United States
Department of
Agriculture

Soil
Conservation
Service

In cooperation with the
Minnesota Agricultural
Experiment Station

Soil Survey of Redwood County, Minnesota

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture, Soil Conservation Service, and the Minnesota Agricultural Experiment Station, in cooperation with the Redwood County Agricultural Extension Service, the Redwood County Soil and Water Conservation Board, and the Redwood Soil and Water Conservation District. The survey was partially funded by the Legislative Commission for Minnesota Resources and by Redwood County. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in 1981. Soil names and descriptions were approved in 1981. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1981.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: An area of the Millington-Du Page association in the Minnesota River Valley that has been planted to corn. Storden loam, 25 to 40 percent slopes, is in the foreground. The Wadena Variant-Rock outcrop-Copaston association is in the background.

Contents

Index to map units ... iv
Summary of tables ... v
Foreword ... vii
General nature of the county ... 1
How this survey was made ... 4
  Map unit composition ... 4
General soil map units ... 7
  Soil descriptions ... 7
Detailed soil map units ... 15
  Soil descriptions ... 15
Prime farmland ... 57
Use and management of the soils ... 59
  Crops and pasture ... 59
  Windbreaks and environmental plantings ... 62
  Recreation ... 62
  Wildlife habitat ... 63
  Engineering ... 64
Soil properties ... 69
  Engineering index properties ... 69
  Physical and chemical properties ... 70
  Soil and water features ... 71
Classification of the soils ... 73
Soil series and their morphology ... 73
Formation of the soils ... 97
References ... 99
Glossary ... 101
Tables ... 107

Soil Series

Biscay series ... 73
Blue Earth series ... 74
Canisteo series ... 75
Coland series ... 75
Copaston series ... 76
Delft series ... 76
Dickinson series ... 77
Dickman series ... 77
Du Page series ... 78
Estherville series ... 79
Everly series ... 80
Glencoe series ... 80
Grogan series ... 81
Hanska series ... 81
Knoke series ... 82
Lemond series ... 82
Letri series ... 83
Linder series ... 83
Mayer series ... 84
Millington series ... 84
Nishna series ... 85
Normania series ... 85
Okoboji series ... 86
Oshawa series ... 87
Oshawa Variant ... 87
Revere series ... 88
Salida series ... 89
Seaforth series ... 89
Spillville series ... 90
Storden series ... 90
Swanlake series ... 91
Terril series ... 91
Tilfer series ... 92
Ves series ... 92
Wadena series ... 93
Wadena Variant ... 94
Webster series ... 94
Wilmonton series ... 95
Wilmonton Variant ... 95
Zumbro series ... 96

Issued May 1985

Index to Map Units

27A—Dickinson fine sandy loam, 0 to 2 percent slopes 15
27B—Dickinson fine sandy loam, 2 to 6 percent slopes 16
31E—Storden loam, 18 to 25 percent slopes 16
31F—Storden loam, 25 to 40 percent slopes 17
39A—Wadena loam, 0 to 2 percent slopes 17
39B—Wadena loam, 2 to 6 percent slopes 18
41A—Estherville sandy loam, 0 to 2 percent slopes 18
41B—Estherville sandy loam, 2 to 6 percent slopes 19
42C—Salida gravelly sandy loam, 2 to 12 percent slopes 19
42E—Salida gravelly sandy loam, 12 to 35 percent slopes 20
86—Canisteo clay loam 20
94B—Terril loam, 2 to 6 percent slopes 21
94C—Terril loam, 6 to 12 percent slopes 21
113—Webster clay loam 21
114—Glencoe silty clay loam 22
128A—Grogan loam, 0 to 2 percent slopes 22
128B—Grogan loam, 2 to 6 percent slopes 23
134—Okoboji silty clay loam 23
149B—Everly clay loam, 2 to 4 percent slopes 24
149B2—Everly clay loam, 3 to 6 percent slopes, eroded 25
227—Lemond loam 25
241—Letri clay loam 26
247—Linder loam 26
255—Mayer loam 28
269—Millington loam 28
282—Hanska fine sandy loam 29
313—Spillville loam, occasionally flooded 29
317—Oshawa silty clay loam 30
321—Tilfer clay loam 30
327A—Dickman sandy loam, 0 to 2 percent slopes 31
327B—Dickman sandy loam, 2 to 6 percent slopes 31
345—Wilmonton clay loam 31
390—Spillville loam, frequently flooded 32
392—Biscay loam 33
399—Biscay loam, depressional 33
421B—Ves loam, 1 to 4 percent slopes 34
421B2—Ves loam, 3 to 6 percent slopes, eroded 34
423—Seaforth loam 34
446—Normania loam 35
562—Knoke silty clay loam 35
574—Du Page loam 36
575—Nishna clay loam 36
654—Revere clay loam 37
818—Lemond-Linder-Estherville complex 37
882—Millington-Zumbro complex 38
883—Du Page-Zumbro complex 40
884—Delft-Webster complex 40
894B2—Everly-Storden complex, 3 to 6 percent slopes, eroded 41
894C2—Storden-Everly complex, 6 to 12 percent slopes, eroded 42
894D2—Storden-Everly complex, 12 to 18 percent slopes, eroded 42
954B2—Ves-Storden loams, 3 to 6 percent slopes, eroded 43
954C2—Storden-Ves loams, 6 to 12 percent slopes, eroded 44
954D2—Storden-Ves loams, 12 to 18 percent slopes, eroded 44
992E—Rock outcrop-Copaston complex, 2 to 40 percent slopes 45
999B2—Ves-Estherville-Storden complex, 3 to 6 percent slopes, eroded 46
999C2—Storden-Estherville-Ves complex, 6 to 12 percent slopes, eroded 47
999D2—Storden-Estherville-Ves complex, 12 to 18 percent slopes, eroded 48
1016—Udorthents, loamy 49
1029—Pits, gravel 49
1053—Aquolls, ponded 49
1833—Coland clay loam, occasionally flooded 49
1834—Coland clay loam, frequently flooded 50
1850—Oshawa Variant stony clay loam 51
1851B—Blue Earth mucky clay loam, sloping 51
1852F—Terril-Swanlake loams, 25 to 70 percent slopes 52
1853A—Wadena Variant loam, 0 to 2 percent slopes 53
1853B—Wadena Variant loam, 2 to 6 percent slopes 53
1897—Seaforth-Wilmonton clay loams 54
1899B—Wilmonton Variant loam, 2 to 12 percent slopes 55
1899E—Wilmonton Variant sandy clay loam, 12 to 40 percent slopes 55

Summary of Tables

Temperature and precipitation (table 1) 108

Freeze dates in spring and fall (table 2) 109

Probability. Temperature.

Growing season (table 3) 109

Acreage and proportionate extent of the soils (table 4) 110

Acres. Percent.

Yields per acre of crops and pasture (table 5) 111

Corn. Soybeans. Oats. Grass-legume hay. Kentucky bluegrass. Bromegrass-alfalfa. Reed canarygrass.

Windbreaks and environmental plantings (table 6) 115

Recreational development (table 7) 121

Camp areas. Picnic areas. Playgrounds. Paths and trails. Golf fairways.

Wildlife habitat (table 8) 126

Potential for habitat elements. Potential as habitat for—Openland wildlife, Woodland wildlife, Wetland wildlife.

Building site development (table 9) 130

Shallow excavations. Dwellings without basements. Dwellings with basements. Small commercial buildings. Local roads and streets. Lawns and landscaping.

Sanitary facilities (table 10) 135

Septic tank absorption fields. Sewage lagoon areas. Trench sanitary landfill. Area sanitary landfill. Daily cover for landfill.

Construction materials (table 11) 140

Roadfill. Sand. Gravel. Topsoil.

Water management (table 12) 145

Limitations for—Pond reservoir areas; Embankments, dikes, and levees. Features affecting—Drainage, Irrigation, Terraces and diversions, Grassed waterways.

Engineering index properties (table 13) 150

Depth. USDA texture. Classification—Unified, AASHTO. Fragments greater than 3 inches. Percentage passing sieve—4, 10, 40, 200. Liquid limit. Plasticity index.

Physical and chemical properties of the soils (table 14) 157

Depth. Clay. Moist bulk density. Permeability. Available water capacity. Reaction. Salinity. Shrink-swell potential. Erosion factors. Wind erodibility group. Organic matter.

Soil and water features (table 15) 162
Hydrologic group. Flooding. High water table. Bedrock. Potential frost action. Risk of corrosion.
Classification of the soils (table 16) 166
Family or higher taxonomic class.

Foreword

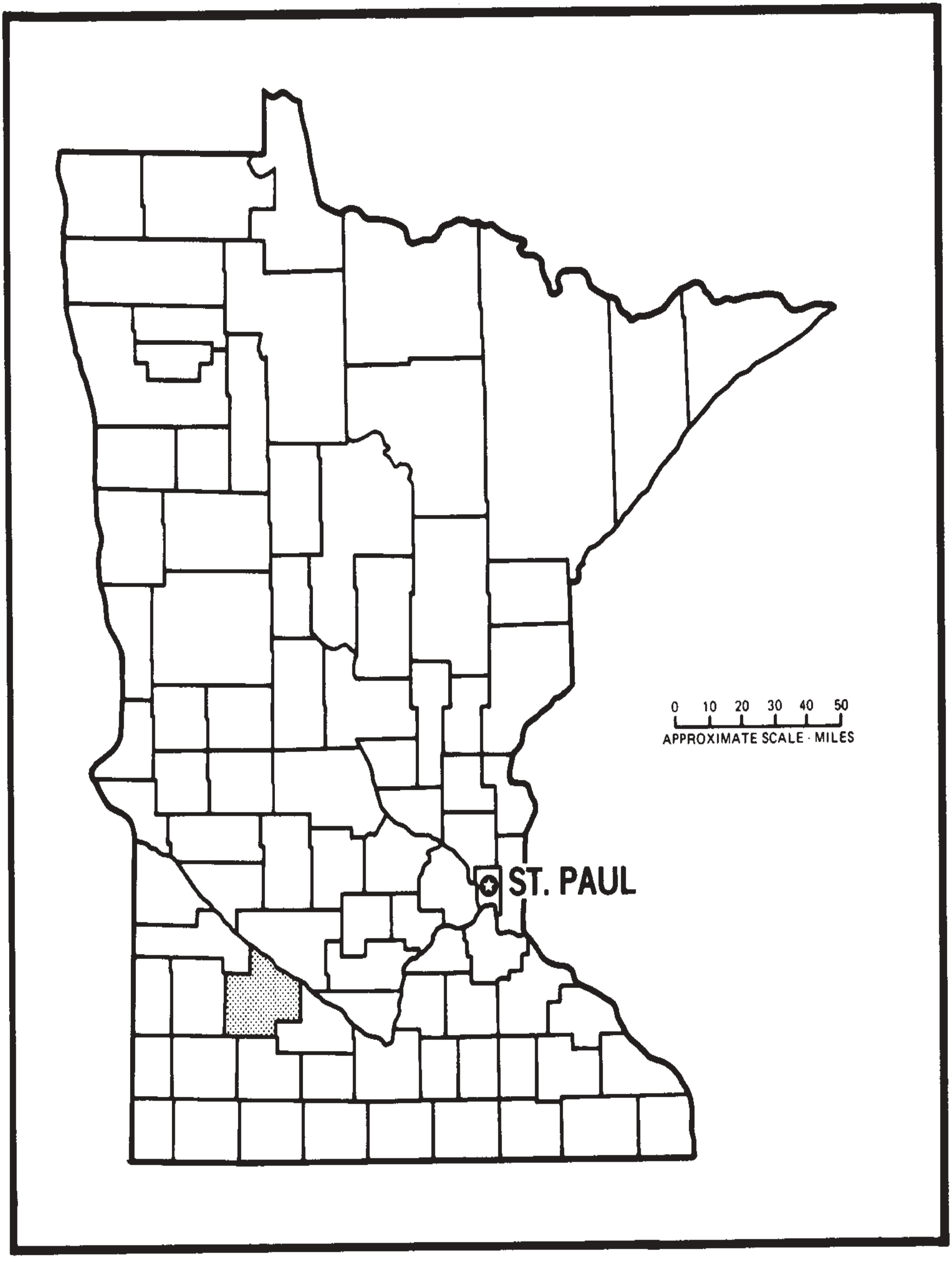
This soil survey contains information that can be used in land-planning programs in Redwood County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact 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 insure 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 Soil Conservation Service or the Cooperative Extension Service.

Donald G. Ferren
State Conservationist
Soil Conservation Service



Location of Redwood County in Minnesota.

Soil Survey of
Redwood County, Minnesota

By James J. Murray, Soil Conservation Service

Fieldwork by Hilding L. Hokanson, Kenneth D. Matzdorf, James J. Murray, Gary D. Nelson, and Kim D. Steffen, Soil Conservation Service, and Philip Nesse, Minnesota Agricultural Experiment Station

United States Department of Agriculture, Soil Conservation Service
In cooperation with Minnesota Agricultural Experiment Station

REDWOOD COUNTY is in the southwestern part of Minnesota. The total land area is 874 square miles, or 559,360 acres. Redwood Falls is the county seat. It is situated by a series of cascades and rapids of the Redwood River. Farming is the most important enterprise. Corn, soybeans, small grains, and hay, feeding and raising livestock, and dairying produce most of the income in the county.

The soils are dark and are nearly level to steep. They formed in glacial till or in material sorted out of the till by water. The original vegetation was tall and medium prairie grasses.

Redwood County was established by an act of the Legislature and was approved February 6, 1862. Redwood County and the county seat, Redwood Falls, were named for the Redwood River.

The population of Redwood County in 1870 was 1,829; in 1900, it was 18,000. In 1940, the population had increased to 22,229; but by 1970, it had decreased to 20,024 *(3)*.

There are 16 incorporated cities in the county: Belview, Clements, Delhi, Lamberton, Lucan, Milroy, Morgan, North Redwood, Redwood Falls, Revere, Sanborn, Seaforth, Vesta, Wabasso, Walnut Grove, and Wanda.

