 percent slopes, 1,700 feet west and 550 feet south of the northeast corner of sec. 12, T. 117 N., R. 31 W.; in Meeker County:

Ap—0 to 9 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; firm; about 1 percent gravel; about 4 percent cobbles; strong effervescence; slightly alkaline; abrupt smooth boundary.

Bk1—9 to 45 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct light brownish gray (2.5Y 6/2) mottles; moderate medium angular blocky structure parting to moderate very fine angular blocky; firm; few fine irregularly shaped white (10YR 8/2), soft masses of calcium carbonate; about 1 percent gravel; about 4 percent cobbles; strong effervescence; slightly alkaline; gradual wavy boundary.

Bk2—45 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common coarse distinct light brownish gray (2.5Y 6/2) mottles; weak coarse columnar structure parting to moderate fine angular blocky; firm; common fine irregularly shaped white (10YR 8/2), soft masses of calcium carbonate; few dark yellowish brown (10YR 4/6) iron concentrations in ped interiors; few black (10YR 2/1) manganese concentrations; about 1 percent gravel; about 4 percent cobbles; violent effervescence; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 7 to 12 inches

Ap horizon:
Hue—10YR or 2.5Y
Value—2 or 3
Chroma—1 or 2
Texture—clay loam
Content of gravel—1 to 2 percent
Content of cobbles and stones—0 to 4 percent

Bk horizon:
Hue—2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—clay, silty clay, or clay loam
Content of gravel—2 to 4 percent
Content of cobbles and stones—1 to 4 percent

Biscay Series

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Outwash plains and terraces
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls

Typical Pedon

Biscay clay loam (fig. I-8), 800 feet west and 2,400 feet south of the northeast corner of sec. 31, T. 117 N., R. 30 W.

Ap—0 to 8 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; slightly alkaline; abrupt smooth boundary.

A1—8 to 18 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; moderate medium subangular blocky structure; friable; slightly alkaline; gradual wavy boundary.

A2—18 to 22 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate medium

subangular blocky structure; friable; slightly alkaline; clear wavy boundary.

Bg1—22 to 30 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bg2—30 to 34 inches; olive gray (5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; about 3 percent gravel; slightly alkaline; gradual smooth boundary.

2Cg—34 to 60 inches; olive gray (5Y 4/2) gravelly coarse sand; common medium distinct grayish brown (2.5Y 5/2) mottles; single grain; loose; common very fine soft light brownish gray (10YR 6/2) calcium carbonate coatings cemented on some pebbles; about 20 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches
Thickness of the mollic epipedon: 16 to 24 inches

Ap horizon:
Hue—10YR, 2.5Y, or neutral
Value—2
Chroma—0 or 1
Texture—clay loam
Content of rock fragments—0 to 2 percent

A horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam or loam
Content of rock fragments—0 to 2 percent

B horizon:
Hue—5Y or 2.5Y
Value—4 or 5
Chroma—1 to 3
Texture—loam, clay loam, or sandy clay loam
Content of rock fragments—0 to 2 percent in the upper part and 0 to 35 percent in the lower part

2C horizon:
Hue—5Y or 2.5Y
Value—4 or 5
Chroma—1 or 2
Texture—loamy coarse sand, loamy sand, coarse sand, sand, or the gravelly analogs of these textures
Content of rock fragments—15 to 50 percent

392—Biscay clay loam

Composition

Biscay and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Rims of depressions and flats on outwash plains and terraces
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At the surface to 1.5 feet below the surface
Available water capacity to 60 inches or root-limiting layer: About 7.6 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Linder soils
- Mayer soils
- Shandep soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Blue Earth Series

Drainage class: Very poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Coprogenous earth
Slope range: 0 to 1 percent
Taxonomic class: Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents

Typical Pedon

Blue Earth mucky silty clay loam, 1,400 feet south and

300 feet west of the northeast corner of sec. 26, T. 117 N., R. 28 W.

A—0 to 8 inches; black (5Y 2/1) mucky silty clay loam (coprogenous earth), dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few snail-shell fragments; strong effervescence; slightly alkaline; clear wavy boundary.

Cg1—8 to 30 inches; very dark gray (5Y 3/1) mucky silty clay loam (coprogenous earth), gray (10YR 5/1) dry; few fine distinct olive (5Y 4/3) mottles; massive; friable; common snail-shell fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg2—30 to 60 inches; black (5Y 2/1) mucky silty clay loam (coprogenous earth), dark gray (10YR 4/1) dry; few fine prominent yellowish brown (10YR 5/6) mottles; massive; nonsticky; few snail-shell fragments; strong effervescence; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the coprogenous earth: 30 to 60 inches

A horizon:
Hue—5Y or 10YR
Value—2 or 3
Chroma—1 or 2
Texture—mucky silty clay loam

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—2 to 4
Chroma—1 or 2
Texture—silty clay loam, loam, clay loam, silt loam, or the mucky analogs of these textures

35—Blue Earth mucky silty clay loam

Composition

Blue Earth and similar soils: About 95 percent
Inclusions: About 5 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Surface layer texture: Mucky silty clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominent parent material: Coprogenous earth
Flooding: None
Seasonal high water table: 2 feet above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 12.6 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Canisteo Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Canisteo clay loam, in an area of Canisteo-Glencoe complex, 1,800 feet west and 1,700 feet north of the southeast corner of sec. 34, T. 115 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.

A1—10 to 17 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

A2—17 to 22 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 3 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

Bg—22 to 30 inches; dark gray (5Y 4/1) clay loam; few fine distinct olive gray (5Y 5/2) mottles; moderate medium subangular blocky structure; friable; few fine irregularly shaped soft light gray (5Y 7/2)

calcium carbonates occurring as threads; about 3 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

Bkg—30 to 60 inches; olive gray (5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; common medium rounded soft light gray (5Y 7/2) masses of calcium carbonate; about 3 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 14 to 23 inches
Calcium carbonate equivalent: About 5 to 20 percent in the solum
Content of rock fragments: 2 to 4 percent gravel by volume throughout the profile

Ap horizon:
Hue—neutral or 10YR
Value—2 or 3
Chroma—0 or 1
Texture—clay loam

A horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, loam, silty clay loam, or silt loam

B horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—clay loam, loam, silty clay loam, silt loam, or sandy loam

Bk horizon:
Hue—10YR, 2.5Y, or 5Y
Value—5 or 6
Chroma—1 to 4
Texture—clay loam, loam, or fine sandy loam

86—Canisteo clay loam

Composition

Canisteo and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Rims of depressions on moraines
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 9.8 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Crippin soils
- Glencoe soils
- Harps soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

956—Canisteo-Glencoe complex

Composition

Canisteo and similar soils: About 55 percent
Glencoe and similar soils: About 30 percent
Inclusions: About 15 percent

Setting

Landform: Canisteo—rims of depressions on moraines; Glencoe—depressions on moraines
Slope: Canisteo—0 to 2 percent; Glencoe—0 to 1 percent

Component Description

Canisteo
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 9.7 inches
Organic matter content: High

Glencoe
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)

Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.1 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Crippin soils
- Harps soils
- Okoboji soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Clarion Series

Drainage class: Well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 2 to 40 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Hapludolls

Typical Pedon

Clarion loam, 2 to 6 percent slopes (fig. I-9), 1,500 feet north and 1,500 feet west of the southeast corner of sec. 3, T. 114 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to weak fine granular; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

A—8 to 12 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; gradual smooth boundary.

Bw1—12 to 24 inches; dark brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; 2 percent gravel; neutral; gradual smooth boundary.

Bw2—24 to 27 inches; brown (10YR 5/3) clay loam; moderate medium subangular blocky structure; friable; about 2 percent gravel; slightly alkaline; gradual wavy boundary.

C1—27 to 37 inches; light olive brown (2.5Y 5/4) loam; massive; friable; few fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; about 4 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

C2—37 to 46 inches; light olive brown (2.5Y 5/4) loam; few fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; few fine rounded soft light gray (10YR 7/2) masses of calcium carbonate; about 4 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—46 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light brownish gray (2.5Y 6/2) and yellowish brown (10YR 5/6) mottles; massive; friable; common medium rounded soft light gray (10YR 7/2) masses of calcium carbonate; about 4 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 36 inches
Thickness of the mollic epipedon: 10 to 18 inches
Content of rock fragments: 2 to 4 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam, clay loam, silt loam, sandy loam, or silty clay loam

Bw horizon:
Hue—10YR
Value—4 or 5
Chroma—3 or 4
Texture—loam or clay loam

C horizon:
Hue—10YR or 2.5Y
Value—5
Chroma—4
Texture—loam or sandy loam

102B—Clarion loam, 2 to 6 percent slopes

Composition

Clarion and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.2 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Nicollet soils
- Swanlake soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

887B—Clarion-Swanlake complex, 2 to 6 percent slopes

Composition

Clarion and similar soils: About 60 percent
Swanlake and similar soils: About 25 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Clarion—back slopes and shoulders; Swanlake—shoulders and summits
Slope: 2 to 6 percent

Component Description

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.1 inches
Organic matter content: High

Swanlake
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.1 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Crippin soils
- Glencoe soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

920B—Clarion-Estherville complex, 2 to 6 percent slopes

Composition

Clarion and similar soils: About 70 percent
Estherville and similar soils: About 20 percent
Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.1 inches
Organic matter content: High

Estherville
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 3.4 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Swanlake soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

920C2—Clarion-Storden-Estherville complex, 6 to 12 percent slopes, eroded

Composition

Clarion and similar soils: About 40 percent
Storden and similar soils: About 25 percent
Estherville and similar soils: About 20 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Clarion—summits and back slopes; Storden—shoulders; Estherville—summits and back slopes
Slope: 6 to 12 percent

Component Description

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.5 inches
Organic matter content: Moderate

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

Estherville
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 3.0 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Delft soils
- Swanlake soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

920D2—Clarion-Storden-Estherville complex, 12 to 18 percent slopes, eroded

Composition

Clarion and similar soils: About 45 percent
Storden and similar soils: About 30 percent
Estherville and similar soils: About 15 percent
Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Clarion—summits and back slopes; Storden—summits; Estherville—summits and back slopes
Slope: 12 to 18 percent

Component Description

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.4 inches
Organic matter content: Moderate

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

Estherville
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 2.9 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Delft soils
- Terril soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

921C2—Clarion-Storden complex, 6 to 12 percent slopes, eroded

Composition

Clarion and similar soils: About 55 percent
Storden and similar soils: About 30 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Clarion—summits and back slopes; Storden—shoulders
Slope: 6 to 12 percent

Component Description

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.5 inches
Organic matter content: Moderate

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)

Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Delft soils
- Swanlake soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Cokato Series

Drainage class: Well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 2 to 12 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Argiudolls

Typical Pedon

Cokato loam, 2 to 6 percent slopes, 250 feet south and 200 feet west of the northeast corner of sec. 17, T. 116 N., R. 28 W.

Ap—0 to 11 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; slightly acid; abrupt smooth boundary.

Bt1—11 to 20 inches; dark brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds and in pores; about 2 percent gravel; neutral; gradual wavy boundary.

Bt2—20 to 28 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium subangular blocky structure; friable; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; about 2 percent gravel; neutral; gradual wavy boundary.

Bk1—28 to 40 inches; light olive brown (2.5Y 5/4) loam; weak medium subangular blocky structure; friable; common rounded white (10YR 8/2), soft masses of calcium carbonate; 2 percent gravel; strong effervescence; slightly alkaline; gradual smooth boundary.

Bk2—40 to 50 inches; light olive brown (2.5Y 4/4) loam; few fine prominent dark brown (7.5YR 4/4) mottles; weak medium subangular blocky structure; friable; common rounded white (10YR 8/2), soft masses of calcium carbonate; about 2 percent gravel; strong effervescence; slightly alkaline; clear wavy boundary.

C—50 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine prominent yellowish brown (10YR 5/6) mottles; massive; friable; few fine irregularly shaped light gray (10YR 7/2), soft threads of calcium carbonate; about 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 48 inches
Thickness of the mollic epipedon: 8 to 14 inches
Content of rock fragments: 2 to 8 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

Bt horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 or 4
Texture—clay loam or loam

Bk or C horizon:
Hue—2.5Y
Value—5 or 6
Chroma—3 or 4
Texture—loam

1204B—Cokato loam, 2 to 6 percent slopes

Composition

Cokato and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.3 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Delft soils
- Le Sueur soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1207B—Cokato-Le Sueur complex, 1 to 6 percent slopes

Composition

Cokato and similar soils: About 45 percent
Le Sueur and similar soils: About 40 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Cokato—back slopes and shoulders; Le Sueur—low summits
Slope: Cokato—2 to 6 percent; Le Sueur—1 to 4 percent

Component Description

Cokato
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: High

Le Sueur
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 11.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Cordova soils
- Swanlake soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1213B—Cokato-Storden complex, 2 to 6 percent slopes

Composition

Cokato and similar soils: About 55 percent
Storden and similar soils: About 30 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Cokato—back slopes and shoulders; Storden—shoulders
Slope: 2 to 6 percent

Component Description

Cokato
Surface layer texture: Loam

Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.3 inches
Organic matter content: High

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Hamel soils
- Le Sueur soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1213C2—Cokato-Storden complex, 6 to 12 percent slopes, eroded

Composition

Cokato and similar soils: About 50 percent
Storden and similar soils: About 40 percent
Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Cokato—back slopes and shoulders; Storden—shoulders
Slope: 6 to 12 percent

Component Description

Cokato
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.2 inches
Organic matter content: High

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamel soils
- Kilkenny soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1229B—Cokato-Storden-Estherville complex, 2 to 6 percent slopes

Composition

Cokato and similar soils: About 45 percent
Storden and similar soils: About 25 percent
Estherville and similar soils: About 20 percent
Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Cokato—back slopes and shoulders; Storden—shoulders; Estherville—back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Cokato
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: High

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

Estherville
Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 2.8 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Le Sueur soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Coland Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Coland clay loam, frequently flooded, 660 feet north and 1,540 feet east of the southwest corner of sec. 34, T. 115 N., R. 28 W.

A1—0 to 9 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

A2—9 to 32 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

A3—32 to 50 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; neutral; very few very dark brown (10YR 2/2) coatings on faces of peds; gradual wavy boundary.

Cg—50 to 60 inches; gray (5Y 5/1) loam; common medium prominent light yellowish brown (2.5Y 6/4) mottles; massive; friable; about 1 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: 48 to more than 60 inches
Thickness of the mollic epipedon: 36 to 50 inches
Content of rock fragments: 0 to 4 percent gravel by volume at a depth of 48 to 60 inches

A1 horizon:
Hue—10YR or neutral
Value—2
Chroma—0 or 1
Texture—clay loam

A2 horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, loam, or silty clay loam

C horizon:
Hue—2.5Y, 5Y, or neutral
Value—2 to 5
Chroma—0 to 2
Texture—clay loam, loam, or sandy loam

1833—Coland clay loam, occasionally flooded

Composition

Coland and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and swales on flood plains
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Alluvium
Flooding: Occasional
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 11.9 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hanlon soils
- Millington soils
- Zook soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

1834—Coland clay loam, frequently flooded

Composition

Coland and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on flood plains
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Alluvium
Flooding: Frequent
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 12.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hanlon soils
- Kalmarville soils
- Millington soils

Major Uses of the Unit

- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Cordova Series

Drainage class: Poorly drained
Permeability: Moderately slow
Landform: Moraines
Parent material: Till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Argiaquolls

Typical Pedon

Cordova clay loam, 150 feet east and 1,400 feet north of the southwest corner of sec. 3, T. 116 N., R. 27 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; about 3 percent gravel; neutral; abrupt smooth boundary.

A1—10 to 15 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 3 percent gravel; neutral; gradual smooth boundary.