General Nature of the County

This section provides general information concerning Redwood County. It discusses the climate; the physiography, relief, and drainage; the transportation and markets; the farming; and the water supply.

Climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Redwood County is in the interior climatic region of North America. Winters are cold. Summers are quite hot with occasional cool spells. Precipitation in the winter occurs as snowstorms; and in the warm months, it is mainly showers, often heavy, when warm moist air moves in from the south. Total annual rainfall is normally adequate for corn, soybeans, and small grains.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Lamberton in the period 1961 to 1975. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 16 degrees F, and the average daily minimum temperature is 6 degrees. The lowest temperature on record, which occurred at Lamberton on January 22, 1970, is -34 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 Lamberton on July 11, 1966, is 104 degrees.

Growing degree days are shown in table 1. They 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 (50 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 25 inches. Of this, 19 inches, or 80 percent, usually falls in April through September. The growing season for most crops falls within this period. In 2 years out of 10, the rainfall in April through September is less than 15 inches. The heaviest 1-day rainfall during the period of record was 3.95 inches at Lamberton on September 21, 1968. Thunderstorms occur on about 45 days each year, and most occur in summer.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and of short duration and result in sparse damage in narrow belts. Hailstorms occur at times in the warmer part of the year in irregular patterns and in relatively small areas.

The average seasonal snowfall is 38 inches. The greatest snow depth at any one time during the period of record was 23 inches. On an average of 69 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is about 60 percent. Humidity is higher at night, and the average at dawn is about 80 percent. The sun shines 65 percent of the time possible in summer and 45 percent in winter. The prevailing wind is from the south. Average windspeed is highest, 14 miles per hour, in April.

Physiography, Relief, and Drainage

The surface of Redwood County is largely a glacial till lowland plain mostly between 1,000 to 1,200 feet above sea level. In the southwestern townships of the county, south of the Cottonwood River, is the Coteau des Prairies. It begins in Springdale Township and ascends to 1,450 feet above sea level in the southwest corner of the county (fig. 1). The Redwood and Cottonwood Rivers flow in shallow valleys across this glacial till lowland plain, except where the Redwood River, joined by Ramsey Creek, approaches the Minnesota River and descends into a deep and picturesque gorge, cascading over the granite ledges.

In the southwestern townships where the Coteau des Prairies is relatively steep, the tributaries of the Cottonwood River have deep ravines. They are fed by springs. Nearly all of the water of the Cottonwood River comes from these spring-fed tributaries.

Rock outcrops are conspicuous along the Minnesota River Valley. The exposed bedrock is granitic gneisses and lesser amphibolitic gneisses. They are some of the oldest known rocks in North America *(4)*. The lowest elevation is about 800 feet above sea level. It is in the northeastern part of the county in the Minnesota River Valley on the border of Redwood and Brown Counties.

The glacial till lowland plain, north of the Cottonwood River, mostly is nearly level to undulating. This glacial till is the New Ulm Till, which contains many shale fragments *(11)*. Slopes are mostly short and complex with closed depressions common. The soils formed mostly in glacial till, but areas along the creeks, rivers, and some hills formed in gravelly or sandy glacial drift. The creek and rivers that drain this area flow into the Minnesota River. The Redwood River flows into the Minnesota River at Redwood Falls. Echo, Rice, and Boiling Springs Creeks flow into the Minnesota River in the northern part of the county, and the Crow and Wabasha Creeks flow into the Minnesota River in the northeastern part of the county. Sleepy Eye Creek and Coal Mine Creek in the southern part of the county flow southeast into the Cottonwood River in Brown County.

The Minnesota River Valley in the northern part of the county varies from about 1/2 to 2 miles in width. This gorge, cut in post-glacial time by the River Warren *(11)*, is about 150 feet deep. It varies from about 1,000 to 800 feet in elevation. In some areas, bedrock is exposed at the surface. Along the deep ravines that dissect the Minnesota River bluffs are some exposures of kaolinitic clays. The soils on the flood plains and terraces formed from alluvium that was deposited by the Minnesota River.

Transportation and Markets

Two railroads cross the county from east to west and serve North Redwood, Delhi, Belview, Sanborn, Lamberton, Revere, and Walnut Grove. Two Federal highways and four state highways serve Redwood County. The major highways are either paved or blacktopped. Gravelled or paved county and township roads serve every farm. About 275 miles of the 616 miles of county roads have been paved and more are being completed each year.

There are grain elevators in most of the cities in Redwood County. Livestock generally is taken by truck to South St. Paul, Albert Lea, or Austin. Most of the milk is marketed as whole milk and is picked up daily by trucks.

Farming

Wheat, corn, oats, barley, potatoes, and wild hay cut from the prairie were the main crops produced by the first settlers. Corn and soybeans for market and for livestock feed are still the principal crops. The acreage of corn and soybeans has increased significantly since 1964. The acreage of oats, the third most important crop, has decreased. It is about 75 percent less than in 1964 *(5)*.

The number of cattle and calves raised has decreased since 1964. The number of hogs and pigs raised has stayed about constant. There are presently two-thirds fewer sheep than in 1964 and about one-half fewer milk cows *(5)*. In 1980 there were 58,104 cattle and calves, 145,000 hogs and pigs, and 3,000 sheep and lambs *(5)*.

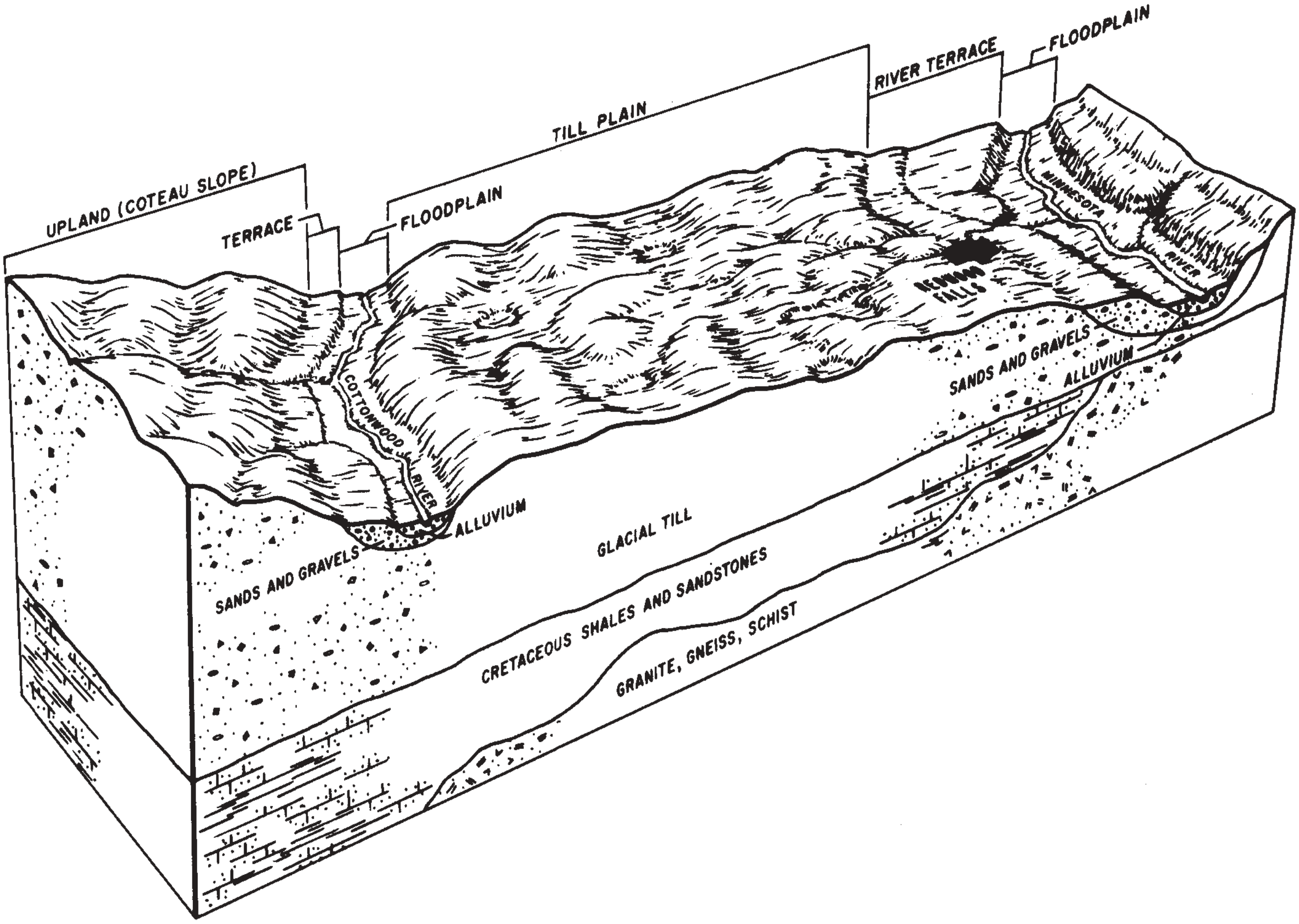


Figure 1.—Cross-sectional view, southwest to northeast, of Redwood County showing landforms, parent material, and kinds of underlying bedrock.

There were 2,158 farms in the county in 1964 and 1,765 in 1980. Most of the land, however, was brought or rented by farmers and is still in use. The average size of farms increased from 250 acres in 1964 to 312 acres in 1980 *(5)*.

Water Supply

Water for domestic use on farms is drawn from glacial till, alluvium, and Cretaceous rock and sandstone. The quantity of water produced varies with the thickness of the drift and the presence of sandy or gravelly strata and with the thickness of the Cretaceous rock and sandstone.

Nearly all of Redwood County is covered with glacial drift. In a few places, thin beds of recent alluvium are on the valley floors; but in most places these deposits rest on glacial sediments. Older rock formations are exposed in the Minnesota River Valley and in a few small areas near Seaforth. The drift is less than 100 feet thick in the west-central townships and near the Minnesota River Valley bluffs; but its average thickness is 150 to 250 feet in the eastern, central, and southwestern townships. Where the drift is considerably thick, it generally includes lenses of sand and gravel that can produce an adequate supply of water for all ordinary purposes. Where the drift is less than 100 feet thick, it cannot produce a reliable source of water. In the northwestern part of the county, the drift is not a satisfactory source of water, but in many places it is the only available source *(7)*.

The head of water varies greatly. The discharge through springs along the Minnesota River valley has lowered the head beneath the adjacent uplands. However, soutwestward away from the valley and in the area between the Redwood and Cottonwood Rivers, the static level in drift wells is 30 to 50 feet below the surface.

Cretaceous bedrock and sandstone lie beneath the drift throughout most of the county. The formation is 150 to 400 feet thick in the southwest townships. It thins out toward the east and west and is absent in the areas along the Redwood River from below Seaforth to the western border of the county *(7)*.

Where the Cretaceous rock is several hundred feet thick, it can yield a moderately large quantity of water. In general, it can be a dependable source of water in the vicinity of Milroy and southwestward and southeastward to Walnut Grove and Revere. Near Lamberton and Lucan, the drift is generally absent or devoid of any water-bearing strata; in a few localities it will furnish some water *(7)*.

The lakes in Redwood County are the Iverson and Long Lakes in Swedes Forest Township, Tiger Lake in Honner Township, Dabbs Lake in Vail Township, Gales Lake in Gales Township, Lake Redwood in Redwood Falls Township, and the southern tip of Timm Lake that extends into Underwood Township from Yellow Medicine County.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; 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 biologic activity.

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

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil 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-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 soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, 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. 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 interpreted the data from these analyses and tests as well as the field-observed characteristics and the soil properties in terms of expected behavior of the soils under different uses. Interpretations for all of the soils were field tested through observation of the soils in different uses under different levels of management. Some interpretations are modified to fit local conditions, and new interpretations sometimes are developed to meet local needs. Data were 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 were 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 state with a fairly high degree of probability that a given soil will have a high water table within certain depths in most years, but they cannot assure 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.

Map Unit Composition

A map unit delineation on a soil map represents an area dominated by one major kind of soil or an area dominated by several kinds of soil. A map unit is identified and named according to the taxonomic classification of the dominant soil or soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural objects. In common with other natural objects, they have a characteristic variability in their properties. 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 soils of other taxonomic classes. Consequently, every map unit is made up of the soil or soils for which it is named and some soils that belong to other taxonomic classes. These latter soils are called inclusions or included soils.

Most inclusions have properties and behavioral patterns 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 (similar) inclusions. They may or may not be mentioned in the map unit descriptions. Other inclusions, however, have properties and behavior divergent enough to affect use or require different management. These are contrasting (dissimilar) inclusions. They generally occupy small areas and cannot be shown separately on the soil maps because of the scale used in mapping. The inclusions of contrasting soils are mentioned in the map unit descriptions. A few inclusions may not have been observed, and consequently are not mentioned in the descriptions, especially where the soil pattern was so complex that it was impractical to make enough observations to identify all of the kinds of soils on the landscape.

The presence of inclusions in a map unit in no way diminishes the usefulness or accuracy of the soil data. The objective of soil mapping is not to delineate pure taxonomic classes of soils 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 onsite investigation is needed to plan for intensive uses in small areas.

General Soil Map Units

The general soil map at the back of this publication shows broad areas called soil associations that have a distinctive pattern of soils, relief, and drainage. Each association on the general soil map is a unique natural landscape. Typically, an association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations 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 can be identified on the map. Likewise, areas where the soils 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 soil association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Soil Descriptions

1. Canisteo-Ves Association

Poorly drained and well drained, nearly level and gently sloping soils that formed in glacial till; on uplands

The soils that make up this association are in broad areas of ground moraines. The slopes are short. The local relief ranges from 2 to 10 feet in elevation. Closed depressions are common.

This association (fig. 2) makes up about 36 percent of the county. It is about 30 percent Canisteo soils and 25 percent Ves soils. Soils of minor extent make up the remaining 45 percent.

The Canisteo soils are poorly drained. They are on the rims of depressions and on broad lowlands. They are calcareous. Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black and very dark gray clay loam about 13 inches thick. The subsoil is grayish brown clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled loam.

The Ves soils are well drained. They are on low knolls. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is dark gray and very dark grayish brown loam about 5 inches thick. The subsoil is about 16 inches thick. It is brown loam in the upper part and light olive brown loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam.

The minor soils are Glencoe, Okoboji, Webster, Normania, Seaforth, and Storden soils. Glencoe and Okoboji soils are very poorly drained and are in shallow depressions. Webster soils are poorly drained and are noncalcareous. They are in swales. Normania and Seaforth soils are moderately well drained and are on concave side slopes and low knolls. Storden soils are well drained and are calcareous. They are on the steeper side slopes.

The soils that make up this association are used mainly for crops. Corn and soybeans are the most common crops. The soils in this association that are poorly and very poorly drained need adequate drainage to make them suitable for crops. The high content of lime in the Canisteo soils causes a fertility imbalance. Erosion is the major concern in management of the Ves soils.

Wetness is the main limitation for use of these soils as sites for buildings, local roads, and septic tank absorption fields. Canisteo soils have a natural high water table at a depth of 1 to 3 feet. Ves soils are well suited to use as sites for buildings and for septic tank absorption fields. Frost action can damage local roads on the Ves soil.

2. Canisteo-Normania-Okoboji Association

Poorly drained, moderately well drained, and very poorly drained, nearly level soils that formed in glacial till or silty alluvial sediments derived from glacial till; on uplands

The soils that make up this association are in broad areas of ground moraines that have short, irregular, convex knolls. These knolls range from 1 to 10 feet above the floor of the lowland till plain. Closed depressions are common.

This association (fig. 3) makes up about 20 percent of the county. It is about 30 percent Canisteo soils, 20 percent Normania soils, and 15 percent Okoboji soils. Soils of minor extent make up the remaining 35 percent.

The Canisteo soils are poorly drained. They are on the rims of depressions and on broad lowlands. They are calcareous. Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black and very dark gray clay loam about 13 inches thick. The subsoil is grayish brown clay loam about 7 inches thick.

The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled loam.

The Normania soils are moderately well drained. They are in broad, slightly concave to slightly convex areas. Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is black and very dark gray loam about 11 inches thick. The subsoil is about 16 inches thick. It is dark grayish brown clay loam in the upper part and grayish brown loam in the lower part. The underlying material to a depth of about 60 inches is light brownish gray, mottled loam.

The Okoboji soils are very poorly drained. They are in shallow, closed depressions. Typically, the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is also black silty clay loam about 40 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled silty clay loam.

The minor soils are Ves, Seaforth, Webster, and Glencoe soils. Ves soils are well drained and are calcareous. They are in convex areas and on slight rises above the lowland till plain. Seaforth soils are moderately well drained and are in convex areas and

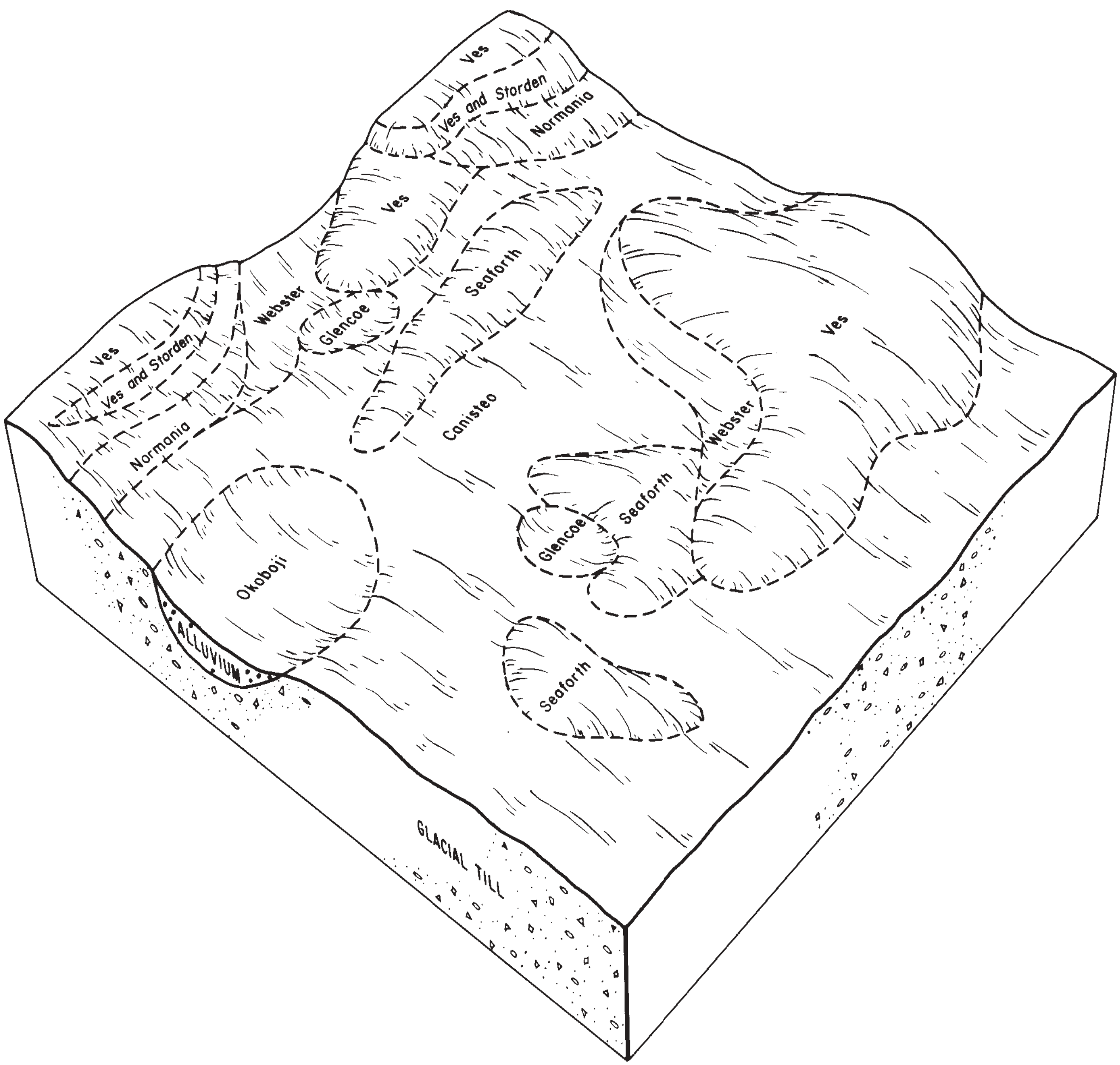


Figure 2.—Relationship of soils, underlying material, and landforms in the Canisteo-Ves association.

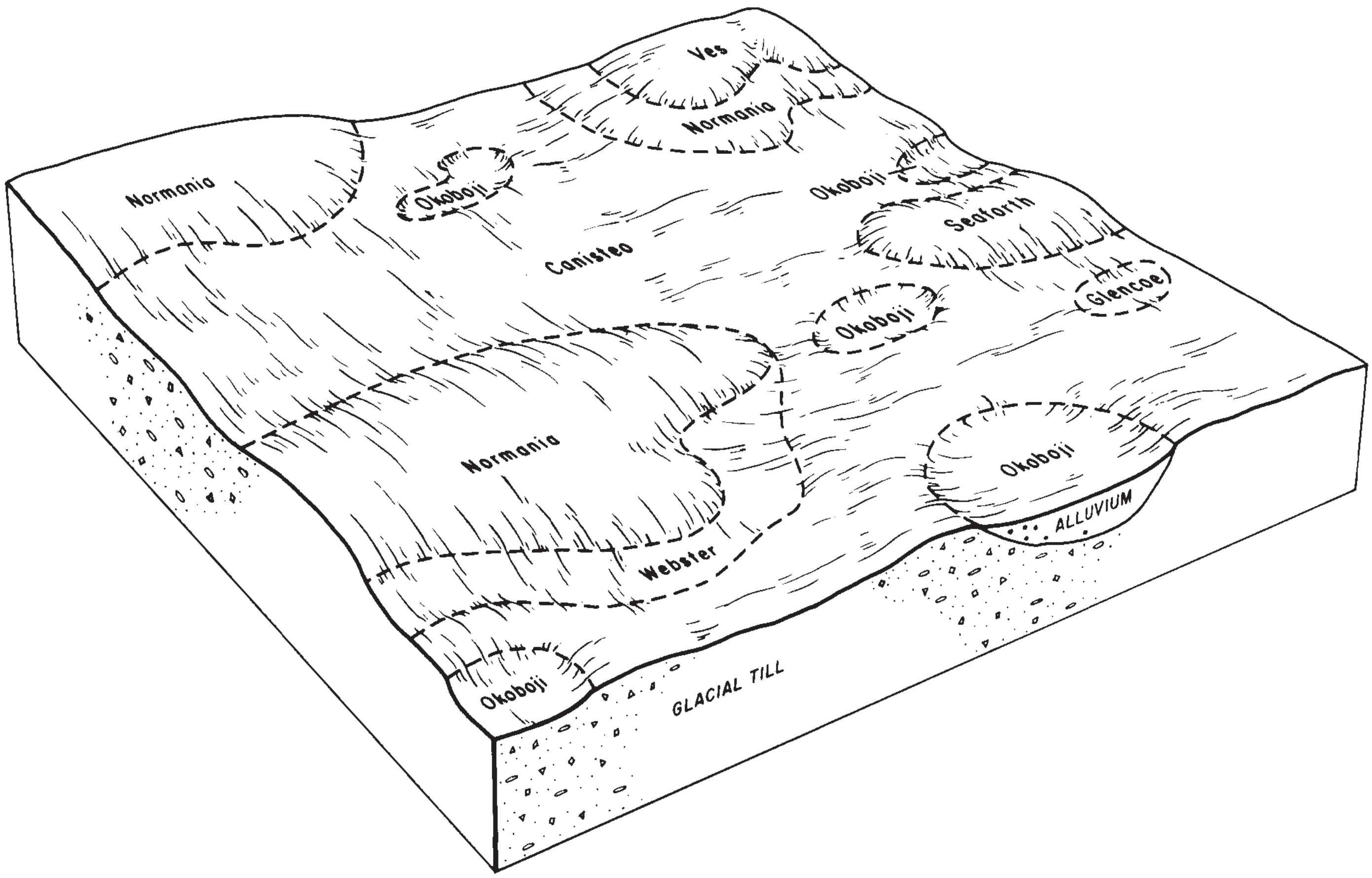


Figure 3.—Relationship of soils, underlying material, and landforms in the Canisteo-Normania-Okoboji association.

slight rises above the lowland till plain. Webster soils are poorly drained and are noncalcareous. They are on broad lowlands and in closed depressions. The Glencoe soils are very poorly drained and are on broad lowlands and in closed depressions. These soils are less clayey than the Okoboji soils.

The soils that make up this association are used mainly for crops. Corn and soybeans are the most common crops. Wetness is a limitation on the Canisteo and Okoboji soils. Tile drainage is needed to make these soils suitable for crops. The high content of lime in the Canisteo soils causes a fertility imbalance.

Wetness is the main limitation for use of these soils as sites for buildings, local roads, and septic tank absorption fields. Canisteo soils have a natural high water table at a depth of 1 to 3 feet. Okoboji soils have a high water table above a depth of 1 foot. These soils are often ponded.

3. Canisteo-Ves-Storden Association

Poorly drained and well drained, nearly level to moderately steep soils that formed in glacial till; on uplands

The soils that make up this association are in broad areas of ground moraines. The slopes are short. The local relief ranges from 2 to 20 feet in elevation. Closed depressions are common.

This association (fig. 4) makes up about 26 percent of the county. It is about 35 percent Canisteo soils, 15 percent Ves soils, and 10 percent Storden soils. Soils of minor extent make up the remaining 40 percent.

The Canisteo soils are poorly drained. They are on the rims of depressions and on broad lowlands. They are calcareous. Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black and very dark gray clay loam about 13 inches thick. The subsoil is grayish brown clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled loam.