A2—15 to 18 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; common very dark brown (10YR 2/2) clay films on faces of peds; about 3 percent gravel; neutral; gradual smooth boundary.

Btg1—18 to 24 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; common distinct very dark grayish brown (2.5YR 3/2) clay films on faces of peds; 3 percent gravel; neutral; gradual wavy boundary.

Btg2—24 to 30 inches; olive gray (5Y 5/2) clay loam; few fine prominent light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; common distinct dark grayish brown (2.5Y 4/2) clay films on faces of peds; about 3 percent gravel; neutral; gradual wavy boundary.

C—30 to 60 inches; light olive gray (5Y 6/2) loam; common medium prominent brown or dark brown (7.5YR 4/4) mottles; massive; friable; few fine irregularly shaped soft light gray (10YR 7/2) threads of calcium carbonate; about 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 40 inches
Thickness of the mollic epipedon: 15 to 24 inches
Thickness of the organic material: 24 to 45 inches
Content of rock fragments: 2 to 6 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam

A horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, loam, or silty clay loam

B horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—clay loam or silty clay loam

C horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—2 or 3
Texture—clay loam or loam

109—Cordova clay loam

Composition

Cordova and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Drainageways and flats on moraines
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 10.1 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cokato soils
- Hamel soils
- Le Sueur soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

978—Cordova-Rolfe complex

Composition

Cordova and similar soils: About 60 percent
Rolfe and similar soils: About 30 percent
Inclusions: About 10 percent

Setting

Landform: Cordova—drainageways and flats on moraines; Rolfe—depressions on moraines
Slope: Cordova—0 to 2 percent; Rolfe—0 to 1 percent

Component Description

Cordova
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 10.1 inches
Organic matter content: High

Rolfe
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 10.6 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Okoboji soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Cosmos Series

Drainage class: Poorly drained
Permeability: Slow
Landform: Lake plains
Parent material: Glaciolacustrine deposits and till
Slope range: 0 to 2 percent
Taxonomic class: Fine, montmorillonitic, mesic Typic Haplaquolls

Typical Pedon

Cosmos silty clay, 2,325 feet east and 110 feet north of the southwest corner of sec. 23, T. 117 N., R. 32 W.; in Meeker County:

Ap—0 to 7 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; weak fine angular blocky structure parting to strong very fine angular blocky; friable; neutral; abrupt smooth boundary.

A—7 to 15 inches; black (N 2/0) silty clay, very dark gray (N 3/0) dry; strong fine angular blocky structure parting to strong very fine angular blocky; friable; neutral; clear smooth boundary.

ABg—15 to 20 inches; very dark gray (10YR 3/1) silty clay, dark gray (N 4/0) dry; strong medium angular blocky structure parting to strong very fine angular blocky; friable; neutral; clear smooth boundary.

Bg—20 to 30 inches; olive gray (5Y 5/2) silty clay; weak coarse prismatic structure parting to strong very fine angular blocky; firm; common olive gray (5Y 4/2) stress surfaces and organic coatings on faces of peds; few light gray or gray (10YR 6/1) crystals in ped interiors; neutral; clear broken boundary.

Bkg1—30 to 36 inches; olive gray (5Y 5/2) silty clay; few fine distinct light olive brown (2.5Y 5/6) mottles; moderate very coarse prismatic structure parting to strong fine angular blocky; firm; many olive gray (5Y 4/2) stress surfaces on faces of peds; few fine irregularly shaped white (10YR 8/1) threads of calcium carbonate; strong effervescence; slightly alkaline; clear broken boundary.

2Bkg2—36 to 60 inches; olive gray (5Y 5/2) clay loam; many medium prominent dark yellowish brown (10YR 4/6) mottles; moderate fine angular blocky structure; firm; common fine irregularly shaped white (10YR 8/2), disseminated threads of calcium carbonate; many stress surfaces on faces of peds; about 3 percent gravel; about 3 percent cobbles; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches
Thickness of the lacustrine sediment: 24 to 40 inches
Thickness of the mollic epipedon: 14 to 24 inches

A horizon:
Hue—neutral or 10YR
Value—2 or 3
Chroma—0 or 1
Texture—silty clay

Bg horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—silty clay, clay, or silty clay loam

Content of cobbles—0 to 1 percent

Bkg horizon:
Hue—5Y or 2.5Y
Chroma—5 or 6
Value—2
Texture—silty clay, clay, or silty clay loam
Content of cobbles—0 to 1 percent

2Bkg horizon:
Hue—5Y
Value—5 or 6
Chroma—2
Texture—silty clay, clay, silty clay loam, or clay loam
Content of gravel—2 to 4 percent
Content of cobbles and stones—1 to 2 percent

1193—Cosmos silty clay

Composition

Cosmos and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and swales on lake plains
Slope: 0 to 2 percent

Component Description

Surface layer texture: Silty clay
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Glaciolacustrine deposits and till
Flooding: None
Seasonal high water table: At a depth of 0.5 foot to 1.5 feet
Available water capacity to 60 inches or root-limiting layer: About 9.6 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Hamel soils
- Okoboji soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Crippin Series

Drainage class: Somewhat poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Crippin loam, 300 feet south and 600 feet west of the northeast corner of sec. 20, T. 115 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.

A—10 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; very few grayish brown (10YR 5/2) coatings on faces of peds and in pores; about 2 percent gravel; strong effervescence; slightly alkaline; clear wavy boundary.

Bw1—16 to 20 inches; brown (10YR 5/3) clay loam; few fine faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; few fine irregularly shaped soft light brownish gray (10YR 6/2), disseminated threads of calcium carbonate; about 2 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

Bw2—20 to 30 inches; light olive brown (2.5Y 5/4) clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; moderate medium subangular blocky structure; friable; very few irregularly shaped soft light brownish gray (2.5Y 6/2) threads of calcium carbonate; about 3 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

Bk—30 to 40 inches; light olive brown (2.5Y 5/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; weak medium subangular blocky structure; friable; common fine irregularly shaped soft light gray (2.5Y 7/2) threads of calcium carbonate; about 4 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

C—40 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium faint grayish brown (2.5Y 5/2) mottles; massive; few fine irregularly shaped soft

light brownish gray (10YR 6/2) threads of calcium carbonates; friable; very few yellowish brown (10YR 5/6) iron stains on faces of peds and in pores; about 4 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 12 to 20 inches
Content of rock fragments: 2 to 5 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR, 2.5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—clay loam or loam

Bw horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—clay loam or loam

Bk and C horizons:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—2 to 4
Texture—loam or clay loam

118—Crippin loam

Composition

Crippin and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Rises on moraines
Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 11.3 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Swanlake soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Delft Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Delft clay loam, 1,950 feet north and 2,500 feet west of the southeast corner of sec. 30, T. 115 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; very few very dark grayish brown (10YR 3/2) coatings on faces of peds and in pores; about 2 percent gravel; neutral; abrupt smooth boundary.

A1—10 to 24 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; about 1 percent gravel; neutral; clear smooth boundary.

A2—24 to 42 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 1 percent gravel; neutral; clear smooth boundary.

C—42 to 60 inches; grayish brown (2.5Y 5/2) loam; few fine distinct olive yellow (2.5Y 6/6) mottles; massive; friable; about 2 percent gravel; slightly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 60 inches
Thickness of the mollic epipedon: 24 to 60 inches
Content of rock fragments: 1 to 5 percent gravel by volume throughout the profile

Ap horizon:
Hue—neutral or 10YR
Value—2
Chroma—0 or 1
Texture—clay loam

A horizon:
Hue—10YR, 5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, loam, or silty clay loam

C horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—2
Texture—loam, clay loam, sandy loam, or silt loam

336—Delft clay loam

Composition

Delft and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Drainageways on moraines
Slope: 1 to 3 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 12.2 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Clarion soils
- Glencoe soils
- Terril soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Dickinson Series

Drainage class: Well drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Outwash plains and terraces
Parent material: Glacial outwash
Slope range: 1 to 6 percent
Taxonomic class: Coarse-loamy, mixed, mesic Typic Hapludolls

Typical Pedon

Dickinson fine sandy loam, 1 to 6 percent slopes, 1,700 feet north and 2,000 feet east of the southwest corner of sec. 30, T. 116 N., R. 28 W.

Ap—0 to 11 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A—11 to 17 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual wavy boundary.

Bw1—17 to 24 inches; dark brown (10YR 3/3) sandy loam; weak fine subangular blocky structure; friable; slightly acid; gradual wavy boundary.

Bw2—24 to 34 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.

C1—34 to 50 inches; yellowish brown (10YR 5/4) loamy sand; single grain; very friable; neutral; clear wavy boundary.

C2—50 to 60 inches; yellowish brown (10YR 5/4) sand; common medium distinct very pale brown (10YR 8/4) mottles; single grain; loose; neutral.

Range in Characteristics

Thickness of the mollic epipedon: 12 to 22 inches
Thickness of the loamy mantle: 20 to 35 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—fine sandy loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—fine sandy loam, sandy loam, or loam

Bw horizon:
Hue—10YR
Value—3 or 4
Chroma—2 to 4
Texture—sandy loam or fine sandy loam

C horizon:
Hue—10YR
Value—4 or 5
Chroma—3 to 6
Texture—sand, fine sand, or loamy sand

27B—Dickinson fine sandy loam, 1 to 6 percent slopes

Composition

Dickinson and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Flats and slight rises on outwash plains and terraces
Slope: 1 to 6 percent

Component Description

Surface layer texture: Fine sandy loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 5.4 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Mayer soils
- Shandep soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Dickman Series

Drainage class: Somewhat excessively drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Terraces
Parent material: Glacial outwash
Slope range: 1 to 6 percent
Taxonomic class: Sandy, mixed, mesic Typic Hapludolls

Typical Pedon

Dickman sandy loam, 1 to 6 percent slopes, 1,800 feet east and 2,150 feet south of the northwest corner of sec. 12, T. 117 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; moderate medium granular structure; friable; about 2 percent gravel; slightly acid; abrupt smooth boundary.

A—8 to 12 inches; very dark grayish brown (10YR 3/2) sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary.

Bw1—12 to 16 inches; dark brown (10YR 3/3) sandy loam; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary.

Bw2—16 to 19 inches; brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; very friable; about 4 percent gravel; neutral; clear wavy boundary.

2Bw3—19 to 40 inches; dark yellowish brown (10YR 4/4) sand; single grain; loose; about 4 percent gravel; neutral; clear wavy boundary.

2C—40 to 60 inches; yellowish brown (10YR 5/4) and light yellowish brown (10YR 6/4) sand; single grain; loose; about 5 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: More than 30 inches
Thickness of the mollic epipedon: 10 to 20 inches
Thickness of the loamy mantle: 12 to 20 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—sandy loam
Content of gravel—2 to 10 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—sandy loam, fine sandy loam, or coarse sandy loam
Content of gravel—2 to 10 percent

Bw horizon:
Hue—10YR or 7.5YR
Value—3 or 4
Chroma—3 or 4
Texture—sandy loam, coarse sandy loam, loamy coarse sand, or loamy sand
Content of gravel—2 to 10 percent

2C horizon:
Hue—7.5YR, 10YR, or 2.5Y
Value—4 to 6
Chroma—2 to 4
Texture—sand or coarse sand
Content of gravel—2 to 15 percent

327B—Dickman sandy loam, 1 to 6 percent slopes

Composition

Dickman and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and slight rises on outwash plains and terraces
Slope: 1 to 6 percent

Component Description

Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 4.4 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Dickinson soils
- Mayer soils
- Shandep soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Estherville Series

Drainage class: Somewhat excessively drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Terraces, outwash plains, and moraines
Parent material: Glacial outwash
Slope range: 0 to 18 percent
Taxonomic class: Sandy, mixed, mesic Typic Hapludolls

Typical Pedon

Estherville loam, 2 to 6 percent slopes (fig. I-10), 2,400 feet north and 400 feet east of the southwest corner of sec. 23, T. 116 N., R. 29 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

A—8 to 10 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary.

Bw—10 to 18 inches; dark yellowish brown (10YR 4/4) sandy loam; moderate medium subangular blocky structure parting to weak medium subangular blocky; friable; about 4 percent gravel; moderately acid; clear smooth boundary.

2C1—18 to 35 inches; brownish yellow (10YR 6/6) and very pale brown (10YR 7/4) gravelly coarse sand; single grain; loose; few fine light gray (10YR 7/2) calcium carbonate coatings cemented to faces of pebbles; about 20 percent gravel; slight effervescence; slightly alkaline; clear wavy boundary.

2C2—35 to 60 inches; very pale brown (10YR 7/3 and 7/4) gravelly coarse sand; single grain; loose; about 30 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 15 to 30 inches
Thickness of the mollic epipedon: 7 to 20 inches
Thickness of the loamy mantle: 10 to 20 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam
Content of gravel—2 to 15 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam or sandy loam
Content of gravel—2 to 15 percent

Bw horizon:
Hue—10YR or 7.5YR
Value—3 or 4
Chroma—3 or 4
Texture—sandy loam, coarse sandy loam, or loam
Content of gravel—2 to 15 percent

2C horizon:
Hue—10YR
Value—4 to 7
Chroma—2 to 6
Texture—coarse sand, sand, or the gravelly analogs of these textures
Content of gravel—10 to 35 percent

41A—Estherville loam, 0 to 2 percent slopes

Composition

Estherville and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Flats on outwash plains and terraces
Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 3.7 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Wadena soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

41B—Estherville loam, 2 to 6 percent slopes

Composition

Estherville and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and slight rises on outwash plains and terraces
Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 3.3 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Wadena soils
- Hawick soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Glencoe Series

Drainage class: Very poorly drained
Permeability: Moderate or moderately slow
Landform: Moraines
Parent material: Colluvium and till

Slope range: 0 to 1 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Glencoe clay loam, in an area of Canisteo-Glencoe complex, 2,300 feet west and 1,500 feet north of the southeast corner of sec. 34, T. 115 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 1 percent gravel; slightly alkaline; abrupt smooth boundary.

A—10 to 20 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; about 1 percent gravel; neutral; gradual wavy boundary.

Ag—20 to 30 inches; black (5Y 2/1) clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 1 percent gravel; neutral; gradual wavy boundary.

Bg—30 to 40 inches; dark gray (5Y 4/1) clay loam; few fine distinct very dark gray (5Y 3/1) mottles; massive; friable; about 1 percent gravel; neutral; gradual wavy boundary.

Cg—40 to 60 inches; light olive gray (5Y 6/2) clay loam; common medium distinct light olive brown (2.5Y 5/4) mottles; massive; friable; about 3 percent gravel; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 60 inches
Thickness of the mollic epipedon: 24 to 46 inches

Ap horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam
Content of gravel—1 to 5 percent

A horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, silty clay loam, or loam
Content of gravel—1 to 5 percent

B horizon:
Hue—2.5Y or 5Y
Value—4 or 5
Chroma—1 or 2
Texture—clay loam, silty clay loam, or loam
Content of gravel—1 to 5 percent

C horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—2
Texture—clay loam, silty clay loam, or loam
Content of gravel—2 to 6 percent

114—Glencoe clay loam

Composition

Glencoe and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.2 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Okoboji soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Hamel Series

Drainage class: Poorly drained
Permeability: Moderately slow
Landform: Moraines
Parent material: Till
Slope range: 0 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Argiaquolls

Typical Pedon

Hamel loam, 1,850 feet south and 1,850 feet east of the northwest corner of sec. 20, T. 116 N., R. 28 W.

Ap—0 to 10 inches; very dark gray (10YR 3/1) loam; weak fine granular structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

A1—10 to 20 inches; very dark gray (10YR 3/1) loam; weak fine subangular blocky structure; friable; 2 percent gravel; neutral; abrupt smooth boundary.