The Ves soils are well drained. They are on low knolls. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is dark brown and very dark

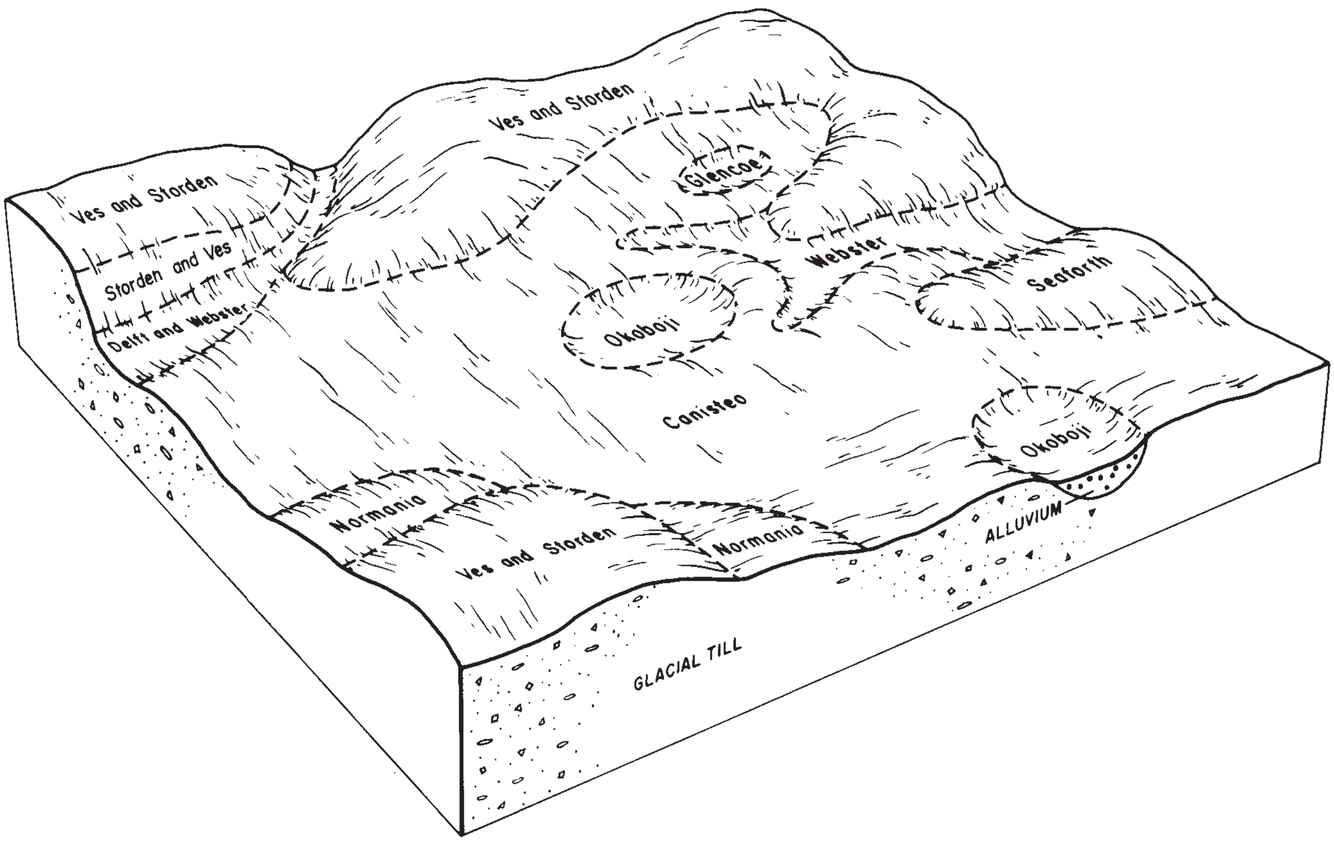


Figure 4.—Relationship of soils, underlying material, and landforms in the Canisteo-Ves-Storden association.

grayish brown loam about 5 inches thick. The subsoil is about 16 inches thick. It is brown loam in the upper part and light olive brown loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam.

The Storden soils are well drained. They are on the steeper side slopes. Typically, the surface layer is dark grayish brown loam about 8 inches thick. The underlying material to a depth of about 60 inches is brown and pale brown loam.

The minor soils are Glencoe, Okoboji, Seaforth, Normania, Delft, and Webster soils. Glencoe and Okoboji soils are very poorly drained and are in shallow closed depressions. Seaforth and Normania soils are moderately well drained and are on elevated knolls and slightly convex slopes. Delft and Webster soils are poorly drained and are noncalcareous. They are on foot slopes and on broad lowlands.

The soils making up this association are used mainly for crops. Corn and soybeans are the most common crops. Wetness is a limitation on the poorly drained and very poorly drained soils. Adequate drainage is needed to make these soils suitable for crops. The high content of lime in the Canisteo soils causes a fertility imbalance. Erosion is a hazard on the steeper slopes. Farming on the contour and conservation tillage are common practices.

The Ves and Storden soils are suited to use as sites for buildings, local roads, and septic tank absorption fields. Steepness is a limitation in some areas, and erosion is a severe hazard if construction sites are not adequately managed. Wetness is a limitation on the Canisteo soils.

4. Estherville-Mayer Association

Well drained and poorly drained, nearly level to moderately steep soils that formed in glacial outwash; on outwash plains, terraces, and moraines

The soils making up this association are in broad areas of outwash plains and terraces and on the adjacent escarpments.

This association (fig. 5) makes up about 4 percent of the county. It is about 35 percent Estherville soils and 20 percent Mayer soils. Soils of minor extent make up the remaining 45 percent.

The Estherville soils are well drained. They are on slight rises on outwash plains and on terrace escarpments. Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is about 10 inches thick. It is dark brown sandy loam in the upper part and dark brown coarse sandy loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand.

The Mayer soils are poorly drained. They are in broad areas on outwash plains and terraces. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is olive gray loam about 12 inches thick. The subsoil also is olive gray loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive gray and olive, mottled gravelly coarse sand and gravelly loamy sand.

The minor soils are Salida, Dickman, Wadena, Linder, Biscay, Hanska, Lemond, and Biscay depressional soils. Salida soils are excessively drained and are on convex knolls. Dickman and Wadena soils are well drained and are in nearly level areas and on convex knolls. Linder soils are somewhat poorly drained and are in nearly level areas and on convex knolls. Biscay, Hanska, and Lemond soils are poorly drained and are in swales, broad wet areas, and on the rim of depressions. Biscay depressional soils are very poorly drained and are in closed depressions.

The soils that make up this association are used mainly for crops. Corn, soybeans, oats, and wheat are the major crops. Droughtiness is a concern in management in many areas. Wetness is a limitation in the swales, broad wet areas, and depressions. Erosion is a hazard on the escarpments. Early maturing crops commonly are grown because of the early season moisture. Returning crop residue to the soil helps retain soil moisture. It is a widely used practice.

In most areas, the soils are suited to use as sites for buildings. Wetness is a limitation in the swales, broad wet areas, and depressions. Most of the soils are poorly suited to use as septic tank absorption fields because of the moderate to rapid permeability of the soils. The soils cannot adequately filter effluent. The poor filtering capacity can result in pollution of ground water.

5. Everly-Letri-Wilmonton Association

Well drained, poorly drained, and moderately well drained, nearly level to hilly soils that formed in loamy sediments and glacial till; on uplands

The soils that make up this association are in broad areas of ground moraines on the coteau slope, which drops in elevation 10 to 70 feet per mile to the

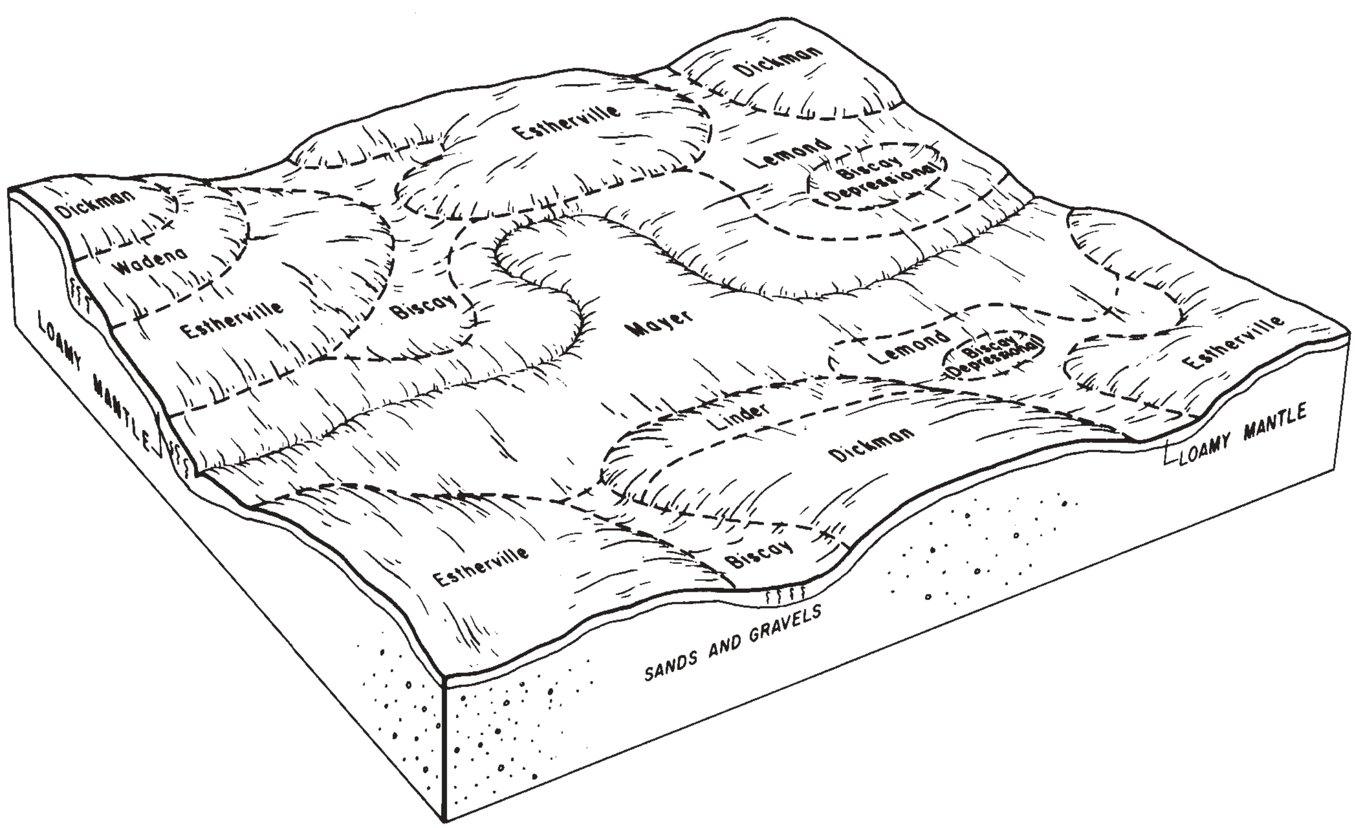


Figure 5.—Relationship of soils, underlying material, and landforms in the Estherville-Mayer association.

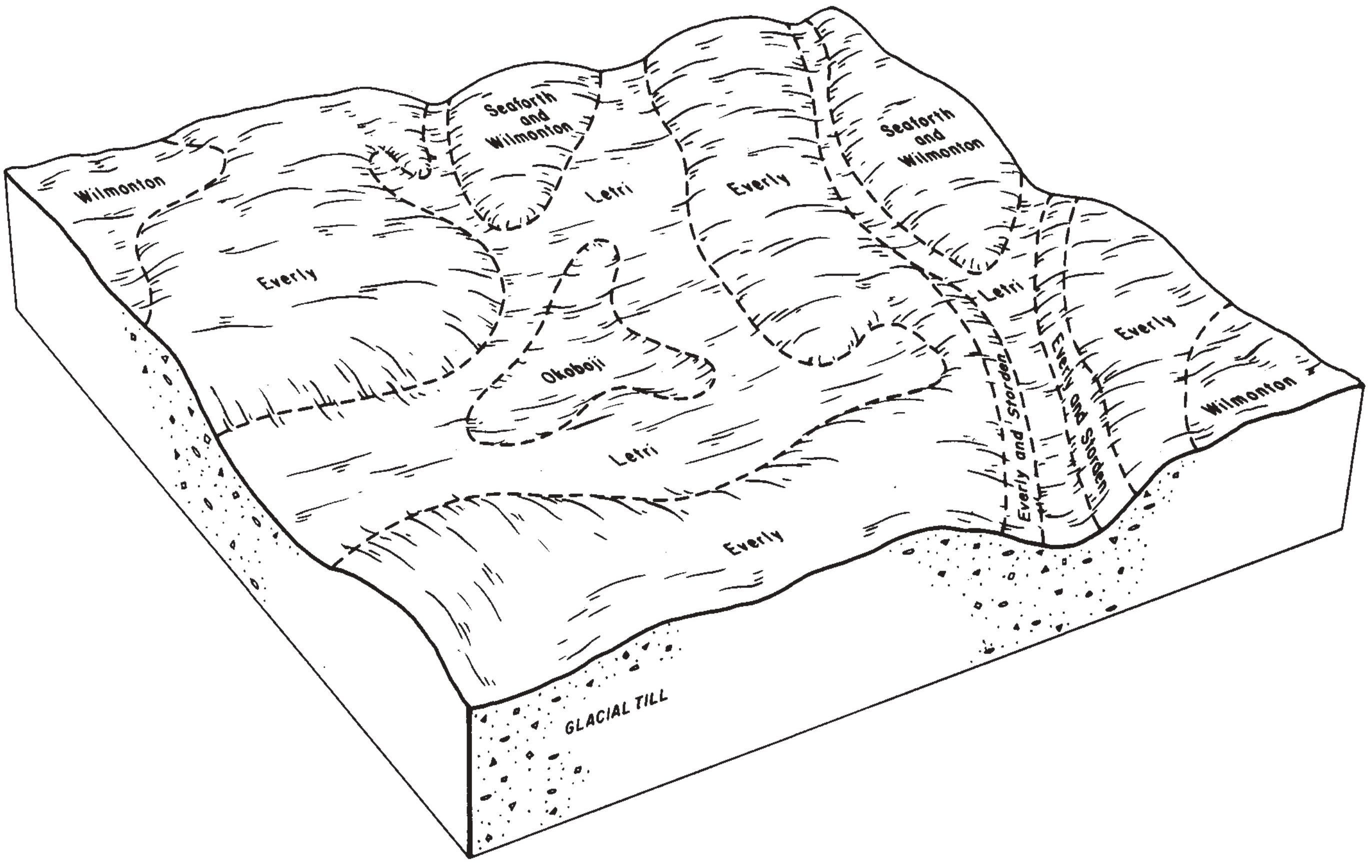


Figure 6.—Relationship of soils, underlying material and landforms in the Everly-Letri-Wilmonton association.

Cottonwood River. The slope drains to the northeast and is dissected by drainageways.

This association (fig. 6) makes up about 8 percent of the survey area. It is about 30 percent Everly soils, 15 percent Letri soils, and 10 percent Wilmonton soils. Soils of minor extent make up the remaining 45 percent.

The Everly soils are well drained. They are on convex side slopes on ground moraines. Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark grayish brown clay loam about 6 inches thick. The subsoil is about 26 inches thick. It is dark brown clay loam in the upper part and yellowish brown clay loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown clay loam.

The Letri soils are poorly drained. They are adjacent to drainageways and on concave toe slopes on ground moraines. Typically, the surface layer is black clay loam about 12 inches thick. The subsurface layer is also black clay loam about 6 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown clay loam in the upper part and grayish brown, mottled clay loam in the lower part. The underlying material to a depth of about 60 inches is light brownish gray, mottled loam in the upper part and light olive brown, mottled loam in the lower part.