A2—20 to 30 inches; black (N 2/0) loam; moderate fine subangular blocky structure parting to weak fine granular; friable; about 2 percent gravel; neutral; clear smooth boundary.

Btg—30 to 42 inches; black (5Y 2/1) clay loam; moderate medium subangular blocky structure; friable; very few faint black (5Y 2/2) clay films on faces of peds and in pores; about 2 percent gravel; neutral; clear wavy boundary.

C—42 to 60 inches; light olive gray (5Y 6/2) loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; very few lime or carbonate coatings; about 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 30 to 60 inches
Thickness of the mollic epipedon: 24 to 44 inches
Content of rock fragments: 1 to 5 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—loam

A horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—loam, clay loam, silt loam, or silty clay loam

B horizon:
Hue—10YR, 2.5Y, or 5Y
Value—2 to 4
Chroma—1 or 2
Texture—clay loam

C horizon:
Hue—2.5Y or 5Y
Value—4 to 6
Chroma—1 or 2
Texture—loam or clay loam

414—Hamel loam

Composition

Hamel and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Drainageways on moraines
Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 11.6 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Glencoe soils
- Terril soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Hanlon Series

Drainage class: Moderately well drained
Permeability: Moderately rapid
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 3 percent
Taxonomic class: Coarse-loamy, mixed, mesic Cumulic Hapludolls

Typical Pedon

Hanlon fine sandy loam, in an area of Hanlon-Kalmarville complex, frequently flooded, 700 feet south

and 200 feet east of the northwest corner of sec. 11, T. 116 N., R. 27 W.

A1—0 to 16 inches; very dark brown (10YR 2/2) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual irregular boundary.

A2—16 to 40 inches; black (10YR 2/1) fine sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw—40 to 60 inches; very dark gray (10YR 3/1) fine sandy loam, grayish brown (10YR 5/2) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; weak fine subangular blocky structure; friable; few brown (10YR 5/3) strata of sand; neutral.

Range in Characteristics

Depth to carbonates: 48 inches or more
Thickness of the mollic epipedon: 40 to 70 inches

A1 horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—fine sandy loam

A2 horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—fine sandy loam or sandy loam

Bw horizon:
Hue—10YR
Value—3 or 4
Chroma—1 or 2
Texture—fine sandy loam, sandy loam, or loamy fine sand

Cg horizon (if it occurs):
Hue—10YR or 2.5Y
Value—3 or 4
Chroma—1 or 2
Texture—loamy sand, sand, sandy loam, or loam

1084—Hanlon-Kalmarville complex, frequently flooded

Composition

Hanlon and similar soils: About 50 percent
Kalmarville and similar soils: About 40 percent
Inclusions: About 10 percent

Setting

Landform: Hanlon—flats and slight rises on flood plains; Kalmarville—depressions on flood plains
Slope: Hanlon—0 to 3 percent; Kalmarville—0 to 1 percent

Component Description

Hanlon
Surface layer texture: Fine sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Alluvium
Flooding: Frequent
Seasonal high water table: At a depth of 3 to 5 feet
Available water capacity to 60 inches or root-limiting layer: About 9.2 inches
Organic matter content: Moderate

Kalmarville
Surface layer texture: Sandy loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Alluvium
Flooding: Frequent
Seasonal high water table: At the surface to 1 foot below the surface
Available water capacity to 60 inches or root-limiting layer: About 9.3 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Coland soils
- Millington soils

Major Uses of the Unit

- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Harps Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 0 to 3 percent
Taxonomic class: Fine-loamy, mesic Typic Calciaquolls

Typical Pedon

Harps clay loam (fig. I-11), 250 feet south and 1,800

feet west of the northeast corner of sec. 20, T. 115 N., R. 30 W.

Akp—0 to 10 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; violent effervescence; moderately alkaline; abrupt smooth boundary.

Ak—10 to 20 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; about 2 percent gravel; violent effervescence; moderately alkaline; gradual wavy boundary.

Bkg—20 to 32 inches; grayish brown (2.5Y 5/2) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable; very few dark grayish brown (10YR 4/2) organic coatings; about 2 percent gravel; strong effervescence with disseminated calcium carbonates; moderately alkaline; gradual wavy boundary.

Cg1—32 to 40 inches; grayish brown (2.5Y 5/2) loam; few medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; about 4 percent gravel; strong effervescence; moderately alkaline with disseminated calcium carbonates; clear wavy boundary.

Cg2—40 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; about 4 percent gravel; strong effervescence with disseminated calcium carbonates; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 12 to 21 inches
Calcium carbonate equivalent: About 15 to 30 percent in the upper 6 to 18 inches
Content of rock fragments: 1 to 5 percent gravel by volume throughout the profile

Akp horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam

Ak horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—clay loam or loam

B horizon:
Hue—10YR, 2.5Y, or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—clay loam, loam, or sandy clay loam

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—5 or 6
Chroma—1 or 2
Texture—loam, clay loam, or sandy clay loam

112—Harps clay loam

Composition

Harps and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Rims of depressions on moraines
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 11.2 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Crippin soils
- Glencoe soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

1092—Harps-Glencoe complex

Composition

Harps and similar soils: About 50 percent
Glencoe and similar soils: About 35 percent
Inclusions: About 15 percent

Setting

Landform: Harps—rims of depressions on moraines; Glencoe—depressions on moraines
Slope: Harps—0 to 2 percent; Glencoe—0 to 1 percent

Component Description

Harps
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 11.2 inches
Organic matter content: High

Glencoe
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.3 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Okoboji soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Hawick Series

Drainage class: Excessively drained
Permeability: Rapid or very rapid
Landform: Outwash plains and terraces
Parent material: Glacial outwash
Slope range: 4 to 12 percent
Taxonomic class: Sandy, mixed, mesic Entic Hapludolls

Typical Pedon

Hawick coarse sandy loam, 4 to 12 percent slopes, 400 feet south and 100 feet east of the northwest corner of sec. 9, T. 116 N., R. 30 W.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) coarse sandy loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 6 percent gravel; neutral; abrupt smooth boundary.
Bw—9 to 16 inches; dark brown (10YR 4/3), brown (10YR 5/3), and pale brown (10YR 6/3) gravelly coarse sand; weak very fine subangular blocky structure; loose; about 15 percent gravel; strong effervescence; slightly alkaline; clear smooth boundary.
C1—16 to 38 inches; brown (10YR 5/3) sand; single grain; loose; about 5 percent gravel; strong effervescence; slightly alkaline; clear smooth boundary.
C2—38 to 60 inches; grayish brown (10YR 5/2), brown (10YR 5/3), and pale brown (10YR 6/3) gravelly coarse sand; single grain; loose; about 15 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 0 to 30 inches
Thickness of the mollic epipedon: 7 to 12 inches
Thickness of the loamy mantle: 0 to 10 inches

Ap horizon:
Hue—10YR
Value—3
Chroma—1 to 3
Texture—coarse sandy loam
Content of gravel—5 to 15 percent

Bw horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—3 or 4
Texture—coarse sand, loamy sand, loamy coarse sand, or the gravelly analogs of these textures
Content of gravel—5 to 25 percent

C horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—2 to 6
Texture—coarse sand, sand, or the gravelly analogs of these textures
Content of gravel—5 to 50 percent

611C—Hawick coarse sandy loam, 4 to 12 percent slopes

Composition

Hawick and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Outwash plains and terraces
Position on landform: Back slopes and shoulders
Slope: 4 to 12 percent

Component Description

Surface layer texture: Coarse sandy loam
Depth class: Very deep (more than 60 inches)
Drainage class: Excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 3.5 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Clarion soils
- Mayer soils
- Wadena soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Hoopeston Series

Drainage class: Somewhat poorly drained
Permeability: Upper part—moderately rapid; lower part—rapid
Landform: Flood plains and terraces
Parent material: Alluvium
Slope range: 1 to 3 percent
Taxonomic class: Coarse-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Hoopeston loam, in an area of Hoopeston-Le Sueur complex, 2,400 feet south and 2,500 feet east of the northwest corner of sec. 8, T. 117 N., R. 27 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

A1—10 to 16 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

A2—16 to 20 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; common black (10YR 2/1) streaks on faces of peds; friable; about 2 percent gravel; neutral; abrupt wavy boundary.

Bw1—20 to 30 inches; dark grayish brown (10YR 4/2) sandy loam; moderate medium subangular blocky structure; common very dark grayish brown (2.5Y 3/2) streaks on faces of peds; very friable; about 2 percent gravel; neutral; gradual smooth boundary.

Bw2—30 to 34 inches; grayish brown (2.5Y 5/2) sandy loam; few fine distinct olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; very friable; about 3 percent gravel; neutral; gradual wavy boundary.

C1—34 to 50 inches; light brownish gray (2.5Y 6/2) sand; common moderate distinct light olive brown (2.5Y 5/4) and dark grayish brown (2.5Y 4/2) mottles; single grain; loose; about 4 percent gravel; neutral; gradual wavy boundary.

C2—50 to 60 inches; grayish brown (2.5Y 5/2) sand; common moderate distinct light olive brown (2.5Y 5/4) mottles; single grain; loose; about 4 percent gravel; slightly alkaline.

Range in Characteristics

Thickness of the mollic epipedon: 8 to 24 inches
Content of rock fragments: 1 to 4 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 to 3
Texture—loam, fine sandy loam, or sandy loam

B horizon:
Hue—10YR, 7.5YR, or 2.5Y

Value—4 to 6
Chroma—2 or 3
Texture—sandy loam, fine sandy loam, loamy sand, or loamy fine sand

C horizon:
Hue—10YR, 2.5Y, or 5Y
Value—3 to 6
Chroma—1 to 4
Texture—sand, fine sand, or loamy sand; stratified with sandy loam and fine sandy loam in some pedons

1228—Hoopeston-Le Sueur complex

Composition

Hoopeston and similar soils: About 60 percent
Le Sueur and similar soils: About 30 percent
Inclusions: About 10 percent

Setting

Landform: Hoopeston—rises on flood plains and terraces; Le Sueur—moraines
Position on landform: Hoopeston—rises; Le Sueur—low summits
Slope: 1 to 3 percent

Component Description

Hoopeston
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat poorly drained
Dominant parent material: Alluvium
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 6.7 inches
Organic matter content: Moderate

Le Sueur
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Estherville soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Kalmarville Series

Drainage class: Poorly drained
Permeability: Moderate or moderately rapid
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 1 percent
Taxonomic class: Coarse-loamy, mixed, nonacid, mesic Mollic Fluvaquents

Typical Pedon

Kalmarville sandy loam, in an area of Hanlon-Kalmarville complex, frequently flooded, 500 feet south and 100 feet east of the northwest corner of sec. 11, T. 116 N., R. 27 W.

A1—0 to 16 inches; black (10YR 2/1) sandy loam, dark grayish brown (10YR 4/2) and light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; many strata of grayish brown (10YR 5/2) sand; about 2 percent gravel; neutral; gradual wavy boundary.

A2—16 to 22 inches; black (10YR 2/1) sandy loam, dark gray (10YR 4/1) and light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; few strata of grayish brown (10YR 5/2) sand; about 1 percent gravel; neutral; gradual wavy boundary.

A3—22 to 32 inches; very dark brown (10YR 2/2) sandy loam, dark gray (10YR 4/1) and light brownish gray (10YR 6/2) dry; weak fine granular structure; friable; common strata of grayish brown (10YR 5/2) sand; about 1 percent gravel; neutral; gradual wavy boundary.

A4—32 to 60 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; massive; sticky; about 1 percent gravel; slightly alkaline.

Range in Characteristics

Content of rock fragments: 0 to 5 percent gravel by volume throughout the profile

A horizon:
Hue—10YR

Value—2 to 6
Chroma—1
Texture—sandy loam, fine sandy loam, silt loam, or loam; coarser textured strata in some pedons

Kilkenny Series

Drainage class: Well drained
Permeability: Moderately slow
Landform: Moraines
Parent material: Till
Slope range: 2 to 6 percent
Taxonomic class: Fine, montmorillonitic, mesic Mollic Hapludalfs

Typical Pedon

Kilkenny clay loam, 2 to 6 percent slopes, 230 feet north and 900 feet east of the southwest corner of sec. 19, T. 117 N., R. 30 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 5 percent gravel, mostly shale fragments; slightly acid; abrupt smooth boundary.

Bt1—7 to 15 inches; dark brown (10YR 4/3) clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; firm; many distinct very dark grayish brown (10YR 3/2) clay films on faces of peds; about 5 percent gravel, mostly shale fragments; moderately acid; gradual wavy boundary.

Bt2—15 to 24 inches; dark yellowish brown (10YR 4/4) clay loam; moderate medium prismatic structure parting to moderate medium angular blocky; firm; common distinct dark grayish brown (10YR 4/2) clay films on faces of peds; about 5 percent gravel, mostly shale fragments; moderately acid; gradual wavy boundary.

Bt3—24 to 27 inches; olive brown (2.5Y 4/4) clay loam; few fine faint light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; few distinct dark grayish brown (10YR 4/2) clay films on faces of peds; about 5 percent gravel, mostly shale fragments; moderately acid; gradual irregular boundary.

C—27 to 60 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct yellowish brown (10YR 5/4) mottles; massive; friable; common fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; about 5 percent gravel, mostly shale fragments; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 40 inches
Thickness of the mollic epipedon: 7 to 10 inches
Content of rock fragments: 2 to 6 percent gravel, dominated by shale fragments, throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—clay loam

Bt horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 to 5
Texture—clay loam, clay, or silty clay loam

C horizon:
Hue—2.5Y
Value—5
Chroma—2 to 6
Texture—clay loam or loam

238B—Kilkenny clay loam, 2 to 6 percent slopes

Composition

Kilkenny and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 9.6 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

• Cordova soils

- Le Sueur soils
- Swanlake soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Klossner Series

Drainage class: Very poorly drained
Permeability: Upper part—moderately slow to moderately rapid; lower part—moderate or moderately slow
Landform: Moraines
Parent material: Organic materials and glaciolacustrine deposits, till, or outwash
Slope range: 0 to 2 percent
Taxonomic class: Loamy, mixed, euic, mesic Terric Medisaprists

Typical Pedon

Klossner muck (fig. I-12), 500 feet south and 1,500 feet west of the northeast corner of sec. 6, T. 115 N., R. 29 W.

Oa1—0 to 9 inches; black (N 2/0) muck, black (10YR 2/1) dry; about 5 percent fiber, less than 1 percent rubbed; weak medium subangular blocky structure; nonsticky; neutral; clear irregular boundary.

Oa2—9 to 24 inches; black (N 2/0) muck, very dark brown (10YR 2/2) dry; about 5 percent fiber, less than 1 percent rubbed; weak medium subangular blocky structure; nonsticky; neutral; gradual wavy boundary.

2A—24 to 42 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; sticky; neutral; gradual irregular boundary.

2C1—42 to 52 inches; dark gray (5Y 4/1) silty clay loam; few fine prominent strong brown (7.5YR 5/6) mottles; massive; sticky; neutral; clear wavy boundary.

2C2—52 to 60 inches; dark gray (5Y 4/1) silty clay loam; few medium prominent strong brown (7.5YR 5/6) mottles; massive; sticky; strong effervescence; slightly alkaline.

Range in Characteristics

Thickness of the organic material: 16 to 50 inches
Organic matter content: 25 to 60 percent in the surface layer

Oa1 horizon:
Hue—neutral or 10YR
Value—2 or 3
Chroma—0 or 1
Texture—muck

Oa2 horizon:
Hue—neutral or 10YR
Value—2 or 3
Chroma—0 or 1
Texture—muck or sapric material

2A horizon:
Hue—neutral or 10YR
Value—2 or 3
Chroma—0 or 1
Texture—silty clay loam, clay loam, or the mucky analogs of these textures

2C horizon:
Hue—5Y, 2.5Y, 10YR, or neutral
Value—4 to 6
Chroma—0 to 2
Texture—silty clay loam, silt loam, loam, clay loam, sandy loam, or sandy clay loam
Content of gravel—0 to 10 percent

539—Klossner muck

Composition

Klossner and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and glaciolacustrine deposits or till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 16.6 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the

"Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

1075—Klossner-Muskego complex, ponded

Composition

Klossner and similar soils: About 45 percent
Muskego and similar soils: About 40 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Klossner
Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and glaciolacustrine deposits or till
Flooding: None
Seasonal high water table: 3 feet above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 18.7 inches
Organic matter content: Very high

Muskego
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and coprogenous earth
Flooding: None
Seasonal high water table: 3 feet above to 1 foot below the surface
Ponding duration: Long
Available water capacity to 60 inches or root-limiting layer: About 20.2 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Okoboji soils

1080—Klossner-Okoboji-Glencoe complex, ponded

Composition

Klossner and similar soils: About 35 percent
Okoboji and similar soils: About 30 percent
Glencoe and similar soils: About 20 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Klossner
Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and glaciolacustrine deposits or till
Flooding: None
Seasonal high water table: 3 feet above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 15.2 inches
Organic matter content: Very high

Okoboji
Surface layer texture: Silty clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 3 feet above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.4 inches
Organic matter content: High

Glencoe
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 3 feet above to 1 foot below the surface

Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Shandep soils

1091—Klossner, sandy substratum-Harps-Mayer complex

Composition

Klossner and similar soils: About 40 percent
Harps and similar soils: About 30 percent
Mayer and similar soils: About 20 percent
Inclusions: About 10 percent

Setting

Landform: Klossner—depressions on outwash plains; Harps—rims of depressions on moraines; Mayer—rims of depressions and flats on outwash plains and terraces
Slope: Klossner—0 to 2 percent; Harps—0 to 3 percent; Mayer—0 to 2 percent

Component Description

Klossner
Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and outwash
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.5 inches
Organic matter content: Very high

Harps
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 11.0 inches
Organic matter content: High

Mayer
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 6.9 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Linder soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Lester Series

Drainage class: Well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 2 to 12 percent
Taxonomic class: Fine-loamy, mixed, mesic Mollic Hapludalfs

Typical Pedon

Lester loam, 2 to 6 percent slopes, 2,100 feet south and 250 feet west of the northeast corner of sec. 11, T. 115 N., R. 27 W.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.
Bt1—9 to 18 inches; dark brown (10YR 4/3) clay loam; moderate medium subangular blocky structure; friable; very few distinct very dark grayish brown (10YR 3/2) clay films on faces of peds and in pores;

about 3 percent gravel; neutral; clear smooth boundary.
Bt2—18 to 26 inches; brown (10YR 5/3) clay loam; moderate medium subangular blocky structure; friable; very few distinct dark grayish brown (10YR 4/2) clay films on faces of peds and in pores; about 3 percent gravel; neutral; clear wavy boundary.
Bt3—26 to 30 inches; olive brown (2.5Y 4/4) clay loam; moderate medium subangular blocky structure; friable; very few distinct dark grayish brown (10YR 4/2) clay films on faces of peds and in pores; about 4 percent gravel; slightly alkaline; clear wavy boundary.
C1—30 to 40 inches; olive brown (2.5Y 4/4) loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; massive; friable; about 5 percent gravel; strong effervescence with disseminated calcium carbonates; slightly alkaline; clear wavy boundary.
C2—40 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; common fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; very few yellowish brown (10YR 5/6) iron stains on faces of peds and in pores; about 5 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 20 to 45 inches
Thickness of the mollic epipedon: 6 to 10 inches
Content of rock fragments: 2 to 8 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

Bt horizon:
Hue—10YR or 2.5Y
Value—4 or 5
Chroma—3 or 4
Texture—clay loam or loam

C horizon:
Hue—2.5Y
Value—4 to 6
Chroma—4 to 6
Texture—loam or clay loam

106B—Lester loam, 2 to 6 percent slopes

Composition

Lester and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Delft soils
- Le Sueur soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

944B—Lester-Storden-Estherville complex, 2 to 6 percent slopes

Composition

Lester and similar soils: About 50 percent
Storden and similar soils: About 25 percent
Estherville and similar soils: About 15 percent
Inclusions: About 10 percent

Setting

Landform: Moraines
Position on landform: Lester—back slopes and shoulders; Storden—shoulders; Estherville—back slopes and shoulders
Slope: 2 to 6 percent

Component Description

Lester
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: Moderate

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

Estherville
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat excessively drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 3.3 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Hamel soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

945B—Lester-Storden complex, 2 to 6 percent slopes

Composition

Lester and similar soils: About 60 percent
Storden and similar soils: About 25 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Lester—back slopes and shoulders; Storden—shoulders
Slope: 2 to 6 percent

Component Description

Lester
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: Moderate

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Hamel soils
- Le Sueur soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning

these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

945C2—Lester-Storden complex, 6 to 12 percent slopes, eroded

Composition

Lester and similar soils: About 50 percent
Storden and similar soils: About 35 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Lester—summits and back slopes; Storden—shoulders
Slope: 6 to 12 percent

Component Description

Lester
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.1 inches
Organic matter content: Moderate

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cordova soils
- Hamel soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

1901B—Lester-Le Sueur complex, 1 to 6 percent slopes

Composition

Lester and similar soils: About 45 percent
Le Sueur and similar soils: About 40 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Lester—back slopes and shoulders; Le Sueur—low summits and back slopes
Slope: Lester—2 to 6 percent; Le Sueur—1 to 4 percent

Component Description

Lester
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: Moderate

Le Sueur
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 11.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Cordova soils
- Swanlake soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Le Sueur Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 1 to 4 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Argiudolls

Typical Pedon

Le Sueur loam, 1,600 feet north and 300 feet east of the southwest corner of sec. 3, T. 116 N., R. 27 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 3 percent gravel; neutral; abrupt smooth boundary.

A1—8 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; about 3 percent gravel; neutral; clear smooth boundary.

A2—12 to 16 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; about 3 percent gravel; neutral; gradual wavy boundary.

Bt1—16 to 26 inches; dark grayish brown (10YR 4/2) clay loam; strong medium subangular blocky structure; friable; very few faint very dark grayish brown (10YR 3/2) clay films on faces of peds and in pores; about 3 percent gravel; slightly acid; clear wavy boundary.

Bt2—26 to 30 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine faint olive brown (2.5Y 4/4) mottles; moderate medium subangular blocky structure; friable; very few faint very dark grayish brown (2.5Y 3/2) clay films on faces of peds and in pores; about 4 percent gravel; neutral; gradual wavy boundary.

C—30 to 60 inches; grayish brown (2.5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; common fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; about 4 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 22 to 38 inches
Thickness of the mollic epipedon: 10 to 18 inches
Content of rock fragments: 1 to 8 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam, clay loam, silt loam, or silty clay loam

Bt horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—2 to 4
Texture—clay loam, loam, or silty clay loam

C horizon:
Hue—2.5Y or 5Y
Value—5
Chroma—2
Texture—loam or clay loam

239—Le Sueur loam

Composition

Le Sueur and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Low summits and back slopes
Slope: 1 to 3 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 10.8 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the

"Soil Properties" section in Part II of this publication.

Inclusions

- Cokato soils
- Cordova soils
- Crippin soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Linder Series

Drainage class: Somewhat poorly drained
Permeability: Upper part—moderate or moderately rapid; lower part—very rapid
Landform: Outwash plains
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Coarse-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Linder loam, 2,300 feet south and 800 feet east of the northwest corner of sec. 16, T. 116 N., R. 29 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure parting to moderate fine granular; friable; about 3 percent gravel; neutral; clear smooth boundary.

A—10 to 16 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; about 3 percent gravel; neutral; clear smooth boundary.

Bw—16 to 25 inches; dark grayish brown (2.5Y 4/2) sandy loam; weak fine subangular blocky structure; very friable; very few very dark grayish brown (2.5Y 3/2) coatings on faces of peds and in pores; about 10 percent gravel; slightly alkaline; clear wavy boundary.

2C—25 to 60 inches; dark grayish brown (2.5Y 4/2) gravelly sand; common fine faint olive brown (2.5Y 4/4) mottles; single grain; loose; few fine irregularly shaped soft light brownish gray (10YR 6/2) coatings of calcium carbonate cemented to faces of pebbles; about 20 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Thickness of the mollic epipedon: 12 to 22 inches
Thickness of the loamy mantle: 24 to 30 inches

Ap horizon:
Hue—10YR or neutral
Value—2
Chroma—0 or 1
Texture—loam
Content of gravel—0 to 3 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam or sandy loam
Content of gravel—0 to 3 percent

Bw horizon:
Hue—2.5Y
Value—4 or 5
Chroma—2 or 3
Texture—sandy loam
Content of gravel—5 to 10 percent

2C horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—2 to 6
Texture—sand, coarse sand, or the gravelly analogs of these textures
Content of gravel—5 to 30 percent

247—Linder loam

Composition

Linder and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and swales on outwash plains
Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Somewhat poorly drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of 2 to 4 feet
Available water capacity to 60 inches or root-limiting layer: About 5.9 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit,

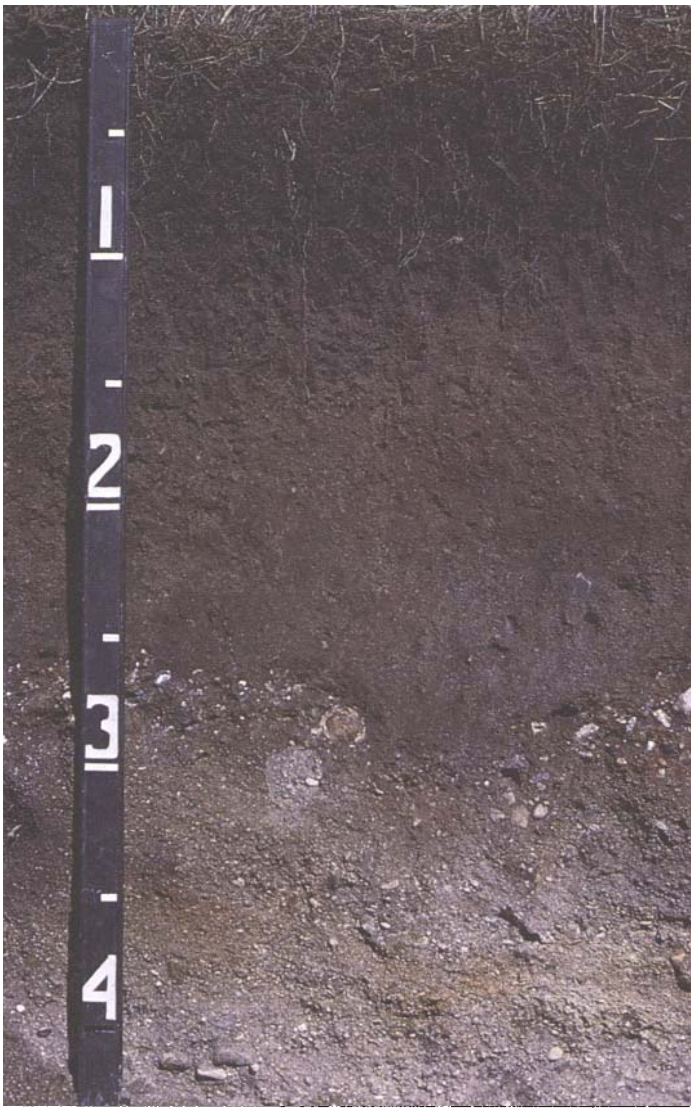

Figure I-8.—A profile of Biscay clay loam. The loamy mantle is about 34 inches thick and is underlain by sand and gravel. Depth is marked in feet.

Figure I-9.—A profile of Clarion loam. The surface soil is about 12 inches thick. An accumulation of lime is at a depth of about 27 inches. Depth is marked in feet.

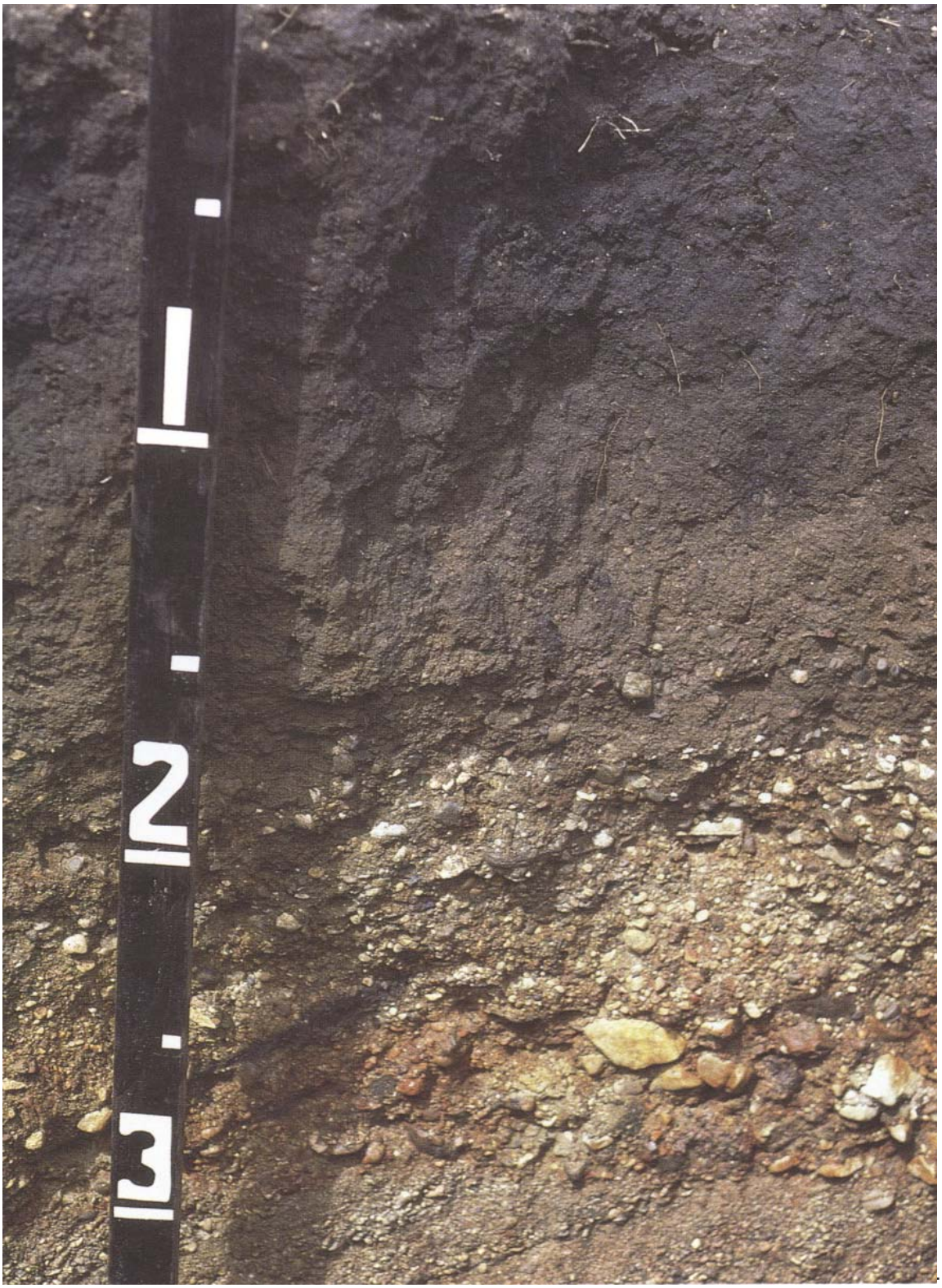

Figure I-10.—A profile of Estherville loam. The loamy mantle is about 18 inches thick and is underlain by sand and gravel. Depth is marked in feet.