The Wilmonton soils are moderately well drained. They are on slightly concave to convex side slopes on ground moraines. Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is also black clay loam about 5 inches thick. The subsoil is about 24 inches thick. It is dark grayish brown and olive brown, mottled clay loam in the upper part and calcareous, light olive brown, mottled clay loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown, mottled clay loam.

The minor soils are Storden, Seaforth, and Okoboji soils. Storden soils are well drained and are calcareous. They are on convex summits and side slopes. Seaforth soils are moderately well drained and are calcareous. They are in slightly convex areas. Okoboji soils are very poorly drained and are in shallow, closed depressions.

The soils that make up this association are used mainly for crops. The more sloping areas along drainageways are used as pasture or woodland. Corn and soybeans are the major crops. The hazard of erosion is the main concern in management in areas of

Everly and Wilmonton soils. Wetness is a concern in management in areas of Letri soils. A drainage system is needed for the Letri soils to be used for crops.

The soils are suited to use as sites for buildings and septic tank absorption fields. Wetness is a limitation on Letri soils and in other depressional areas.

6. Millington-Du Page Association

Poorly drained and moderately well drained, nearly level soils that formed in alluvium; on flood plains

The soils that make up this association are on bottom lands along streams and rivers throughout the county. They are subject to flooding and are commonly dissected by stream channels.

This association makes up about 4 percent of the county. It is about 40 percent Millington soils and 15 percent Du Page soils. Soils of minor extent make up the remaining 45 percent.

The Millington soils are poorly drained. They are on bottom lands adjacent to stream channels and are subject to occasional flooding. Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is also black loam about 28 inches thick. The underlying material to a depth of about 60 inches is stratified, dark gray loam and very dark gray sandy clay loam.

The Du Page soils are moderately well drained. They are in higher positions on the bottom lands and are subject to occasional flooding. Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is 23 inches thick. It is black loam in the upper part and very dark gray loam in the lower part. The underlying material to a depth of about 60 inches is dark gray loam.

The minor soils are Copaston, Dickman, Estherville, Wadena, Terril, Lemond, Mayer, and Oshawa soils. Copaston, Dickman, Estherville, and Wadena soils are well drained. Terril soils are moderately well drained. Lemond and Mayer soils are poorly drained. All of these soils are in isolated, elevated areas on flood plains and terraces. They are not subject to flooding. Oshawa soils are poorly drained and are in swales and old oxbows and are subject to frequent flooding.

The soils that make up this association are used mainly for pasture and crops. Corn and soybeans are the most common crops. The flooding and wetness are the main concerns in management. Areas that are frequently flooded are in permanent pasture. Native grasses provide good grazing if the soil is properly fertilized. Areas that are occasionally flooded are commonly used for crops. Flooding generally occurs early in spring before crops are planted, but crops are damaged in some years if flooding occurs after planting.

The soils are generally not suited to use as sites for buildings or septic tank absorption fields because of the flooding. The areas are narrow, and more suitable sites are generally in adjacent higher positions that are not subject to flooding.

7. Terril-Swanlake-Storden Association

Well drained and moderately well drained, steep and very steep soils that formed in glacial till and in local alluvium derived from glacial till; on river bluffs and foot slopes

The soils that make up this association are on bluffs, escarpments, and associated foot slopes and fans along the Minnesota and Redwood Rivers. The bluffs and escarpments are 100 to 200 feet above the flood plain.

This association makes up about 1 percent of the county. It is about 40 percent Terril soils, 20 percent Swanlake soils, and 15 percent Storden soils. Soils of minor extent make up the remaining 25 percent.

The Terril soils are moderately well drained. They are on foot slopes. Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is about 26 inches thick. It is black loam in the upper part and very dark brown loam in the lower part. The subsoil is dark brown, mottled loam about 18 inches thick. The underlying material to a depth of about 60 inches is olive brown loam.

The Swanlake soils are well drained. They are on summits and shoulders along bluffs and escarpments. Typically, the surface layer is black loam about 9 inches thick. The underlying material to a depth of about 60 inches is brown and light olive brown loam.

The Storden soils are well drained. They are on convex summits and side slopes. Typically, the surface layer is dark grayish brown loam about 8 inches thick. The underlying material extends to a depth of about 60 inches. It is dark brown and olive brown loam in the upper part and light olive brown loam in the lower part.

The minor soils are Salida, Copaston, Ves, and Millington soils. Also included in this association are small areas where bedrock is exposed at the surface. Salida soils are excessively drained and are on side slopes and escarpments. The parent material in these soils is outwash materials. Copaston soils are well drained and are on side slopes. Bedrock is close to the surface in these soils. Ves soils are well drained and are on the convex parts of the side slopes. Millington soils are poorly drained and are on the flood plains at the base of bluffs and escarpments.

The soils that make up this association are mainly in permanent pasture or woodland. The main concern in management is the hazard of erosion. Many trees and shrubs grow well on these soils. The suitability of these soils for habitat for upland wildlife and for recreational uses is good.

Slope is the main limitation for use of the soils as sites for buildings and septic tank absorption fields. Large amounts of cut and fill material are generally required. Side slope seepage can occur in septic tank absorption fields. Sites that are more suitable for buildings are generally nearby on adjacent uplands that are not as steeply sloping.

8. Wadena Variant-Rock outcrop-Copaston Association

Rock outcrop and well drained and moderately well drained, nearly level to very steep soils that formed in glacial drift and alluvium; on terraces

The soils that make up this association are on terraces and associated escarpments in the Minnesota River Valley. The slopes are complex. In most areas, stones and boulders are scattered on the surface.

This association makes up about 1 percent of the county. It is about 25 percent Wadena Variant soils, 20 percent Rock outcrop, and 15 percent Copaston soils. Soils of minor extent make up the remaining 40 percent.

The Wadena Variant soils are moderately well drained and well drained. They are on terraces underlain by bedrock. Typically, the surface layer is black loam about 11 inches thick. The subsoil is dark grayish brown loam about 7 inches thick. The underlying material to a depth of about 32 inches is light yellowish brown and pale brown loam underlain by igneous and metamorphic bedrock.

The Rock outcrop that makes up this association is in nearly level to very steep areas. It consists of igneous and metamorphic rock and is mostly gneiss.

The Copaston soils are well drained. They are in nearly level to very steep areas. Bedrock is near the surface of the soils. Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown sandy loam about 5 inches thick. The subsoil is dark brown sandy loam about 4 inches thick. The underlying material is igneous and metamorphic bedrock.

The minor soils are Du Page, Terril, Millington, and Oshawa Variant soils. None of these soils have bedrock within 60 inches of the surface. Du Page and Terril soils are moderately well drained and are on concave foot slopes on bottom lands at the base of bluffs and escarpments. Du Page soils are subject to occasional flooding. The Millington soils are poorly drained, and the Oshawa Variant soils are very poorly drained. Both of these soils are in depressional areas on the flood plains and are subject to flooding and ponding.

Nearly all areas of the soils in this association are in permanent pasture or in woodland. These soils support a fair stand of native grasses. The woodland consists mostly of cedar trees. The main concerns in management are droughtiness and the shallow depth to bedrock. The soils are generally not suited to crops because of the shallow depth to bedrock and complex slopes. These soils are well suited to openland or woodland wildlife habitat.

The soils are generally not suited to use as sites for buildings or septic tank absorption fields because of the shallow depth to bedrock in many places. There are quarries in some areas.

Detailed Soil Map Units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and Management of the Soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

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 material, 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 material. 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, Ves loam, 1 to 4 percent slopes, is one of several phases in the Ves series.

Some map units are made up of two or more major soils. These map units are called soil complexes. A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Ves-Estherville-Storden complex, 3 to 6 percent slopes, eroded, is an example.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 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.

Soil Descriptions

27A—Dickinson fine sandy loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on stream benches and outwash plains. Individual areas of this soil are circular or oblong and range from 4 to about 250 acres in size.

Typically, the surface layer is black fine sandy loam about 7 inches thick. The subsurface layer is black and very dark gray fine sandy loam about 10 inches thick. The subsoil is dark brown and dark yellowish brown fine sandy loam about 19 inches thick. The underlying material to a depth of about 60 inches is yellowish brown fine sand. In some places, this soil has a clay loam or silt loam surface layer. The underlying material, in some places, is stratified, loamy and silty sediments. Also, in some places, the surface layer has become loamy sand or sand by the addition of windblown material.

Included in mapping are small areas of Wadena soils. These soils are well drained. They are on rises. Wadena soils are more clayey and have less sand in the upper part of the profile than the Dickinson soil. Also included are areas of Linder and Hanska soils. Linder soils are somewhat poorly drained. They are in slightly concave or plane positions on the landscape. Hanska soils are poorly drained. They are in swales and drainageways. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Dickinson soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium. The available water capacity is low or moderate. The organic matter content is moderate. The available phosphorus is low to medium, and the available potassium is high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn, soybeans, or small grains. It has fair potential for the crops commonly grown in the county. The major limitation is the low to moderate available water capacity of the soil. This soil is well suited to early maturing crops, such as small grains that generally mature before the hot, dry summer weather. If the summer is hot and dry, corn and soybean yields are lower because of insufficient soil moisture. Soil blowing is a concern in management if this soil is bare. Leaving all or part of the crop residue on the surface helps reduce soil blowing.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low to moderate available water capacity and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings. Constructing roads on well compacted, suitable base material helps prevent damage caused by frost action.

This soil readily absorbs the effluent in a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of septic tank effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Dickinson soil is in capability subclass IIs.

27B—Dickinson fine sandy loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil in convex positions on stream benches, outwash plains, and uplands. Most areas of this soil are dissected by shallow drainageways. Individual areas are circular or oblong and range from 4 to 20 acres in size.

Typically, the surface layer is black fine sandy loam about 7 inches thick. The subsurface layer is black and very dark grayish brown fine sandy loam about 10 inches thick. The subsoil is dark brown, friable fine sandy loam about 15 inches thick. The underlying material to a depth of about 60 inches is yellowish brown loamy fine sand and sand. In some places, the underlying material is stratified loamy or silty sediments; or the upper part of the surface layer has become loamy sand by the addition of wind-blown material. In some places, erosion has exposed the dark brown subsoil, and the loamy mantle is thinner than typical.

Included in mapping are small areas of Estherville, Linder, and Hanska soils. Estherville soils are well drained. They are on knolls and ridges. Estherville soils have more sand in the upper mantle than the Dickinson soil. Linder soils are somewhat poorly drained. They are in slightly concave or plane positions on the landscape. Hanska soils are poorly drained. They are in swales and drainageways. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Dickinson soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium. The available water capacity is low or moderate. The organic matter content is moderate. The available phosphorus is low to medium, and the available potassium is high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn, soybeans, and small grains. It has fair potential for the crops commonly grown in the county. The major limitation is the low to moderate available water capacity of the soil. In addition, erosion is a hazard. Because of droughtiness, this soil is best suited to early maturing crops, such as small grains that generally mature before the hot, dry summer weather. If the summer is hot and dry, corn and soybean yields are reduced because of insufficient soil moisture. Soil blowing is a concern in managment if the soil is bare. Leaving all or part of crop residue on the surface helps reduce soil blowing.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low to moderate available water capacity of this soil and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suitable as a site for dwellings. Constructing roads on well compacted, suitable base material helps prevent damage caused by frost action.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of septic tank effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Dickinson soil is in capability subclass IIe.

31E—Storden loam, 18 to 25 percent slopes. This is a steep, well drained soil on convex slopes along streams on glacial moraines. Most areas of this soil are dissected by drainageways and gullies. Individual areas are oblong or irregular in shape and range from 5 to about 20 acres in size.

Typically, the surface layer is dark grayish brown loam about 10 inches thick. The underlying material extends to a depth of 60 inches or more. It is dark brown and olive brown loam in the upper part and light olive brown loam in the lower part. In some areas, erosion has exposed the underlying material. In some places, the surface layer is darker than typical.

Included in mapping are small areas of Terril and Ves soils. Terril soils are moderately well drained. They are on toe slopes. Ves soils are well drained. They are on the side slopes and have a thicker and darker surface layer than that of the Storden soil. Also included are areas of soils on small, sandy and gravelly knolls. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Storden soil is moderate. Surface runoff is rapid. The available water capacity is high. The organic matter content is low. The available potassium is low, and the available phosphorus is medium to high. The seasonal high water table is at a depth of more than 6 feet.

This soil generally is not suited to crops because of the steep slopes. It is suited to pasture and in most places is used for pasture. Because runoff is rapid on the steep slopes, however, drought is a hazard. Grazing is limited to late in spring and early in summer. Erosion is a severe hazard if the pasture is overgrazed.

Trees and shrubs that are tolerant of the high content of lime in the soil should be selected for windbreaks and environmental plantings. Erosion is a concern in management. Site preparation should be limited to the area within 2 feet of the planting to minimize erosion. Because the soil is moderately alkaline and erosion is a hazard, optimum growth and survival are not expected. Competing plants can be controlled by cultivation or by herbicides.

Slope is the main limitation to use of this soil as sites for buildings. Extensive land shaping generally is needed, and buildings should be designed to conform to the natural slope. Large amounts of cut and fill material generally are needed in constructing roads on this soil. Roads should be placed on the contour and roadbanks planted to well adapted grasses to minimize erosion.

For septic tank absorption fields to function properly on this soil, land shaping is necessary in most places and the distribution lines should be installed across the slope.

This Storden soil is in capability subclass VIe.

31F—Storden loam, 25 to 40 percent slopes. This is a very steep, well drained soil on convex slopes parallel to streams and large drainageways on glacial moraines. Most areas of this soil are dissected by drainageways. Individual areas are oblong or irregular in shape and range from 5 to about 80 acres in size.