Figure I-11.—A profile of Harps clay loam. The reddish mottles are a result of the seasonal high water table. Depth is marked in feet.

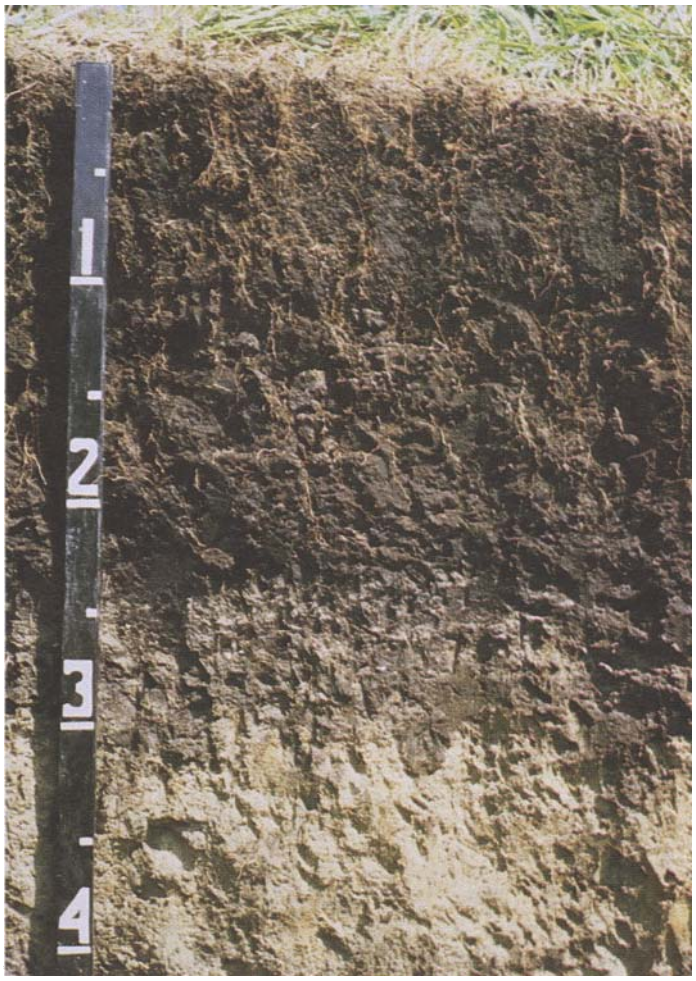

Figure I-12.—A profile of Klossner muck. The organic surface soil is about 24 inches thick and is underlain by loamy material. Depth is marked in feet.

Figure I-13.—A profile of Storden loam. The dark grayish brown surface layer is about 8 inches thick. Depth is marked in feet.

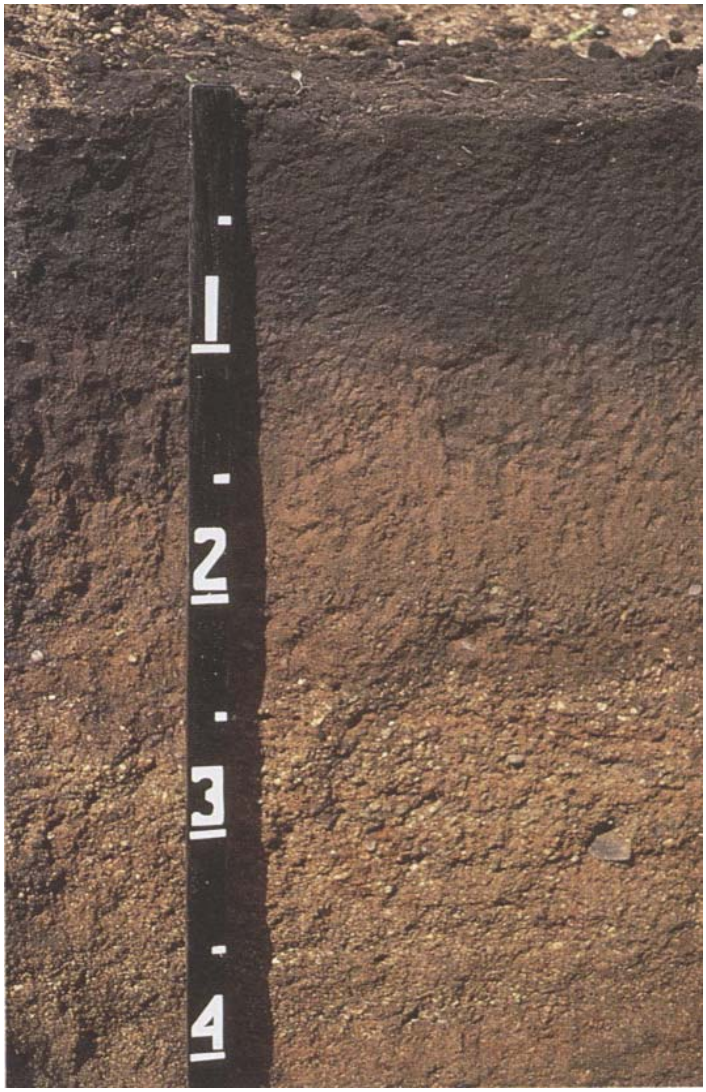

Figure I-14.—A profile of Wadena loam. The loamy mantle is about 28 inches thick and is underlain by sand and gravel. Depth is marked in feet.

such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Estherville soils
- Mayer soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Mayer Series

Drainage class: Poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Outwash plains and terraces
Parent material: Glacial outwash
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls

Typical Pedon

Mayer loam, 2,150 feet north and 400 feet west of the southeast corner of sec. 14, T. 116 N., R. 30 W.

Ap—0 to 9 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.

A1—9 to 18 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; about 2 percent gravel; strong effervescence; slightly alkaline; gradual wavy boundary.

A2—18 to 22 inches; very dark gray (10YR 3/1) loam, gray (10YR 5/1) dry; moderate medium subangular blocky structure; friable; very few dark grayish brown (2.5Y 4/2) coatings; about 2 percent gravel; strong effervescence with disseminated calcium carbonate; slightly alkaline; clear wavy boundary.

Bg—22 to 30 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; few very dark grayish brown (10YR 3/2) coatings; about 2 percent gravel; strong effervescence with disseminated calcium carbonate; moderately alkaline; clear wavy boundary.

2C1—30 to 50 inches; olive gray (5Y 4/2 and 5/2) gravelly coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; very few dark grayish brown (2.5Y 4/2) coatings; few fine irregularly shaped light brownish gray (10YR 6/2) calcium carbonate coatings cemented to faces of pebbles; about 15 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.

2C2—50 to 60 inches; dark grayish brown (2.5Y 4/2) and grayish brown (2.5Y 5/2) gravelly coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grain; loose; few fine irregularly shaped light brownish gray (10YR 6/2) coatings of calcium carbonate cemented to faces of pebbles; about 20 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 14 to 24 inches
Thickness of the loamy mantle: 20 to 40 inches

Ap horizon:
Hue—neutral or 10YR
Value—2
Chroma—0 or 1
Texture—loam
Content of gravel—0 to 10 percent

A horizon:
Hue—10YR, 2.5Y, or 5Y
Value—2 or 3
Chroma—0 or 1
Texture—loam, clay loam, or silt loam
Content of gravel—0 to 10 percent

B horizon:
Hue—10YR, 2.5Y, or 5Y
Value—4 or 5
Chroma—1 to 3
Texture—loam, clay loam, silt loam, or sandy clay loam
Content of gravel—0 to 10 percent

2C horizon:
Hue—5Y, 2.5Y, or 10YR
Value—3 to 5
Chroma—1 to 3
Texture—coarse sand, sand, or the gravelly analogs of these textures
Content of gravel—10 to 50 percent

255—Mayer loam

Composition

Mayer and similar soils: About 85 percent

Inclusions: About 15 percent

Setting

Landform: Rims of depressions and flats on outwash plains and terraces
Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of 1 to 3 feet
Available water capacity to 60 inches or root-limiting layer: About 6.9 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Canisteo soils
- Linder soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Millington Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 1 percent
Taxonomic class: Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls

Typical Pedon

Millington loam, frequently flooded, 100 feet south and 1,500 feet east of the northwest corner of sec. 9, T. 116 N., R. 30 W.

A1—0 to 9 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 1 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

A2—9 to 15 inches; black (10YR 2/1) loam with few sand seams, very dark gray (10YR 3/1) dry; common fine distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; friable; about 1 percent gravel; slight effervescence; slightly alkaline; gradual wavy boundary.

Bg—15 to 38 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium subangular blocky structure; friable; about 1 percent gravel; strong effervescence with disseminated calcium carbonate; slightly alkaline; gradual irregular boundary.

Cg—38 to 60 inches; dark gray (10YR 4/1) loam; few fine distinct dark brown (10YR 3/3) mottles; massive; friable; about 1 percent gravel; very few very dark gray (10YR 3/1) organic coatings; strong effervescence with disseminated calcium carbonate; slightly alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 24 to 40 inches
Content of rock fragments: 0 to 5 percent gravel by volume throughout the profile

A1 horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—loam

A2 horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—loam, silt loam, silty clay loam, or clay loam

B horizon:
Hue—10YR
Value—2 or 3
Chroma—1
Texture—loam, clay loam, or silt loam

Cg horizon:
Hue—10YR
Value—4 or 5
Chroma—1 or 2
Texture—loam, clay loam, sandy loam, or silty clay loam

269—Millington clay loam, occasionally flooded

Composition

Millington and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and swales on flood plains
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Alluvium
Flooding: Occasional
Seasonal high water table: 0.5 foot above to 2.0 feet below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Coland soils
- Mayer soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

362—Millington loam, frequently flooded

Composition

Millington and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and swales on flood plains
Slope: 0 to 1 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Alluvium
Flooding: Frequent
Seasonal high water table: 0.5 foot above to 2.0 feet below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.3 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Coland soils
- Hanlon soils

Major Uses of the Unit

- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Muskego Series

Drainage class: Very poorly drained
Permeability: Upper part—moderate or moderately rapid; lower part—slow
Landform: Moraines
Parent material: Organic materials and coprogenous earth
Slope range: 0 to 1 percent
Taxonomic class: Coprogenous, euic, mesic Limnic Medisaprists

Typical Pedon

Muskego muck, 1,400 feet north and 1,500 feet west of the southeast corner of sec. 35, T. 117 N., R. 29 W.

Oa1—0 to 9 inches; sapric material, very dark brown (10YR 2/2) broken face and dark reddish brown (7.5YR 3/2) rubbed; about 15 percent fiber, 5 percent rubbed; weak medium platy structure; nonsticky; neutral; clear smooth boundary.

Oa2—9 to 36 inches; sapric material, dark brown (7.5YR 3/2) broken face and very dark grayish brown (10YR 3/2) rubbed; about 20 percent fiber, 5 percent rubbed; moderate medium platy structure; nonsticky; neutral; clear smooth boundary.

C1—36 to 50 inches; black (10YR 2/1) coprogenous earth (mucky silty clay loam); massive; few snail-shell fragments; slightly sticky; slight effervescence;

slightly alkaline; gradual smooth boundary.
C2—50 to 60 inches; black (5Y 2/1) coprogenous earth (mucky silty clay loam); massive; few snail-shell fragments; slightly sticky; slight effervescence; slightly alkaline.

Range in Characteristics

Depth to coprogenous earth: 16 to 51 inches
Content of rock fragments: 0 to 3 percent gravel by volume throughout the profile

Oa1 horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—sapric material

Oa2 horizon:
Hue—7.5YR or 10YR
Value—2 or 3
Chroma—1 to 3
Texture—mainly sapric material; a thin layer of hemic material in some pedons

C horizon:
Hue—5Y, 2.5Y, or 10YR
Value—2 to 5
Chroma—1 or 2
Texture—coprogenous earth

525—Muskego muck

Composition

Muskego and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 2 percent

Component Description

Surface layer texture: Muck
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and coprogenous earth
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Long
Available water capacity to 60 inches or root-limiting layer: About 19.4 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture
- Woodland

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section
- Forest Land section

Nicollet Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 1 to 3 percent
Taxonomic class: Fine-loamy, mixed, mesic Aquic Hapludolls

Typical Pedon

Nicollet clay loam, 200 feet south and 2,300 feet east of the northwest corner of sec. 3, T. 114 N., R. 30 W.

Ap—0 to 11 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.
A—11 to 16 inches; very dark grayish brown (10YR 3/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate medium subangular blocky structure; friable; very few very dark gray (10YR 3/1) organic coatings on faces of peds and in pores; about 2 percent gravel; neutral; gradual smooth boundary.
Bw—16 to 26 inches; brown (10YR 4/3) clay loam; common fine faint dark grayish brown (10YR 4/2) mottles; moderate medium subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary.
C1—26 to 36 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct light brownish gray (10YR 6/2) mottles; massive; friable; few fine irregularly shaped soft light brownish gray (2.5Y 6/2) threads of calcium carbonate; about 2 percent gravel; strong effervescence; moderately alkaline; gradual wavy boundary.
C2—36 to 60 inches; light olive brown (2.5Y 5/4) clay loam; common medium distinct light brownish gray

(10YR 6/2) mottles; massive; friable; very few dark yellowish brown (10YR 4/6) iron stains on faces of peds and in pores; common fine irregularly shaped soft light brownish gray (2.5Y 6/2) threads of calcium carbonate; about 2 percent gravel; strong effervescence; moderately alkaline.

Range in Characteristics

Depth to carbonates: 20 to 48 inches
Thickness of the mollic epipedon: 10 to 24 inches
Content of rock fragments: 1 to 5 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—clay loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—clay loam, loam, or silty clay loam

B horizon:
Hue—10YR or 2.5Y
Value—3 to 5
Chroma—2 to 4
Texture—clay loam or loam

C horizon:
Hue—2.5Y or 5Y
Value—5 or 6
Chroma—2 to 4
Texture—clay loam or loam

130—Nicollet clay loam

Composition

Nicollet and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Low summits and back slopes
Slope: 1 to 3 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2.5 to 5.0 feet
Available water capacity to 60 inches or root-limiting layer: About 10.4 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Clarion soils
- Glencoe soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Okoboji Series

Drainage class: Very poorly drained
Permeability: Moderately slow
Landform: Moraines
Parent material: Colluvium and till
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic, mesic Cumulic Haplaquolls

Typical Pedon

Okoboji silty clay loam, 1,300 feet north and 1,700 feet west of the southeast corner of sec. 30, T. 115 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A1—10 to 25 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate medium subangular blocky structure; firm; neutral; clear wavy boundary.

A2—25 to 36 inches; black (10YR 2/1) silty clay loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; firm; neutral; gradual wavy boundary.

Bg—36 to 45 inches; very dark gray (10YR 3/1) silty clay loam; moderate medium subangular blocky structure; firm; neutral; gradual wavy boundary.

Cg—45 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay loam; medium distinct light olive brown (2.5Y 5/6) mottles; massive; very few very dark grayish brown (2.5Y 3/2) organic coatings on faces of peds and in pores; friable; neutral.

Range in Characteristics

Thickness of the mollic epipedon: 24 to 48 inches

Ap horizon:
Hue—neutral or 10YR
Value—2
Chroma—0 or 1
Texture—silty clay loam

A horizon:
Hue—neutral, 10YR, or 5Y
Value—2
Chroma—0 or 1
Texture—silty clay loam or mucky silty clay loam

Bg horizon:
Hue—10YR, 2.5Y, 5Y, or neutral
Value—3 to 5
Chroma—0 to 2
Texture—silty clay loam or silty clay

C horizon:
Hue—2.5Y, 5Y, or neutral
Value—4 or 5
Chroma—0 to 2
Texture—silty clay loam, loam, or silt loam

134—Okoboji silty clay loam

Composition

Okoboji and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Surface layer texture: Silty clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Colluvium and till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.7 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Glencoe soils
- Harps soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

386—Okoboji mucky silty clay loam

Composition

Okoboji and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on moraines
Slope: 0 to 1 percent

Component Description

Surface layer texture: Mucky silty clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Organic materials and glaciolacustrine deposits or till
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 11.9 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Canisteo soils
- Harps soils
- Klossner soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Rolfe Series

Drainage class: Very poorly drained
Permeability: Slow
Landform: Moraines
Parent material: Colluvium and till
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic, mesic Typic Argialbolls

Typical Pedon

Rolfe loam, in an area of Cordova-Rolfe complex, 2,300 feet south and 2,200 feet east of the northwest corner of sec. 19, T. 117 N., R. 30 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A—8 to 14 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak thick platy structure parting to moderate very fine subangular blocky; friable; slightly acid; gradual wavy boundary.

E—14 to 26 inches; dark gray (10YR 4/1) loam, light gray or gray (10YR 6/1) dry; few fine distinct dark yellowish brown (10YR 4/4) mottles; moderate thick platy structure parting to moderate very fine subangular blocky; friable; neutral; gradual irregular boundary.

Btg1—26 to 35 inches; olive gray (5Y 4/2) silty clay; common fine faint olive (5Y 5/4) mottles; strong medium prismatic structure parting to strong medium angular blocky; firm; many distinct dark gray (10YR 3/1) clay films on faces of peds and in pores; neutral; gradual wavy boundary.

2Btg2—35 to 43 inches; olive gray (5Y 4/2) clay loam; few fine distinct light olive brown (2.5Y 5/4) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; many distinct very dark gray (5Y 3/1) clay films on faces of peds and in pores; neutral; gradual wavy boundary.

2Btg3—43 to 60 inches; olive gray (5Y 4/2) loam; common medium distinct light olive brown (2.5Y 5/4) mottles; moderate medium subangular blocky structure; friable; common distinct very dark gray (5Y 3/1) clay films on faces of peds; about 2 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: 42 to 60 inches
Thickness of the mollic epipedon: 10 to 24 inches

Ap horizon:
- Hue—10YR
- Value—2 or 3
- Chroma—1
- Texture—loam

A horizon:
- Hue—10YR
- Value—2 or 3
- Chroma—1
- Texture—loam or silt loam

E horizon:
- Hue—10YR
- Value—3 or 4
- Chroma—1
- Texture—loam or silt loam

Btg and 2Btg horizons:
- Hue—5Y, 2.5Y, or 10YR
- Value—3 to 6
- Chroma—1 or 2
- Texture—silty clay or clay in the upper part and clay loam or loam in the lower part
- Content of gravel—0 to 5 percent

Shandep Series

Drainage class: Very poorly drained
Permeability: Upper part—moderate; lower part—rapid
Landform: Outwash plains and terraces
Parent material: Glacial outwash
Slope range: 0 to 1 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Haplaquolls

Typical Pedon

Shandep clay loam, 2,400 feet south and 2,500 feet east of the northwest corner of sec. 22, T. 116 N., R. 29 W.

Ap—0 to 9 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; moderate fine granular structure; friable; about 1 percent gravel; neutral; abrupt smooth boundary.

A1—9 to 20 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; moderate very fine subangular blocky structure; friable; about 1 percent gravel; neutral; clear smooth boundary.

A2—20 to 28 inches; very dark gray (5Y 3/1) clay loam, very dark gray (10YR 3/1) dry; moderate fine subangular blocky structure; friable; about 2 percent gravel; neutral; clear smooth boundary.

Bg—28 to 36 inches; dark gray (5Y 4/1) clay loam; few fine faint dark grayish brown (2.5Y 4/2) mottles; moderate medium subangular blocky structure; friable; about 4 percent gravel; slightly acid; clear smooth boundary.

BCg—36 to 41 inches; gray (5Y 5/1) loam; common medium prominent yellowish red (5YR 5/8) mottles; weak fine subangular blocky structure; friable; about

2 percent gravel; neutral; clear wavy boundary.
2Cg—41 to 60 inches; olive gray (5Y 4/2) loamy sand; common fine faint dark gray (5Y 4/1) mottles; single grain; very friable; about 6 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: 40 to more than 60 inches
Thickness of the mollic epipedon: 26 to 32 inches
Thickness of the loamy mantle: 40 to 60 inches

Ap horizon:
Hue—neutral or 5Y
Value—2 or 3
Chroma—0 or 1
Texture—clay loam
Content of gravel—0 to 3 percent

A horizon:
Hue—neutral or 5Y
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, loam, or silty clay loam
Content of gravel—0 to 3 percent

Bg horizon:
Hue—5Y or neutral
Value—4 or 5
Chroma—0 or 1
Texture—clay loam or loam
Content of gravel—0 to 3 percent

BCg horizon:
Hue—5Y
Value—4 or 5
Chroma—1
Texture—loam, gravelly sandy loam, or sandy loam
Content of gravel—0 to 3 percent

2Cg horizon:
Hue—5Y
Value—4
Chroma—1
Texture—loamy sand or gravelly loamy sand
Content of gravel—5 to 20 percent

517—Shandep clay loam

Composition

Shandep and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Depressions on outwash plains and terraces
Slope: 0 to 1 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Very poorly drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: 1 foot above to 1 foot below the surface
Ponding duration: Very long
Available water capacity to 60 inches or root-limiting layer: About 9.0 inches
Organic matter content: Very high

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Glencoe soils
- Mayer soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Spillville Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Hapludolls

Typical Pedon

Spillville loam, occasionally flooded, 400 feet south and 1,500 feet east of the northwest corner of sec. 11, T. 115 N., R. 27 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; abrupt smooth boundary.
A1—10 to 20 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.
A2—20 to 32 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; neutral; gradual smooth boundary.

A3—32 to 40 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; friable; common very dark grayish brown (10YR 3/2) streaks on interior of peds; neutral; gradual irregular boundary.
C—40 to 60 inches; very dark grayish brown (10YR 3/2) loam; massive; friable; common fine faint dark brown (10YR 3/3) mottles; neutral.

Range in Characteristics

Depth to carbonates: 40 to 60 inches
Thickness of the mollic epipedon: 36 to more than 60 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam or silt loam

C horizon:
Hue—10YR or 2.5Y
Value—3 or 4
Chroma—1 or 2
Texture—loam or sandy loam

313—Spillville loam, occasionally flooded

Composition

Spillville and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and slight rises on flood plains
Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Dominant parent material: Alluvium
Flooding: Occasional
Seasonal high water table: At a depth of 3 to 5 feet
Available water capacity to 60 inches or root-limiting layer: About 11.3 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Coland soils
- Millington soils
- Terril soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Storden Series

Drainage class: Well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 2 to 40 percent
Taxonomic class: Fine-loamy, mixed (calcareous), mesic Typic Udorthents

Typical Pedon

Storden loam (fig. I-13), in an area of Clarion-Storden complex, 6 to 12 percent slopes, eroded, 2,500 feet north and 1,700 feet east of the southwest corner of sec. 20, T. 115 N., R. 30 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, light gray or gray (10YR 6/1) dry; weak medium subangular blocky structure; friable; about 5 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.
C1—8 to 30 inches; light yellowish brown (10YR 6/4) loam; massive; friable; about 3 percent gravel; strong effervescence with disseminated calcium carbonate; moderately alkaline; gradual wavy boundary.
C2—30 to 40 inches; yellowish brown (10YR 5/4) loam; massive; friable; few fine irregularly shaped soft light gray (10YR 7/2) threads of calcium carbonate; about 3 percent gravel; strong effervescence; moderately alkaline; clear wavy boundary.
C3—40 to 60 inches; brown (10YR 5/3) loam; few fine distinct dark yellowish brown (10YR 4/6) mottles; massive; friable; about 4 percent gravel; strong effervescence with disseminated calcium carbonate; moderately alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Content of rock fragments: 2 to 10 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—4 or 5
Chroma—2 or 3
Texture—loam

C horizon:
Hue—10YR or 2.5Y
Value—5 or 6
Chroma—2 to 6
Texture—loam or clay loam

960D2—Storden-Clarion complex, 12 to 18 percent slopes, eroded

Composition

Storden and similar soils: About 45 percent
Clarion and similar soils: About 40 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Storden—shoulders; Clarion—summits and back slopes
Slope: 12 to 18 percent

Component Description

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.5 inches
Organic matter content: Moderately low

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.5 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Delft soils
- Swanlake soils
- Terril soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

960F—Storden-Clarion complex, 18 to 40 percent slopes

Composition

Storden and similar soils: About 45 percent
Clarion and similar soils: About 40 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Storden—shoulders; Clarion—summits and back slopes
Slope: 18 to 40 percent

Component Description

Storden
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 10.6 inches
Organic matter content: Moderately low

Clarion
Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.2 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this

section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Delft soils
- Terril soils

Major Uses of the Unit

- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Strout Series

Drainage class: Moderately well drained
Permeability: Moderately slow
Landform: Moraines
Parent material: Till
Slope range: 2 to 6 percent
Taxonomic class: Fine, mixed, mesic Typic Hapludolls

Typical Pedon

Strout clay, in an area of Strout-Arkton complex, 2 to 6 percent slopes, 300 feet west and 300 feet north of the southeast corner of sec. 14, T. 118 N., R. 32 W.; in Meeker County:

Ap—0 to 7 inches; black (10YR 2/1 dry) clay; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

AB—7 to 10 inches; black (10YR 2/1) clay, dark gray (10YR 4/1) dry; about 20 percent masses of dark olive brown (2.5Y 4/4) clay, light yellowish brown (2.5Y 6/4) dry; moderate fine angular blocky structure parting to moderate very fine angular blocky; friable; about 2 percent gravel; about 1 percent cobbles; neutral; clear smooth boundary.

Bw1—10 to 16 inches; olive brown (2.5Y 4/4 dry) clay; moderate fine angular blocky structure parting to moderate very fine angular blocky; firm; dark grayish brown (2.5Y 4/2) stress surfaces on faces of peds; about 2 percent gravel; about 1 percent cobbles; neutral; clear smooth boundary.

Bw2—16 to 24 inches; olive brown (2.5Y 4/4) clay; moderate fine prismatic structure parting to moderate very fine angular blocky; firm; dark grayish brown (2.5Y 4/2) stress surfaces on faces of peds; about 3 percent gravel; about 1 percent cobbles; neutral; clear smooth boundary.

Bk1—24 to 36 inches; light olive brown (2.5Y 5/4) clay loam; weak coarse angular blocky structure parting to weak fine angular blocky; firm; few fine irregular soft white (10YR 8/2), disseminated threads of calcium carbonate; about 3 percent gravel; about 2 percent cobbles; strong effervescence; slightly alkaline; clear smooth boundary.

Bk2—36 to 60 inches; light olive brown (2.5Y 5/4) clay loam; few fine distinct light brownish gray (2.5Y 6/2) mottles; weak coarse angular blocky structure parting to weak fine angular blocky; firm; common fine irregular soft white (10YR 8/2), disseminated threads of calcium carbonate; about 3 percent gravel; about 2 percent cobbles; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 18 to 36 inches
Thickness of the mollic epipedon: 7 to 24 inches

A horizon:
- Hue—10YR
- Value—2 or 3
- Chroma—1 or 2
- Texture—clay
- Content of gravel—1 to 2 percent
- Content of cobbles and stones—0 to 1 percent

Bw horizon:
- Hue—2.5Y
- Value—4
- Chroma—3 or 4
- Texture—clay loam, clay, silty clay, or silty clay loam
- Content of gravel—1 to 3 percent
- Content of cobbles and stones—1 to 3 percent

Bk horizon:
- Hue—2.5Y
- Value—4 to 6
- Chroma—2 to 4
- Texture—clay loam, clay, silty clay, or silty clay loam
- Content of gravel—2 to 4 percent
- Content of cobbles and stones—2 to 4 percent

1159B—Strout-Arkton complex, 2 to 6 percent slopes

Composition

Strout and similar soils: About 65 percent
Arkton and similar soils: About 20 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Strout—back slopes and shoulders; Arkton—shoulders and summits
Slope: Strout—2 to 6 percent; Arkton—4 to 6 percent

Component Description

Strout
Surface layer texture: Clay
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2.5 to 4.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.3 inches
Organic matter content: High

Arkton
Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 2.5 to 6.0 feet
Available water capacity to 60 inches or root-limiting layer: About 8.9 inches
Organic matter content: Moderate

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Cosmos soils
- Hamel soils
- Swanlake soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Swanlake Series

Drainage class: Well drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 2 to 6 percent
Taxonomic class: Fine-loamy, mixed, mesic Entic Hapludolls

Typical Pedon

Swanlake loam, in an area of Clarion-Swanlake complex, 2 to 6 percent slopes, 1,900 feet south and 1,000 feet west of the northeast corner of sec. 20, T. 115 N., R. 30 W.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; strong effervescence; slightly alkaline; abrupt smooth boundary.

C1—8 to 32 inches; yellowish brown (10YR 5/4) loam; massive; friable; few fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; about 2 percent gravel; strong effervescence; slightly alkaline; gradual wavy boundary.

C2—32 to 60 inches; yellowish brown (10YR 5/4) loam; few fine distinct yellowish brown (10YR 5/8) mottles; massive; friable; common fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; about 3 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Carbonates: Throughout the profile
Thickness of the mollic epipedon: 7 to 12 inches
Content of rock fragments: 2 to 10 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—3
Chroma—1 or 2
Texture—loam
Content of gravel—2 to 10 percent

C horizon:
Hue—10YR or 2.5Y
Value—4 to 6
Chroma—3 to 6
Texture—loam
Content of gravel—2 to 10 percent

Terril Series

Drainage class: Moderately well drained
Permeability: Moderate
Landform: Moraines
Parent material: Alluvium
Slope range: 2 to 6 percent
Taxonomic class: Fine-loamy, mixed, mesic Cumulic Hapludolls

Typical Pedon

Terril loam, 2 to 6 percent slopes, 800 feet south and 1,800 feet east of the northwest corner of sec. 23, T. 116 N., R. 28 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark

gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 1 percent gravel; neutral; abrupt smooth boundary.
A1—10 to 24 inches; very dark brown (10YR 2/2) loam, very dark grayish brown (10YR 3/2) dry; moderate medium subangular blocky structure; friable; about 1 percent gravel; neutral; gradual smooth boundary.
A2—24 to 30 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; friable; about 1 percent gravel; neutral; gradual wavy boundary.
Bw1—30 to 48 inches; brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; many very dark grayish brown (10YR 3/2) organic coatings; about 1 percent gravel; neutral; gradual wavy boundary.
Bw2—48 to 60 inches; brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; about 1 percent gravel; neutral.