Typically, the surface layer is dark grayish brown loam about 8 inches thick. The underlying material extends to a depth of 60 inches or more. It is grayish brown loam in the upper part and brown loam in the lower part. In some places, the surface layer and underlying material are sandy loam, or the underlying material has sandy strata, or the surface layer is darker than typical.

Included in mapping are small areas of Terril soils, which are moderately well drained. They are on the lower part of side slopes. Also included are areas of soils on sandy and gravelly knolls. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Storden soil is moderate. Surface runoff is very rapid. The available water capacity is high. The organic matter content is low. The available potassium is low, and the available phosphorus is medium to high. The seasonal high water table is at a depth of more than 6 feet.

This soil generally is not suited to crops because of the very steep slopes. It is suited to pasture and in most places is used for pasture. Runoff is rapid on the very steep slopes, however, and, as a result, drought is a hazard. Grazing is limited to late in spring and early in summer. Erosion is a severe hazard if the pasture is overgrazed.

This soil generally is not suitable for windbreaks, but it is suitable for environmental plantings. Slope is the main concern in management. Hand planting generally is necessary. Optimum growth and survival are not expected.

This soil generally is not suited to use as sites for buildings, local roads, or septic tank absorption fields because of very steep slopes.

This Storden soil is in capability subclass VIIe.

39A—Wadena loam, 0 to 2 percent slopes. This is a nearly level, well drained soil in plane to slightly convex or concave positions on outwash plains and terraces. Individual areas of this soil are irregular in shape and range from 3 to about 230 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 5 inches thick. The subsoil is dark brown, friable loam about 16 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places, the surface layer has become sandy loam by the addition of wind-blown material. In some places, the underlying material contains silty strata.

Included in mapping are small areas of Biscay, Mayer, and Dickman soils. Biscay and Mayer soils are poorly drained. They are in drainageways. Dickman soils are well drained. They are on knobs and knolls. Dickman soils have more sand and less clay in the upper mantle than the Wadena soil. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Wadena soil is moderate in the surface layer, subsurface layer, and subsoil and rapid in the underlying material. Surface runoff is medium. The available water capacity is low or moderate. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn, soybeans, and small grains. It has fair potential for the crops commonly grown in the county. The major limitation is the low to moderate available water capacity of the soil. Good yields of small grains are generally obtained because they mature before the dry, hot weather of late July and August. If the summer is hot and dry, corn and soybean yields are lower because of insufficient soil moisture. If this soil is plowed in the fall, soil blowing can occur. Leaving all or part of crop residue on the surface of the soil helps to maintain organic matter content and soil tilth and reduces soil blowing.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low or moderate available water capacity and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings and for local roads.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of septic tank effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Wadena soil is in capability subclass IIs.

39B—Wadena loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil in slightly convex or concave positions on outwash plains, terraces, and uplands. Individual areas of this soil are irregular in shape and range from 4 to about 70 acres in size.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is very dark gray loam about 5 inches thick. The subsoil is about 16 inches thick. It is friable, dark brown loam in the upper part and friable, yellowish brown loam in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown gravelly coarse sand. In some places on knolls and crests, the dark surface layer is less than 12 inches thick. In places in nearly level areas and swales, the surface layer is more than 20 inches thick. In some places, the upper part of the surface layer has become sandy loam by the addition of wind-blown material.

Included in mapping are small areas of Biscay and Mayer soils. These soils are poorly drained. They are in drainageways. Also included at the base of side slopes and drainageways are some areas of soils that are underlain by silty sediments. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Wadena soil is moderate in the surface layer, subsurface layer, and subsoil and rapid in the underlying material. Surface runoff is medium. The available water capacity is low to moderate. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for crops. Corn, soybeans, and small grains are the major crops grown. This soil has fair potential for the crops commonly grown in the county, but it is better suited to small grains than to corn and soybeans. The major limitations are the low to moderate available water capacity of the soil and the hazard of erosion. This soil is best suited to early maturing crops, such as small grains that generally mature before the hot, dry summer weather. Fair crops of corn and soybeans can be produced on this soil except during periods of prolonged drought. Soil blowing can occur if this soil is plowed in the fall. Leaving all or part of crop residue on the surface helps to maintain organic matter content and soil tilth and reduces soil blowing. Grassed waterways and terraces help to control erosion.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low to moderate available water capacity of the soil and the coarse textured underlying material also limit kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings and roads.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of septic tank effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Wadena soil is in capability subclass IIe.

41A—Estherville sandy loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on outwash plains and terraces. Individual areas of this soil are oblong or irregular in shape and range from 3 to about 320 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is brown, friable coarse sandy loam about 5 inches thick. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand. In some places, the surface layer is more than 18 inches thick. In some places, the sandy underlying material is only a few feet thick and is underlain by glacial till or silty alluvium.

Included in mapping are small areas of Wadena and Salida soils. The Wadena soils are well drained. They are in slightly concave positions. Wadena soils are more clayey in the upper part than the Estherville soil. Salida soils are excessively drained. They are on convex knobs. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Estherville soil is moderately rapid in the upper part and rapid in the underlying material. Surface runoff is slow. The available water capacity is low. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for corn, soybeans, and small grains. It has poor potential for corn and soybeans because of insufficient moisture in July and August. When rainfall is adequate, however, corn yields are good. This soil is best suited to early maturing crops, such as oats, wheat, and hay. The major limitation is the low available water capacity, and soil blowing is a hazard, especially in spring.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low available water capacity and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suitable for sites for buildings and local roads.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of the effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Estherville soil is in capability subclass IIIs.

41B—Estherville sandy loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on convex slopes on outwash plains and terraces. Individual areas of this soil are irregular in shape and range from 3 to about 160 acres in size.

Typically, the surface layer is black sandy loam about 9 inches thick. The subsoil is a dark brown, friable sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is brown gravelly coarse sand. In some places, the upper part of the surface layer has become loamy sand by the addition of wind-blown material. In some places, the sandy underlying material is only a few feet thick and is underlain by glacial till or silty alluvium.

Included in mapping are small areas of Salida and Wadena soils. Salida soils are excessively drained. They are on crests and side slopes. Wadena soils are well drained. They are in slightly concave positions. Wadena soils are more clayey in the upper part than the Estherville soil. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Estherville soil is moderately rapid in the upper part and rapid in the underlying material. Surface runoff is medium. The available water capacity is low. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil is used mainly for corn, soybeans, and small grains. It has poor potential for corn and soybeans because of insufficient moisture in July and August. When rainfall is adequate, however, corn yields are good. This soil is best suited to early maturing crops, such as oats, wheat, and hay. The major limitation is the low available water capacity, and soil blowing is a hazard, especially in spring.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low available water capacity and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suitable for sites for buildings and local roads.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of the effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Estherville soil is in capability subclass IIIs.

42C—Salida gravelly sandy loam, 2 to 12 percent slopes. This is a gently sloping and sloping, excessively drained soil on convex slopes on terraces, outwash plains, and uplands. Individual areas of this soil are irregular in shape or circular and range from 3 to about 30 acres in size.

Typically, the surface layer is very dark gray gravelly sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown, dark yellowish brown, and yellowish brown very gravelly sand and gravelly coarse sand. Erosion has exposed the sandy underlying material in spots. In some places, the topsoil has become loamy sand by the addition of wind-blown material.

Included in mapping are small areas of Estherville and Wadena soils. Estherville and Wadena soils are well drained. They are on side slopes and in swales. The included soils make up 5 to 10 percent of the map unit.

The permeability of the Salida soil is very rapid. Surface runoff is slow. The available water capacity is very low. The organic matter content is low. The available potassium is low, and the available phosphorous is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil generally is not suited to crops. It is poorly suited to pasture, but in most areas this soil is used for pasture. Gravel pits are common throughout areas of this soil. The major limitation is the very low available water capacity of the soil. This soil can provide some grazing early in the spring. Areas of this soil generally are in native grass because the soil is too shallow to gravel to produce a suitable seedbed. Wind and water erosion are hazards.

This soil generally is not suited to trees and shrubs for use as windbreaks and environmental plantings. The main limitation is the very low available water capacity of the soil. Seedling mortality is high.

Slope is the main limitation to use of this soil as sites for buildings. Buildings constructed on this soil should be designed to conform to the natural slope. Land shaping may be necessary in some areas. Roads constructed on this soil should be run on the contour, when possible, and roadbanks planted to well adapted grasses to minimize erosion.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. The poor filtering capacity can result in pollution of the ground water.

This Salida soil is in capability subclass VIs.

42E—Salida gravelly sandy loam, 12 to 35 percent slopes. This is a moderately steep to very steep, excessively drained soil on convex slopes on terraces, outwash plains, and uplands. Individual areas of this soil are irregular in shape and range from 3 to about 35 acres in size.

Typically, the surface layer is very dark gray gravelly sandy loam about 8 inches thick. The underlying material to a depth of about 60 inches is yellowish brown very gravelly coarse sand. Erosion has exposed the sandy underlying material in spots. In some places, the topsoil has become loamy sand by the addition of wind-blown material.

Included in mapping are small areas of Estherville and Wadena soils. Estherville and Wadena soils are well drained. They are on side slopes and in swales. The included soils make up 3 to 10 percent of the map unit.

The permeablity of the Salida soil is very rapid. Surface runoff is slow. The available water capacity is very low. The organic matter content is low. The available potassium is low, and the available phosphorus is medium. The seasonal high water table is at a depth of more than 6 feet.

This soil generally is not suited to crops. It is poorly suited to pasture, but in most areas this soil is used for pasture. The major limitation is droughtiness, which is caused by the very low available water capacity of the soil. This soil can provide some grazing early in the spring. Areas of this soil generally are in native grasses because the soil is too steep to cultivate.

This soil generally is not suited to trees and shrubs for use as windbreaks and environmental plantings. The main limitations are the very low available water capacity of the soil and the steep slopes. Seedling mortality is high.

Slope is the main limitation to use of this soil as sites for buildings. Extensive land shaping generally is needed, and buildings should be designed to conform to the natural slope. Large amounts of cut and fill material generally are needed when constructing roads on this soil. Roads should be run on the contour, where possible, and roadbanks planted to well adapted grasses to minimize the erosion hazard.

This soil is poorly suited to use as septic tank absorption fields because of the steep slopes and because it does not adequately filter the effluent. The poor filtering capacity can result in pollution of the ground water.

This Salida soil is in capability subclass VIIs.

86—Canisteo clay loam. This is a nearly level, poorly drained, calcareous soil on the rims of depressions and on slightly convex, broad lowlands. Individual areas of this soil are irregular in shape and range from 4 to about 2,000 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black and very dark gray clay loam about 13 inches thick. The subsoil is grayish brown, friable clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is grayish brown and light brownish gray, mottled loam. In some areas, the surface layer is more than 24 inches thick. In some places, the underlying material is silty.

Included in mapping are small areas of Glencoe, Okoboji, Seaforth, and Webster soils. Glencoe and Okoboji soils are very poorly drained. They are in depressions. Webster soils are poorly drained and are noncalcareous. Webster and the Canisteo soils are in similar positions on the landscape. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Canisteo soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium. The seasonal high water table ranges from 1 to 3 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, this soil has good potential for all crops commonly grown in the county. The major limitation is wetness. In addition, soil blowing is a hazard on this soil. Applications of potash and phosphate correct the fertility imbalance in the soil, which is caused by a high content of lime. Leaving all or part of the crop residue on the surface and restricting field operations during wet periods help to maintain optimum infiltration, fertility, and tilth. If this soil is tilled when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of the high content of lime in the soil and the excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

This Canisteo soil is in capability subclass IIw.

94B—Terril loam, 2 to 6 percent slopes. This is a gently sloping, moderately well drained soil on foot slopes and alluvial fans. The slopes are slightly concave, and areas are generally dissected by shallow drainageways. Individual areas of this soil are elongated and narrow and range from 3 to about 100 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 24 inches thick. The subsoil is dark brown and dark yellowish brown loam about 26 inches thick. In some places, the underlying material has sandy strata. In some more sloping areas, the surface layer is less than 24 inches thick and depth to calcareous glacial till is less than 40 inches. In some places, the surface layer is more than 36 inches thick.

Included in mapping are small areas of Delft and Normania soils. Delft soils are poorly drained. They are on foot plains and toe slopes. Normania soils are moderately well drained. They are on slightly convex side slopes. Normania soils have a thinner surface layer than that of the Terril soil. The included soils make up 5 to 10 percent of the map unit.

The permeability of the Terril soil is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. The hazard of erosion is the main concern in management. Contour farming and leaving large amounts of crop residue on the surface help control erosion. Drainageways that are shaped, seeded, and maintained as grassed waterways reduce the hazard of gully erosion.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings and septic tank absorption fields. Constructing roads on well compacted, suitable base fill material helps prevent damage caused by low soil strength.

This Terril soil is in capability subclass IIe.

94C—Terril loam, 6 to 12 percent slopes. This is a sloping, moderately well drained soil on foot slopes and alluvial fans. The slopes are slightly concave and are generally dissected by drainageways. Individual areas of this soil are elongated and narrow and range from 3 to about 160 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 26 inches thick. The subsoil is mottled, dark brown, friable loam about 20 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown loam. In some places, the underlying material has thin sandy strata. In some places, the surface layer is less than 24 inches thick or more than 36 inches thick, and calcareous glacial till is at a depth of less than 40 inches.

Included in mapping are small areas of Delft and Normania soils. Delft soils are poorly drained. They are on foot slopes and toe slopes. Normania soils are moderately well drained. They are on slightly convex side slopes. Normania soil has a thinner surface layer than the Terril soil. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Terril soil is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn and soybeans. It has fair potential for the crops commonly grown in the county. The major hazard is erosion. Contour farming and leaving large amounts of crop residue on the surface control erosion. Drainageways that are shaped, seeded, and maintained as grassed waterways reduce the hazard of gully erosion.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. The hazard of erosion is a management concern. Site preparation should be limited to the area within 2 feet of the planting to minimize erosion. Competing plants can be controlled by cultivation or by herbicides.