Range in Characteristics

Depth to carbonates: 40 inches or more
Thickness of the mollic epipedon: 24 to 36 inches
Content of rock fragments: 0 to 5 percent gravel by volume throughout the profile

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam, silt loam, or clay loam

Bw horizon:
Hue—10YR
Value—4
Chroma—3 or 4
Texture—loam or clay loam; sandy loam below a depth of 40 inches

94B—Terril loam, 2 to 6 percent slopes

Composition

Terril and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Moraines
Position on landform: Foot slopes
Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Moderately well drained
Dominant parent material: Alluvium
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 11.7 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Delft soils
- Nicollet soils
- Webster soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

1016—Udorthents, loamy

Composition

Udorthents and similar soils: About 95 percent
Inclusions: About 5 percent

Setting

Landform: Moraines
Slope: 0 to 18 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 6.6 inches
Organic matter content: Low

Additional information specific to this map unit is

available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Webster soils

1030—Udorthents-Pits, gravel, complex

Composition

Udorthents and similar soils: About 65 percent
Pits: About 30 percent
Inclusions: About 5 percent

Setting

Landform: Outwash plains and terraces
Slope: 0 to 50 percent

Component Description

Udorthents
Surface layer texture: Variable
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Organic matter content: Very low

Additional information specific to this map unit is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils

Wadena Series

Drainage class: Well drained
Permeability: Upper part—moderate; lower part—very rapid
Landform: Outwash plains and terraces
Parent material: Glacial outwash
Slope range: 0 to 6 percent
Taxonomic class: Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls

Typical Pedon

Wadena loam, 0 to 2 percent slopes (fig. I-14), 1,200 feet west and 2,100 feet south of the northeast corner of sec. 31, T. 117 N., R. 30 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 2 percent gravel; neutral; abrupt smooth boundary.

A—10 to 14 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; neutral; clear wavy boundary.

Bw1—14 to 24 inches; dark yellowish brown (10YR 4/4) loam; moderate medium subangular blocky structure; friable; about 2 percent gravel; neutral; clear wavy boundary.

Bw2—24 to 28 inches; dark yellowish brown (10YR 3/4) loam; moderate medium subangular blocky structure; friable; about 10 percent gravel; neutral; gradual wavy boundary.

2C—28 to 60 inches; dark grayish brown (10YR 4/2), brown or dark brown (10YR 4/3), and dark yellowish brown (10YR 3/4) gravelly coarse sand; single grain; loose; few fine irregularly shaped light brownish gray (10YR 6/2) coatings of calcium carbonate cemented to faces of pebbles; about 35 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 26 to 60 inches
Thickness of the mollic epipedon: 12 to 22 inches
Thickness of the loamy mantle: 24 to 34 inches

Ap horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam
Content of gravel—0 to 8 percent

A horizon:
Hue—10YR
Value—2 or 3
Chroma—1 or 2
Texture—loam or clay loam
Content of gravel—0 to 8 percent

B horizon:
Hue—10YR or 7.5YR
Value—3 to 5
Chroma—3 or 4
Texture—loam, clay loam, sandy loam, or sandy clay loam
Content of gravel—2 to 15 percent

2C horizon:
Hue—10YR or 7.5YR
Value—4 to 6
Chroma—2 to 4
Texture—coarse sand, sand, or the gravelly or very gravelly analogs of these textures
Content of gravel—10 to 50 percent

39A—Wadena loam, 0 to 2 percent slopes

Composition

Wadena and similar soils: About 90 percent
Inclusions: About 10 percent

Setting

Landform: Flats on outwash plains and terraces
Slope: 0 to 2 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 6.2 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Mayer soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

39B—Wadena loam, 2 to 6 percent slopes

Composition

Wadena and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Flats and slight rises on outwash plains and terraces
Slope: 2 to 6 percent

Component Description

Surface layer texture: Loam
Depth class: Very deep (more than 60 inches)
Drainage class: Well drained
Dominant parent material: Glacial outwash
Flooding: None
Seasonal high water table: At a depth of more than 6 feet
Available water capacity to 60 inches or root-limiting layer: About 6.0 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Biscay soils
- Estherville soils
- Mayer soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Webster Series

Drainage class: Poorly drained
Permeability: Moderate
Landform: Moraines
Parent material: Till
Slope range: 0 to 2 percent
Taxonomic class: Fine-loamy, mixed, mesic Typic Haplaquolls

Typical Pedon

Webster clay loam, 250 feet north and 1,000 feet east of the southwest corner of sec. 34, T. 115 N., R. 30 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak medium subangular blocky structure; friable; about 2 percent gravel; slightly acid; abrupt smooth boundary.

A—10 to 18 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; moderate medium subangular blocky structure; friable; about 2 percent gravel; neutral; gradual wavy boundary.

Bg—18 to 25 inches; olive gray (5Y 4/2) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; moderate medium subangular blocky structure; friable; few dark gray (5Y 4/1) organic coatings on faces of peds; about 2 percent gravel; neutral; gradual wavy boundary.

C—25 to 60 inches; olive gray (5Y 5/2) clay loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; common fine irregularly shaped soft light brownish gray (10YR 6/2) threads of calcium carbonate; about 2 percent gravel; strong effervescence; slightly alkaline.

Range in Characteristics

Depth to carbonates: 24 to 32 inches
Thickness of the mollic epipedon: 15 to 20 inches
Content of rock fragments: 1 to 5 percent gravel by volume throughout the profile

Ap horizon:
Hue—neutral, 10YR, or 2.5Y
Value—2 or 3
Chroma—0 or 1
Texture—clay loam

A horizon:
Hue—neutral, 10YR, or 2.5Y
Value—2 or 3
Chroma—0 or 1
Texture—clay loam, loam, or silty clay loam

Bg horizon:
Hue—5Y or 2.5Y
Value—4 or 5
Chroma—1 or 2
Texture—clay loam, loam, or silty clay loam

Cg horizon:
Hue—5Y or 2.5Y
Value—4 to 6
Chroma—1 to 3
Texture—clay loam, loam, or sandy loam

113—Webster clay loam

Composition

Webster and similar soils: About 85 percent
Inclusions: About 15 percent

Setting

Landform: Drainageways and flats on moraines
Slope: 0 to 2 percent

Component Description

Surface layer texture: Clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Till
Flooding: None
Seasonal high water table: At a depth of 1 to 2 feet
Available water capacity to 60 inches or root-limiting layer: About 11.1 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Glencoe soils
- Nicollet soils

Major Uses of the Unit

- Cropland
- Hayland
- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

Zook Series

Drainage class: Poorly drained
Permeability: Slow
Landform: Flood plains
Parent material: Alluvium
Slope range: 0 to 1 percent
Taxonomic class: Fine, montmorillonitic, mesic Cumulic Haplaquolls

Typical Pedon

Zook silty clay loam, frequently flooded, 1,500 feet north and 500 feet east of the southwest corner of sec. 33, T. 115 N., R. 28 W.

A1—0 to 20 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

A2—20 to 30 inches; black (N 2/0) silty clay loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; neutral; clear wavy boundary.

Bg—30 to 50 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium subangular blocky structure; firm; neutral; clear wavy boundary.

Cg—50 to 60 inches; black (5Y 2/1) silty clay loam, dark gray (10YR 4/1) dry; massive; friable; neutral.

Range in Characteristics

Thickness of the mollic epipedon: 36 to 50 inches

A1 horizon:
Hue—10YR or neutral
Value—2
Chroma—0 or 1
Texture—silty clay loam

A2 horizon:
Hue—10YR or neutral
Value—2 or 3
Chroma—0 or 1
Texture—silty clay loam or silty clay

Bg horizon:
Hue—10YR to 5Y
Value—1 to 4
Chroma—1
Texture—silty clay or silty clay loam

Cg horizon:
Hue—10YR to 5Y or neutral
Value—1 to 4
Chroma—0 or 1
Texture—silty clay or silty clay loam

1095—Zook silty clay loam, frequently flooded

Composition

Zook and similar soils: About 95 percent
Inclusions: About 5 percent

Setting

Landform: Flats and swales on flood plains
Slope: 0 to 1 percent

Component Description

Surface layer texture: Silty clay loam
Depth class: Very deep (more than 60 inches)
Drainage class: Poorly drained
Dominant parent material: Alluvium
Flooding: Frequent
Seasonal high water table: At the surface to 3 feet below the surface
Available water capacity to 60 inches or root-limiting layer: About 10.7 inches
Organic matter content: High

A typical soil series description with range in characteristics is included, in alphabetical order, in this section. Additional information specific to this map unit, such as horizon depth and textures, is available in the "Soil Properties" section in Part II of this publication.

Inclusions

- Coland soils

Major Uses of the Unit

- Pasture

For general and detailed information concerning these uses, see Part II of this publication:

- Agronomy section

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Glossary

Ablation till. Loose, permeable till deposited during the final downwasting of glacial ice. Lenses of crudely sorted sand and gravel are common.

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

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

Aquic conditions. Current soil wetness characterized by saturation, reduction, and redoximorphic features.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Argillic horizon. A subsoil horizon characterized by an accumulation of illuvial clay.

Aspect. The direction in which a slope faces.

Association, soil. A group of soils or miscellaneous areas geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

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

Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	more than 9

Back slope. The geomorphic component that forms the steepest inclined surface and principal element of many hill slopes. Back slopes in profile are commonly steep and linear and descend to a foot slope. In terms of gradational process, back slopes are erosional forms produced mainly by mass wasting and running water.

Basal till. Compact till deposited beneath the ice.

Base saturation. The degree to which material having cation-exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, and K), expressed as a percentage of the total cation-exchange capacity.

Bedding planes. Fine strata, less than 5 millimeters thick, in unconsolidated alluvial, eolian, lacustrine, or marine sediment.

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bedrock-controlled topography. A landscape where the configuration and relief of the landforms are determined or strongly influenced by the underlying bedrock.

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

Bisequum. Two sequences of soil horizons, each of which consists of an illuvial horizon and the overlying eluvial horizons.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Brush management. Use of mechanical, chemical, or biological methods to make conditions favorable for reseeding or to reduce or eliminate competition from woody vegetation and thus allow understory grasses and forbs to recover. Brush management increases forage production and thus reduces the

hazard of erosion. It can improve the habitat for some species of wildlife.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

California bearing ratio (CBR). The load-supporting capacity of a soil as compared to that of a standard crushed limestone, expressed as a ratio. First standardized in California. A soil having a CBR of 16 supports 16 percent of the load that would be supported by standard crushed limestone, per unit area, with the same degree of distortion.

Canopy. The leafy crown of trees or shrubs. (See Crown.)

Capillary water. Water held as a film around soil particles and in tiny spaces between particles. Surface tension is the adhesive force that holds capillary water in the soil.

Catena. A sequence, or "chain," of soils on a landscape that formed in similar kinds of parent material but have different characteristics as a result of differences in relief and drainage.

Cation. An ion carrying a positive charge of electricity. The common soil cations are calcium, potassium, magnesium, sodium, and hydrogen.

Cation-exchange capacity. The total amount of exchangeable cations that can be held by the soil, expressed in terms of milliequivalents per 100 grams of soil at neutrality (pH 7.0) or at some other stated pH value. The term, as applied to soils, is synonymous with base-exchange capacity but is more precise in meaning.

Catsteps. Very small, irregular terraces on steep hillsides, especially in pasture, formed by the trampling of cattle or the slippage of saturated soil.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a channer.

Chemical treatment. Control of unwanted vegetation through the use of chemicals.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay depletions. Low-chroma zones having a low content of iron, manganese, and clay because of the chemical reduction of iron and manganese and the removal of iron, manganese, and clay. A type of redoximorphic depletion.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Climax plant community. The plant community on a given site that will be established if present environmental conditions continue to prevail and the site is properly managed.

Coarse textured soil. Sand or loamy sand.

Cobble (or cobblestone). A rounded or partly rounded fragment of rock 3 to 10 inches (7.6 to 25 centimeters) in diameter.

Cobbly soil material. Material that is 15 to 35 percent, by volume, rounded or partially rounded rock fragments 3 to 10 inches (7.6 to 25 centimeters) in diameter. Very cobbly soil material is 35 to 60 percent of these rock fragments, and extremely cobbly soil material is more than 60 percent.

Colluvium. Soil material or rock fragments, or both, moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex slope. Irregular or variable slope. Planning or establishing terraces, diversions, and other water-control structures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil or miscellaneous areas in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation cropping system. Growing crops in combination with needed cultural and management practices. In a good conservation cropping system, the soil-improving crops and practices more than offset the soil-depleting crops and practices. Cropping systems are needed on all tilled soils. Soil-improving practices in a conservation cropping system include the use of rotations that contain grasses and legumes and the return of crop residue to the soil. Other practices include the use of green manure crops of grasses and legumes, proper tillage, adequate fertilization, and weed and pest control.

Conservation tillage. Any tillage and planting system in which a cover of crop residue is maintained on at least 30 percent of the surface after planting in order to reduce the hazard of water erosion; in areas where wind erosion is the primary concern, a system that maintains a cover of at least 1,000 pounds of flat residue of small grain or its equivalent during the critical erosion period.

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

Sticky.—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.

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

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cropping system. Growing crops according to a planned system of rotation and management practices.

Crop residue management. Returning crop residue to the soil, which helps to maintain soil structure, organic matter content, and fertility and helps to control erosion.

Cross-slope farming. Deliberately conducting farming operations on sloping farmland in such a way that tillage is across the general slope.

Crown. The upper part of a tree or shrub, including the living branches and their foliage.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Delta. A body of alluvium having a surface that is nearly flat and fan shaped; deposited at or near the mouth of a river or stream where it enters a body of relatively quiet water, generally a sea or lake.

Dense layer (in tables). A very firm, massive layer that has a bulk density of more than 1.8 grams per cubic centimeter. Such a layer affects the ease of digging and can affect filling and compacting.

Depth, soil. Generally, the thickness of the soil over bedrock. Very deep soils are more than 60 inches deep over bedrock; deep soils, 40 to 60 inches; moderately deep, 20 to 40 inches; shallow, 10 to 20 inches; and very shallow, less than 10 inches.

Depth to rock (in tables). Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

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

Excessively drained.—These soils have very high and high hydraulic conductivity and a low water-holding capacity. They are not suited to crop production unless irrigated.

Somewhat excessively drained.—These soils have high hydraulic conductivity and a low water-holding capacity. Without irrigation, only a narrow range of crops can be grown and yields are low.

Well drained.—These soils have an intermediate or high water-holding capacity. They retain optimum amounts of moisture, but they are not wet close enough to the surface or long enough during the growing season to adversely affect yields.

Moderately well drained.—These soils are wet close enough to the surface or long enough that planting or harvesting operations or yields of most field crops are affected. Moderately well drained soils commonly have a layer with low hydraulic conductivity, a wet layer relatively high in the profile, additions of water by seepage, or some combination of these.

Somewhat poorly drained.—These soils are wet close enough to the surface or long enough that planting or harvesting operations or crop growth is markedly restricted under natural conditions.

Somewhat poorly drained soils commonly have a layer with low hydraulic conductivity, a wet layer high in the profile, additions of water through seepage, or a combination of these.
Poorly drained.—These soils commonly are so wet at or near the surface during a considerable part of the year that field crops cannot be grown under natural conditions. Poor drainage is caused by a saturated zone, a layer with low hydraulic conductivity, seepage, or a combination of these.
Very poorly drained.—These soils are wet to the surface most of the time. The wetness prevents the growth of important crops (except for rice) under natural conditions.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Duff. A generally firm organic layer on the surface of mineral soils. It consists of fallen plant material that is in the process of decomposition and includes everything from the litter on the surface to underlying pure humus.

Eluviation. The movement of material in true solution or colloidal suspension from one place to another within the soil. Soil horizons that have lost material through eluviation are eluvial; those that have received material are illuvial.

Endosaturation. A type of saturation of the soil in which all horizons between the upper boundary of saturation and a depth of 2 meters are saturated.

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.

Ephemeral stream. A stream, or reach of a stream, that flows only in direct response to precipitation. It receives no long-continued supply from melting snow or other source, and its channel is above the water table at all times.