Buildings constructed on this soil should be designed to conform to the natural slope, and land shaping may be necessary. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength. For septic tank absorption fields to function properly on this soil, land shaping is necessary in most places and the distribution lines should be installed across the slope.

This Terril soil is in capability subclass IIIe.

113—Webster clay loam. This is a nearly level, poorly drained soil in swales and broad, concave areas on till plains. Individual areas of this soil are elongated and range from 4 to about 3,000 acres in size.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is black clay loam about 9 inches thick. The subsoil is gray clay loam about 14 inches thick. The underlying material to a depth of about 60 inches is a light gray, mottled clay loam in the upper part and mottled, olive loam in the lower part. In some areas, free lime is in the lower part of the surface layer. In some places on flat ridgetops, the subsoil has more clay than typical and is thicker.

Included in mapping are small areas of Canisteo, Glencoe, Okoboji, Normania and Seaforth soils. Canisteo soils are poorly drained and are calcareous. They are in slightly convex areas. Glencoe and Okoboji soils are very poorly drained. They are in depressions. Normania and Seaforth soils are moderately well drained. They are on slight rises. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Webster soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is high. The seasonal high water table is at a depth of 1 to 2 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, it has good potential for the crops commonly grown in the county. The major limitation is wetness. Leaving all or part of the crop residue on the surface of the soil and restricting field operations during periods of wetness help to maintain good soil tilth. If the soil is tilled in the fall, crops can be planted early in the spring. If this soil is plowed when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed in an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Webster soil is in capability subclass IIw.

114—Glencoe silty clay loam. This is a level, very poorly drained soil in closed depressions or in low-gradient swales. Individual areas of this soil are circular or irregular in shape and range from 4 to about 100 acres in size. This soil is subject to ponding.

Typically, the surface layer is black silty clay loam about 16 inches thick. The subsurface layer is very dark gray silty clay loam about 10 inches thick. The subsoil is olive gray, mottled, friable silty clay loam about 7 inches thick. The underlying material to a depth of about 60 inches is olive and light olive brown, mottled clay loam. In some places, the underlying material is stratified sandy and silty sediments. Also, in some depressions, free lime is at or near the surface.

Included in mapping are small areas of Canisteo and Okoboji soils. Canisteo soils are poorly drained. They are on slight rises or on the rims of depressions. Okoboji soils are very poorly drained. They are near the center of depressions. Okoboji soils have more clay in the surface and subsurface layers and in the subsoil than the Glencoe soil. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Glencoe soil is moderate or moderately slow. Surface runoff is slow to ponded. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is near or above the surface layer.

In most areas, this soil is used for corn and soybeans. If adequately drained, this soil has good potential for the crops commonly grown in the county. The major limitations are wetness and the ponding. During prolonged periods of wetness, growth is reduced. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase crop yields and maintain good soil tilth. Tilling the soil in the fall helps maintain good soil tilth. If the soil is tilled when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Ponding for long periods increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the ponding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by ponding, frost action, and low soil strength.

This Glencoe soil is in capability subclass IIIw.

128A—Grogan loam, 0 to 2 percent slopes. This is a nearly level, well drained or moderately well drained soil on plane or slightly convex slopes. Individual areas of this soil are elongated or irregular in shape and range from 4 to about 25 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is friable very fine sandy loam about 19 inches thick. It is dark brown in the upper part and mottled dark yellowish brown in the lower part. The underlying material to a depth of about 60 inches is yellowish brown very fine sandy loam with bands of silt loam. In some places, carbonates are closer to the surface than is typical. In some places, the soil is fine sandy loam or sandy loam above the underlying material. In some places, glacial till is at a depth of 3 feet.

Included in mapping are small areas of Hanska and Lemond soils. Hanska and Lemond soils are poorly drained. They are in drainageways and on concave foot slopes. Also included are some areas, high in the Minnesota River Valley, of soils having bedrock at a depth of 4 to 10 feet. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Grogan soil is moderately rapid. Surface runoff is slow. The available water capacity is high. The organic matter content is moderate. The available phosphorus is low, and the available potassium is high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. Soil blowing is a management concern. Leaving large amounts of crop residue on the surface reduces soil blowing.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings and septic tank absorption fields. Constructing roads on well compacted, suitable base material helps prevent damage caused by frost action.

This Grogan soil is in capability class I.

128B—Grogan loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on knolls and side slopes. Individual areas of this soil are elongated or irregular in shape and range from 4 to about 50 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark grayish brown loam about 6 inches thick. The subsoil is dark yellowish brown and yellowish brown, friable loam and silt loam about 19 inches thick. The underlying material to a depth of about 60 inches is yellowish brown very fine sandy loam with bands of silt loam. In some places, the surface layer is coarser textured because wind has blown the finer particles away. In a few places, carbonates are at a depth of less than 20 inches. In some places, stones or a thin gravelly layer is at a depth of 3 feet or less.

Included in mapping are small areas of Hanska and Linder soils. Hanska soils are poorly drained. They are in drainageways. Linder soils are somewhat poorly drained. They are in slightly concave areas. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Grogan soil is moderately rapid. Surface runoff is slow. The available water capacity is high. The organic matter content is moderate. The available phosphorus is low, and the available potassium is high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. The major hazard is erosion. Soil blowing is also a hazard if the soil is plowed in the fall. Leaving large amounts of crop residue on the surface and contour farming reduce erosion and soil blowing.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings and septic tank absorption fields. Constructing roads on well compacted, suitable base material helps prevent damage caused by frost action.

This Grogan soil is in capability subclass IIe.

134—Okoboji silty clay loam. This is a level, very poorly drained soil in depressions. Individual areas of this soil are circular or oblong and range from 4 to about 160 acres in size. This soil is subject to ponding (fig. 7).

Typically the surface layer is black silty clay loam about 8 inches thick. The subsurface layer is also black silty clay loam about 40 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled silty clay loam. In some places, clay loam till is at a depth of 4 feet or less. Also, in some places, the surface layer is less than 24 inches thick.

Included in mapping are small areas of Knoke and Canisteo soils. Knoke soils are very poorly drained and are calcareous. They and the Okoboji soils are in similar positions on the landscape. Canisteo soils are poorly drained. They are on the rims of depressions. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Okoboji soil is moderately slow. Surface runoff is slow to ponded. The available water capacity is high. The organic matter content is very high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is near or above the surface.

In most areas, this soil is used for corn and soybeans. If adequately drained, it has good potential for the crops commonly grown in the county. The major limitation is wetness. During periods of prolonged wetness, ponding damages crops or reduces crop growth. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase and maintain good soil tilth. If the soil is tilled in the fall,

Figure 7.—Ponding after an intensive rainfall on an area of Okoboji silty clay loam.

crops can be planted early in the spring. If the soil is tilled when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Ponding for long periods increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the ponding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by ponding, frost action, and low soil strength.

This Okoboji soil is in capability subclass IIIw.

149B—Everly clay loam, 2 to 4 percent slopes. This is a gently undulating, well drained soil on convex slopes on uplands. The slopes typically are about 200 feet in length. Individual areas of this soil are circular or oblong and range from 4 to about 150 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is very dark grayish brown clay loam about 6 inches thick. The subsoil is about 26 inches thick. It is dark brown, friable clay loam in the upper part and yellowish brown, friable to firm clay loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown clay loam. In some places, the underlying material is at a depth of 42 inches or more. In some areas, the surface layer is sandy loam.

Included in mapping are small areas of Letri and Wilmonton soils. Letri soils are poorly drained. They are in wet drainageways. Wilmonton soils are moderately well drained. They are on slightly concave slopes and in swales. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Everly soil is moderately slow. Surface runoff is medium. The available water capacity is high. Organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. Erosion is a slight hazard. In many areas, terracing and contour farming are difficult because of the short complex or irregular slopes. Grassed waterways and conservation tillage help control erosion and surface water runoff. Leaving crop residue on the surface and applying fertilizer help to maintain the organic matter content of the soil and to maintain good soil tilth. If the soil is plowed in the fall, large amounts of crop residue should be left on the surface to control erosion.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on this soil, the foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. In addition, backfilling around the foundation with a suitable coarse material also protects the building from structural damage. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength.

This soil cannot readily absorb the effluent from a septic tank absorption field because of its slow permeability. This limitation can be overcome by installing a larger field than average.

This Everly soil is in capability subclass IIe.

149B2—Everly clay loam, 3 to 6 percent slopes, eroded. This is a gently undulating, well drained soil on convex slopes on upland till plains. The slopes, typically, are about 200 feet in length, and they have a well developed drainage system. Most areas of the soil are dissected by shallow drainageways. Individual areas are circular or oblong and range from 4 to about 100 acres in size.

Typically, the surface layer is very dark gray clay loam about 10 inches thick. The subsoil is about 16 inches thick. It is friable, dark brown clay loam in the upper part and friable, dark yellowish brown loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown and grayish brown, calcareous loam. The surface layer has a grayish cast because of erosion and because part of the subsoil has been mixed into the surface layer. In some places, the surface layer is thinner than is typical, and erosion has exposed the subsoil in spots. Also in some places, the surface layer is sandy loam.

Included in mapping are small areas of Letri, Wilmonton, and Storden soils. Letri soils are poorly drained. They are in drainageways and on toe slopes. Wilmonton soils are moderately well drained. They are on slightly concave slopes and in swales. Storden soils are well drained. They are on shoulders of slopes. Storden soils have free carbonates throughout. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Everly soil is moderately slow. Surface runoff is medium. The available water capacity is high. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. The major concern is the moderate hazard of erosion. In many areas, terracing and contour farming are difficult because of the short complex or irregular slopes. Conservation tillage and grassed waterways control water runoff and erosion. Leaving crop residue on the surface, rotating crops, and applying fertilizer help to maintain organic matter content and good soil tilth and to control erosion. If this soil is plowed in the fall, leaving a rough surface and some crop residue helps hold snow on the ground and controls erosion.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on this soil, the foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. In addition, backfilling around the foundation with a suitable coarse material also prevents structural damage. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength.

This soil cannot readily absorb the effluent from a septic tank absorption field because of its slow permeability. This limitation can be overcome by installing a larger field than average.

This Everly soil is in capability subclass IIe.

227—Lemond loam. This is a nearly level, poorly drained soil on nearly plane or slightly convex slopes on the rims of depressions and broad flats. Individual areas of this soil generally are elongated and range from 4 to about 500 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is very dark gray sandy loam about 6 inches thick. The subsoil is grayish brown and olive gray, mottled, very friable sandy loam about 14 inches thick. The underlying material to a depth of about 60 inches is olive gray, mottled loamy coarse sand. In some places, the underlying material has silty layers. Glacial till is at a depth of 3 feet in some places.

Included in mapping are small areas of Biscay, Hanska, and Linder soils. Biscay soils are very poorly drained. They are in swales. Hanska soils are poorly drained and are noncalcareous. They are in slightly concave areas. Linder soils are somewhat poorly drained. They are on slight knolls. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Lemond soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is slow. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is at a depth of 0 to 3 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, it is well suited to the crops commonly grown in the county. Wetness is the major limitation. Liberal applications of potash and phosphate generally are needed to offset the effect of the high content of lime in the soil. Soil blowing can occur in some large, open areas. Leaving all or part of the crop residue on the surface and restricting field operations during periods of wetness reduce soil blowing and help maintain good soil tilth.

Trees and shrubs that are tolerant of the high content of lime in the soil and excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as building sites because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Constructing roads on raised suitable base material and providing adequate side ditches and culverts minimize wetness problems and help prevent damage caused by frost action.

Subsurface seepage trenches for treatment of effluent from septic tank absorption fields cannot be used on the soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Lemond soil is in capability subclass IIw.

241—Letri clay loam. This is a nearly level, poorly drained soil on plane to slightly concave slopes or dissected till plains. Individual areas of this soil are oblong and range from 4 to about 900 acres in size (fig. 8).

Typically, the surface layer is black clay loam about 12 inches thick. The subsurface layer is black clay loam about 6 inches thick. The subsoil is about 15 inches thick. It is dark grayish brown, friable clay loam in the upper part and grayish brown, mottled, firm to friable clay loam in the lower part. The underlying material to a depth of about 60 inches is light brownish gray, mottled loam in the upper part and light olive brown, mottled loam in the lower part. In some places, the surface layer and subsoil contain gypsum. In some places, thin layers of sandy material are in the lower part of the soil.

Included in mapping are small areas of Delft, Okoboji, and Wilmonton soils. Delft soils are poorly drained. They are on foot slopes and toe slopes. Delft soils have a thicker surface layer than the Letri soil. Okoboji soils are very poorly drained. They are in depressions. Wilmonton soils are moderately well drained. They are in higher positions on the landscape than the Letri soil. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Letri soil is moderately slow. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at a depth of 1/2 to 2 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, this soil is well suited to the crops commonly grown in the county. The major limitation is wetness. Leaving all or part of the crop residue on the surface, seeding and maintaining grassed waterways, and restricting tillage operations during periods of wetness improve infiltration, permeability, and soil tilth. If the soil is tilled in the fall, crops can be planted early in the spring. If the soil is tilled when wet, clods form and compaction is likely.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Constructing roads on raised suitable base material and providing adequate side ditches and culverts minimize the wetness problems and help prevent damage caused by frost action and low soil strength.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Letri soil is in capability subclass IIw.

247—Linder loam. This is a nearly level, somewhat poorly drained soil on nearly plane or slightly convex outwash plains and stream benches. Individual areas of this soil are oblong or irregular in shape and range from 4 to about 70 acres in size.

Figure 8.—Grassed waterway in an area of Letri clay loam.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 8 inches thick. The subsoil is about 10 inches thick. It is dark grayish brown, friable sandy loam in the upper part and grayish brown, friable sandy loam in the lower part. The underlying material to a depth of about 60 inches is grayish brown coarse sand. In some places, the subsoil has thin silty strata, or the underlying material is at a depth of more than 42 inches, or the lower part of the surface layer is calcareous.