Episaturation. A type of saturation indicating a perched water table in a soil in which saturated layers are underlain by one or more unsaturated layers within 2 meters of the surface.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of human or animal activities or of a catastrophe in nature, such as a fire, that exposes the surface.

Erosion pavement. A layer of gravel or stones that remains on the surface after fine particles are removed by sheet or rill erosion.

Escarpment. A relatively continuous and steep slope or cliff breaking the general continuity of more gently sloping land surfaces and resulting from erosion or faulting. The term is more often applied to cliffs resulting from differential erosion.

Esker. A long, narrow, sinuous, steep-sided ridge composed of irregularly stratified sand and gravel that were deposited by a subsurface stream flowing between ice walls or through ice tunnels of a retreating glacier and that were left behind when the ice melted. Eskers range from less than 1 mile to more than 100 miles in length and from 10 to 100 feet in height.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Excess lime (in tables). Excess carbonates in the soil that restrict the growth of some plants.

Excess salts (in tables). Excess water-soluble salts in the soil that restrict the growth of most plants.

Fan terrace. A relict alluvial fan, no longer a site of active deposition, incised by younger and lower alluvial surfaces.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fibric soil material (peat). The least decomposed of all organic soil material. Peat contains a large amount of well preserved fiber that is readily identifiable according to botanical origin. Peat has the lowest bulk density and the highest water content at saturation of all organic soil material.

Field moisture capacity. The moisture content of a soil, expressed as a percentage of the ovendry weight, after the gravitational, or free, water has drained away; the field moisture content 2 or 3 days after a soaking rain; also called *normal field capacity, normal moisture capacity,* or *capillary capacity.*

Fine textured soil. Sandy clay, silty clay, or clay.

Firebreak. An area cleared of flammable material to stop or help control creeping or running fires. It

also serves as a line from which to work and to facilitate the movement of fire fighters and equipment. Designated roads also serve as firebreaks.

First bottom. The normal flood plain of a stream, subject to frequent or occasional flooding.

Flaggy soil material. Material that is, by volume, 15 to 35 percent flagstones. Very flaggy soil material is 35 to 60 percent flagstones, and extremely flaggy soil material is more than 60 percent flagstones.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist 6 to 15 inches (15 to 38 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to inundation under flood-stage conditions unless protected artificially. It is generally a constructional landform consisting of sediment deposited during overflow and lateral migration of the stream.

Foot slope. The geomorphic component that forms the inner, gently inclined surface at the base of a hill slope. The surface is dominantly concave. In terms of gradational processes, a foot slope is a transition zone between an upslope site of erosion (back slope) and a downslope site of deposition (toe slope).

Forb. Any herbaceous plant not a grass or a sedge.

Forest cover. All trees and other woody plants (underbrush) covering the ground in a forest.

Forest type. A stand of trees similar in composition and development because of given physical and biological factors by which it may be differentiated from other stands.

Fragile (in tables). A soil that is easily damaged by use or disturbance.

Fragipan. A loamy, brittle subsurface horizon low in porosity and content of organic matter and low or moderate in clay but high in silt or very fine sand. A fragipan appears cemented and restricts roots. When dry, it is hard or very hard and has a higher bulk density than the horizon or horizons above. When moist, it tends to rupture suddenly under pressure rather than to deform slowly.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial drift. Pulverized and other rock material transported by glacial ice and then deposited. Also, the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash. Gravel, sand, and silt, commonly stratified, deposited by glacial meltwater.

Glaciofluvial deposits. Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial meltwater. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors.

Graded stripcropping. Growing crops in strips that grade toward a protected waterway.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock as much as 3 inches (2 millimeters to 7.6 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, as much as 3 inches (7.6 centimeters) in diameter.

Green manure crop (agronomy). A soil-improving crop grown to be plowed under in an early stage of maturity or soon after maturity.

Ground water. Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hard bedrock. Bedrock that cannot be excavated except by blasting or by the use of special equipment that is not commonly used in construction.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric material and the more decomposed sapric material.

High-chroma zones. Zones having chroma of 3 or more. Typical color in areas of iron concentrations.

High-residue crops. Such crops as small grain and corn used for grain. If properly managed, residue from these crops can be used to control erosion until the next crop in the rotation is established.

These crops return large amounts of organic matter to the soil.

Hill. A natural elevation of the land surface, rising as much as 1,000 feet above surrounding lowlands, commonly of limited summit area and having a well defined outline; hillsides generally have slopes of more than 6 percent. The distinction between a hill and a mountain is arbitrary and is dependent on local usage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an uppercase letter represents the major horizons. Numbers or lowercase letters that follow represent subdivisions of the major horizons. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

E horizon.—The mineral horizon in which the main feature is loss of silicate clay, iron, aluminum, or some combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics, such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the overlying soil material. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon.—Soft, consolidated bedrock beneath the soil.

R layer.—Consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but it can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Igneous rock. Rock formed by solidification from a molten or partially molten state. Major varieties include plutonic and volcanic rock. Examples are andesite, basalt, and granite.

Illuviation. The movement of soil material from one horizon to another in the soil profile. Generally, material is removed from an upper horizon and deposited in a lower horizon.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration capacity. The maximum rate at which water can infiltrate into a soil under a given set of conditions.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Intake rate. The average rate of water entering the soil under irrigation. Most soils have a fast initial rate; the rate decreases with application time. Therefore, intake rate for design purposes is not a constant but is a variable depending on the net irrigation application. The rate of water intake, in inches per hour, is expressed as follows:

Less than 0.2	very low
0.2 to 0.4	low
0.4 to 0.75	moderately low
0.75 to 1.25	moderate
1.25 to 1.75	moderately high
1.75 to 2.5	high
More than 2.5	very high

Intermittent stream. A stream, or reach of a stream, that flows for prolonged periods only when it receives ground-water discharge or long, continued contributions from melting snow or other surface and shallow subsurface sources.

Iron concentrations. High-chroma zones having a high content of iron and manganese oxide because of chemical oxidation and accumulation, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic concentration.

Iron depletions. Low-chroma zones having a low content of iron and manganese oxide because of chemical reduction and removal, but having a clay content similar to that of the adjacent matrix. A type of redoximorphic depletion.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are:
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Kame. A moundlike hill of glacial drift, composed chiefly of stratified sand and gravel.

Karst (topography). The relief of an area underlain by limestone that dissolves in differing degrees, thus forming numerous depressions or small basins.

Knoll. A small, low, rounded hill rising above adjacent landforms.

Lacustrine deposit. Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Landslide. The rapid downhill movement of a mass of soil and loose rock, generally when wet or saturated. The speed and distance of movement, as well as the amount of soil and rock material, vary greatly.

Large stones (in tables). Rock fragments 3 inches (7.6 centimeters) or more across. Large stones adversely affect the specified use of the soil.

Leaching. The removal of soluble material from soil or other material by percolating water.

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

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low-chroma zones. Zones having chroma of 2 or less. Typical color in areas of iron depletions.

Low-residue crops. Such crops as corn used for silage, peas, beans, and potatoes. Residue from these crops is not adequate to control erosion until the next crop in the rotation is established. These crops return little organic matter to the soil.

Low strength. The soil is not strong enough to support loads.

Marl. An earthy, unconsolidated deposit consisting chiefly of calcium carbonate mixed with clay in approximately equal amounts.

Masses. Concentrations of substances in the soil matrix that do not have a clearly defined boundary with the surrounding soil material and cannot be removed as a discrete unit. Common compounds making up masses are calcium carbonate, gypsum or other soluble salts, iron oxide, and manganese oxide. Masses consisting of iron oxide or manganese oxide generally are considered a type of redoximorphic concentration.

Mechanical treatment. Use of mechanical equipment for seeding, brush management, and other management practices.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Metamorphic rock. Rock of any origin altered in mineralogical composition, chemical composition, or structure by heat, pressure, and movement. Nearly all such rocks are crystalline.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous area. An area that has little or no

natural soil and supports little or no vegetation.

Moderately coarse textured soil. Coarse sandy loam, sandy loam, or fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, or silty clay loam.

Mollic epipedon. A thick, dark, humus-rich surface horizon (or horizons) that has high base saturation and pedogenic soil structure. It may include the upper part of the subsoil.

Moraine. An accumulation of glacial drift in a topographic landform resulting chiefly from the direct action of glacial ice. Some types are lateral, recessional, and terminal.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Descriptive terms are as follows: abundance—*few, common,* and *many;* size—*fine, medium,* and *coarse;* and contrast—*faint, distinct,* and *prominent.* The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium,* from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse,* more than 15 millimeters (about 0.6 inch).

Muck. Dark, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Mudstone. Sedimentary rock formed by induration of silt and clay in approximately equal amounts.

Munsell notation. A designation of color by degrees of three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color with hue of 10YR, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nodules. Cemented bodies lacking visible internal structure. Calcium carbonate, iron oxide, and manganese oxide are common compounds making up nodules. If formed in place, nodules of iron oxide or manganese oxide are considered types of redoximorphic concentrations.

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. Plant and animal residue in the soil in various stages of decomposition. The content of organic matter in the surface layer is described as follows:

Very low	less than 0.5 percent
Low	0.5 to 1.0 percent
Moderately low	1.0 to 2.0 percent
Moderate	2.0 to 4.0 percent
High	4.0 to 8.0 percent
Very high	more than 8.0 percent

Outwash plain. An extensive area of glaciofluvial material that was deposited by meltwater streams.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture. (See Fibric soil material.)

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedisediment. A thin layer of alluvial material that mantles an erosion surface and has been transported to its present position from higher lying areas of the erosion surface.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affects the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management, such as slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil

changes from semisolid to plastic.

Plateau. An extensive upland mass with relatively flat summit area that is considerably elevated (more than 100 meters) above adjacent lowlands and separated from them on one or more sides by escarpments.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poor filter (in tables). Because of rapid or very rapid permeability, the soil may not adequately filter effluent from a waste disposal system.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Potential native plant community. See Climax plant community.

Potential rooting depth (effective rooting depth). Depth to which roots could penetrate if the content of moisture in the soil were adequate. The soil has no properties restricting the penetration of roots to this depth.

Prescribed burning. Burning an area under conditions of weather and soil moisture and at the time of day that will result in the intensity of heat and spread required to accomplish specific forest management, wildlife, grazing, or fire hazard reduction purposes.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degrees of acidity or alkalinity, expressed as pH values, are:

Extremely acid	less than 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Moderately acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Slightly 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

Redoximorphic concentrations. Nodules, concretions, soft masses, pore linings, and other features resulting from the accumulation of iron or manganese oxide. An indication of chemical reduction and oxidation resulting from saturation.

Redoximorphic depletions. Low-chroma zones from which iron and manganese oxide or a combination of iron and manganese oxide and clay has been removed. These zones are indications of the chemical reduction of iron resulting from saturation.

Redoximorphic features. Redoximorphic concentrations, redoximorphic depletions, reduced matrices, a positive reaction to alpha,alpha-dipyridyl, and other features indicating the chemical reduction and oxidation of iron and manganese compounds resulting from saturation.

Reduced matrix. A soil matrix that has low chroma in situ because of chemically reduced iron (Fe II). The chemical reduction results from nearly continuous wetness. The matrix undergoes a change in hue or chroma within 30 minutes after exposure to air as the iron is oxidized (Fe III). A type of redoximorphic feature.

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rill. A steep-sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Road cut. A sloping surface produced by mechanical means during road construction. It is commonly on the uphill side of the road.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil

is called surface runoff. Water that enters the soil before reaching surface streams is called groundwater runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs the growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-sized particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Saprolite. Unconsolidated residual material underlying the soil and grading to hard bedrock below.

Saturation. Wetness characterized by zero or positive pressure of the soil water. Under conditions of saturation, the water will flow from the soil matrix into an unlined auger hole.

Scarification. The act of abrading, scratching, loosening, crushing, or modifying the surface to increase water absorption or to provide a more tillable soil.

Second bottom. The first terrace above the normal flood plain (or first bottom) of a river.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Sequum. A sequence consisting of an illuvial horizon and the overlying eluvial horizon. (See Eluviation.)

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and surface runoff.

Shrink-swell (in tables). The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silica. A combination of silicon and oxygen. The mineral form is called quartz.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Siltstone. Sedimentary rock made up of dominantly silt-sized particles.

Similar soils. Soils that share limits of diagnostic criteria, behave and perform in a similar manner, and have similar conservation needs or management requirements for the major land uses in the survey area.

Sinkhole. A depression in the landscape where limestone has been dissolved.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75.

Slickensides. Polished and grooved surfaces produced by one mass sliding past another. In soils, slickensides may occur at the bases of slip surfaces on the steeper slopes; on faces of blocks, prisms, and columns; and in swelling clayey soils, where there is marked change in moisture content.

Slippage (in tables). Soil mass susceptible to movement downslope when loaded, excavated, or wet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slope (in tables). Slope is great enough that special practices are required to ensure satisfactory performance of the soil for a specific use.

Sloughed till. Water-saturated till that has flowed slowly downhill from its original place of deposit by glacial ice. It may rest on other till, on glacial outwash, or on a glaciolacustrine deposit.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.6 centimeters) in diameter. Small stones

adversely affect the specified use of the soil.

Soft bedrock. Bedrock that can be excavated with trenching machines, backhoes, small rippers, and other equipment commonly used in construction.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and 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.

Soil separates. Mineral particles less than 2 millimeters in equivalent diameter and ranging between specified size limits. The names and sizes, in millimeters, of separates recognized in the United States are as follows:

Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A, E, and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the substratum. The living roots and plant and animal activities are largely confined to the solum.

Stone line. A concentration of rock fragments in a soil. Generally, it is indicative of an old weathered surface. In a cross section, the line may be one fragment or more thick. It generally overlies material that weathered in place and is overlain by recent sediment of variable thickness.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded or 15 to 24 inches (38 to 60 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

Stripcropping. Growing crops in a systematic arrangement of strips or bands that provide vegetative barriers to wind erosion and water erosion.

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

Stubble mulch. Stubble or other crop residue left on the soil or partly worked into the soil. It protects the soil from wind and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

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

Subsoiling. Tilling a soil below normal plow depth, ordinarily to shatter or loosen a layer that restricts roots.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A, E, AB, or EB) below the surface layer.

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

Surface soil. The A, E, AB, and EB horizons, considered collectively. It includes all subdivisions of these horizons.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances. It commonly is a massive, arcuate ridge or complex of ridges underlain by till and other types of drift.

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 water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

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."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till. Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Till plain. An extensive area of nearly level to undulating or gently sloping soils that are underlain by till or consist of till. Slopes are 0 to 6 percent.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Toe slope. The outermost inclined surface at the base of a hill. Toe slopes are commonly gentle and linear in profile.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Toxicity (in tables). Excessive amount of toxic substances, such as salts, that severely hinder establishment of vegetation or severely restrict plant growth.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

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

Valley fill. In glaciated regions, material deposited in stream valleys by glacial meltwater. In nonglaciated regions, alluvium deposited by heavily loaded streams.

Variegation. Refers to patterns of contrasting colors assumed to be inherited from the parent material rather than to be the result of poor drainage.

Varve. A sedimentary layer or a lamina or sequence of laminae deposited in a body of still water within a year. Specifically, a thin pair of graded glaciolacustrine layers seasonally deposited, usually by meltwater streams, in a glacial lake or other body of still water in front of a glacier.

Water bars. Smooth, shallow ditches or depressional areas that are excavated at an angle across a sloping road. They are used to reduce the downward velocity of water and divert it off and away from the road surface. Water bars can easily be driven over if constructed properly.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

Wilting point (or permanent wilting point). The moisture content of soil, on an ovendry basis, at which a plant (specifically a sunflower) wilts so much that it does not recover when placed in a humid, dark chamber.

Windthrow. The uprooting and tipping over of trees by the wind.

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