Included in mapping are small areas of Estherville, Lemond, and Mayer soils. Estherville soils are well drained. They are on knolls and knobs. Lemond and Mayer soils are poorly drained. They are in slightly convex positions on the landscape lower than the Linder soil. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Linder soil is moderately rapid in the surface and subsurface layer and in the upper part of the subsoil and very rapid in the underlying material. Surface runoff is slow. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at a depth of 2 to 4 feet.

In most areas, this soil is used for corn and soybeans. It has fair suitability for most crops grown in the county but is best suited to small grains and other early maturing crops. The main limitation is the moderate available water capacity of the soil. In addition, soil blowing is a hazard in unprotected areas. The water table, which is fairly high, helps to replenish the available water in the soil. Without adequate rainfall during the summer, corn and soybean yields are reduced; also, during a dry spring, soil blowing can be severe. Leaving large amounts of crop residue on the surface helps to maintain good soil tilth and reduces soil blowing.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from buildings. Tile drains around the foundation remove excess subsurface water. Constructing roads on well compacted, suitable base material help prevent damage caused by frost action.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Linder soil is in capability subclass IIs.

255—Mayer loam. This is a nearly level, poorly drained soil on slightly convex slopes on outwash plains and terraces and on uplands. Individual areas of this soil are irregular in shape and range from 4 to about 900 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark gray loam about 12 inches thick. The subsoil is olive gray, friable loam about 10 inches thick. The underlying material to a depth of about 60 inches is olive gray and olive, mottled gravelly coarse sand and stratified gravelly loamy sand. In some places, sand and gravel are at a depth of more than 40 inches, or the surface layer and subsoil are clay loam, or the underlying material has silty layers. In a few small areas in depressions, the soil is very poorly drained.

Included in mapping are small areas of Biscay and Linder soils. Biscay soils are poorly drained, and they are noncalcareous. Linder soils are somewhat poorly drained. They are on slight rises. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Mayer soil is moderate in the upper part and rapid in the underlying material. Surface runoff is slow. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at a depth of 1 to 3 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, it has good potential for the crops commonly grown in the county. The major limitation is wetness. Liberal applications of potash and phosphate generally are needed to correct the fertility imbalance in the soil, which is caused by a high content of lime. Soil blowing is a concern in open areas. Clods form and compaction is likely if the soil is tilled when it is wet. Good management, such as returning crop residue to the soil and restricting field operations during periods of wetness, helps to maintain optimum infiltration, permeability, and tilth.

Trees and shrubs that are tolerant of the high content of lime in the soil and the excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation help to remove excess subsurface water. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by soil wetness and frost action.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Mayer soil is in capability subclass IIw.

269—Millington loam. This is a nearly level, poorly drained soil on flood plains. Individual areas of this soil generally are elongated and range from 4 to about 1,200 acres in size. This soil is occasionally flooded. In the Minnesota River Valley, in the townships of Swedes Forest, Delhi, and Honner, this Millington soil is above the flood level, but it is subject to brief flooding caused by runoff from adjacent slopes.

Typically, the surface layer is black loam about 8 inches thick. The subsurface layer is black loam about 28 inches thick. The underlying material to a depth of about 60 inches is stratified, dark gray loam and very dark gray sandy clay loam. In some places, 1 to 3 feet of noncalcareous, dark, loamy sediment has been deposited on the surface. In some areas, there are layers of sand in the profile.

Included in mapping are small areas of Mayer and Nishna soils. Mayer soils are poorly drained. They are in higher positions on the landscape than the Millington soil. Nishna soils are poorly drained. They are more clayey than the Millington soil and are in lower positions on the landscape. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Millington soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 0 to 2 feet.

In most areas, this soil is used for corn and soybeans. If flooding is controlled and the soil is adequately drained and fertilized, it has good potential for the crops commonly grown in the county. Flooding can be controlled by constructing dikes along the streams and rivers to help keep the floodwater within the channel. Flooding of brief duration occurs early in the spring and in June during periods of heavy rain. Liberal applications of potash and phosphate generally are needed to correct the fertility imbalance in the soil, which is caused by a high content of lime. Good management, such as leaving large amounts of crop residue on the surface and restricting field operations during periods of wetness, helps to maintain optimum infiltration, permeability, and tilth. Clods form and compaction is likely if the soil is cultivated when it is wet. If the soil is tilled in the fall, crops can be planted early in the spring.

Trees and shrubs that are tolerant of the high content of lime in the soil and excessive moisture should be selected for windbreaks and environmental plantings. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding. Soils that are better suited to these uses are generally nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help to prevent damage caused by flooding, wetness, and low soil strength.

This Millington soil is in capability subclass IIw.

282—Hanska fine sandy loam. This is a nearly level, poorly drained soil on slightly concave slopes on outwash plains and terraces. Individual areas of this soil are irregular in shape and range from 4 to about 30 acres in size.

Typically, the surface layer is black fine sandy loam about 9 inches thick. The subsurface layer is black and very dark gray fine sandy loam about 9 inches thick. The subsoil is grayish brown, friable sandy loam about 20 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled sand with bands of silt loam. Glacial till is at a depth of 4 feet or less in some places. In some places, the surface layer is more than 24 inches thick.

Included in mapping are small areas of Lemond and Linder soils. Lemond soils are poorly drained and are calcareous. They are in slightly convex areas. Linder soils are somewhat poorly drained. They are on low knolls. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Hanska soil is moderately rapid in the upper part, and it is rapid in the underlying material. Surface runoff is slow. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 0 to 3 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, it has good potential for the crops commonly grown in the county. Wetness is the major limitation. Soil blowing is a concern in some large open areas. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase and maintain good soil tilth and reduce soil blowing. If the soil is tilled in the fall, crops can be planted early in the spring.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from building. Tile drains around the foundation remove excess subsurface water. Constructing roads on raised suitable base material and providing adequate side ditches and culverts minimize wetness and help prevent damage caused by frost action.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Hanska soil is in capability subclass IIw.

313—Spillville loam, occasionally flooded. This is a nearly level, moderately well drained soil on bottom lands. Individual areas of this soil are oblong or irregular in shape and range from 10 to about 200 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black, very dark brown, and very dark gray loam about 38 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown loam. In some places, there are thin layers of a sandy material in the lower part of the surface soil and in the underlying material. The lower part of the surface soil is calcareous in some places.

Included in mapping are small areas of Coland and Delft soils. Coland soils are poorly drained. They are in lower positions on the landscape than the Spillville soil. Delft soils are poorly drained. They are on toe slopes on uplands. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Spillville soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus and potassium are low to medium. The seasonal high water table is at a depth of 3 to 5 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. The major hazard is occasional flooding that generally occurs in the spring and in June during periods of heavy rain. Leaving large amounts of crop residue on the surface helps to maintain good soil tilth.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Excessive moisture in the spring can reduce plant growth. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding hazard. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by flooding and low soil strength.

This Spillville soil is in capability subclass IIw.

317—Oshawa silty clay loam. This is a level, very poorly drained soil on concave slopes of old oxbows and in swales on the flood plains. Individual areas of this soil generally are oblong and range from 4 to about 200 acres in size. This soil is subject to frequent flooding.

Typically, the surface layer is very dark gray, mottled silty clay loam about 10 inches thick. The subsurface layer is about 29 inches thick. It is black, mottled clay loam in the upper part and very dark gray, mottled silty clay loam in the lower part. The underlying material to a depth of about 60 inches is olive gray, mottled silt loam. In some places, the surface layer is sandy loam or loam, noncalcareous recent alluvium deposited by rivers and streams.

Included in mapping are small areas of Millington and Zumbro soils. Millington soils are poorly drained, and Zumbro soils are moderately well drained. These soils are on slight rises. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Oshawa soil is moderately slow. Surface runoff is ponded. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is near or above the surface.

This soil generally is not suited to use for crops. It is well suited to use as habitat for wetland wildlife, and in most areas this soil is used as habitat for wetland wildlife. The major limitations for crops are wetness and frequent flooding. When the soil is not flooded, it provides limited grazing. Rotation grazing and proper stocking utilize existing forage crops most efficiently.

This soil is not suited to trees because of wetness, the high content of lime, and frequent flooding. If these limitations are reduced, some trees can be grown of species that tolerate lime and wetness.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by flooding and low soil strength.

This Oshawa soil is in capability subclass VIw.

321—Tilfer clay loam. This is a nearly level, moderately deep, poorly drained or very poorly drained soil on flat and slightly concave slopes on low and intermediate stream benches. Individual areas of this soil are oblong or irregular in shape and range from 4 to about 50 acres in size. This soil is subject to occasional flooding.

Typically, the surface layer is black clay loam about 10 inches thick. The subsurface layer is very dark gray clay loam about 9 inches thick. The subsoil is grayish brown, mottled, friable loam about 13 inches thick. Igneous and metamorphic bedrock is at a depth of about 32 inches. In some places, the surface soil is more than 24 inches thick, and bedrock is at a depth of more than 40 inches.

Included in mapping are small areas of Rock outcrop and Wadena Variant soils. Rock outcrop is on knolls, and Wadena Variant soils are on rises. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Tilfer soil is moderate. Surface runoff is slow. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 0 to 2 feet.

This soil is not suited to use for crops. Because of the depth to bedrock, this soil is difficult to drain adequately. The soil is limited to crops that can be planted late in the spring and that mature early. In most areas, this soil is used as pasture or as habitat for wildlife. It has fair suitability for these uses. Fair yields of forage crops can be obtained if the soil is fertilized and well managed. The major limitation is wetness. Shallow water developments will attract waterfowl.

Trees and shrubs that are tolerant of the high content of lime and the excessive moisture should be selected for windbreaks and environmental plantings. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding and the seasonal high water table. Soils that are better suited generally are nearby. Constructing roads on raised well compacted base material and providing adequate side ditches and culverts help prevent damage caused by flooding and by frost action.

This Tilfer soil is in capability subclass Vw.

327A—Dickman sandy loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on nearly plane slopes on outwash plains and terraces. Individual areas of this soil generally are irregular in shape and range from 4 to about 300 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark gray sandy loam about 2 inches thick. The subsoil is about 21 inches thick. It is dark brown sandy loam in the upper part and dark brown loamy sand in the lower part. The underlying material to a depth of about 60 inches is yellowish brown coarse sand. In some places, the surface soil is less than 10 inches thick. In places, the surface soil has become loamy sand by the addition of wind-blown material.

Included in mapping are small areas of Linder, Hanska, and Biscay soils. Linder soils are somewhat poorly drained. They are in nearly level areas. Hanska and Biscay soils are poorly drained. They are in drainageways. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Dickman soil is moderately rapid. Surface runoff is slow. The available water capacity is low or moderate. The organic matter content is moderate. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is below a depth of 6 feet.

In most areas, this soil is used for corn, soybeans, oats, and wheat. It has fair potential for crops. The soil is best suited to small grains and other early maturing crops. The major limitations are the low available water capacity and the hazard of soil blowing. When rainfall is adequate, however, corn and soybeans yields are satisfactory. Leaving large amounts of crop residue on the surface helps to maintain good soil tilth and organic matter content and reduces the hazard of soil blowing.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low available water capacity and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suitable for sites for buildings and for local roads. This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of the effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Dickman soil is in capability subclass IIIs.

327B—Dickman sandy loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on convex slopes on outwash plains and terraces and on side slopes or uplands. Individual areas of this soil are irregular in shape and range from 4 to about 200 acres in size.

Typically, the surface layer is black sandy loam about 10 inches thick. The subsurface layer is very dark brown sandy loam about 3 inches thick. The subsoil is about 20 inches thick. It is dark brown sandy loam in the upper part and dark brown loamy sand and sand in the lower part. The underlying material to a depth of about 60 inches is light olive brown fine sand.

Included in mapping are small areas of Linder, Hanska, and Biscay soils. Linder soils are somewhat poorly drained. They are in level areas. Hanska and Biscay soils are poorly drained. They are in lower, slightly concave areas than the Dickman soil. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Dickman soil is moderately rapid. Surface runoff is medium. The available water capacity is low or moderate. The organic matter content is moderate. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn, soybeans, oats, and wheat. It has poor potential for crops. The major limitations are the low available water capacity and the hazard of erosion. Small grains and other early maturing crops that grow well in soils that have a low available water capacity are suited to this soil. When rainfall is adequate, corn and soybean yields are satisfactory. Leaving large amounts of crop residue on the surface and farming on the contour control erosion. Drainageways that are shaped, seeded, and maintained as grassed waterways reduce the hazard of gully erosion.

Trees and shrubs tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The low available water capacity and the coarse textured underlying material also limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

This soil is suitable for sites for buildings and for local roads.

This soil readily absorbs the effluent from a septic tank absorption field but does not adequately filter it. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of the effluent, shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

This Dickman soil is in capability subclass IIIe.

345—Wilmonton clay loam. This is a nearly level, moderately well drained soil on slightly concave to slightly convex slopes on dissected ground moraines.

Individual areas of this soil are elongated to oblong and range from 4 to about 400 acres in size.

Typically, the surface layer is black clay loam about 8 inches thick. The subsurface layer is black clay loam about 6 inches thick. The subsoil is about 25 inches thick. It is dark grayish brown and olive brown, mottled clay loam in the upper part and calcareous, light olive brown, mottled clay loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown, mottled clay loam. In some places on low knolls, free carbonates are at a depth of less than 20 inches and the dark surface layer is less than 14 inches thick.

Included in mapping are small areas of Everly and Letri soils. Everly soils are well drained. They are on knolls. Letri soils are poorly drained. They are in swales and drainageways. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Wilmonton soil is moderately slow. Surface runoff is medium. The available water capacity is high. The organic matter content is high. The available phosporus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 2 1/2 to 5 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. Leaving large amounts of crop residue on the surface helps to maintain good soil tilth.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

Buildings constructed on this soil should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation remove excess subsurface water. The site should be landscaped so that the surface water drains away from the building. Foundations and footings should be designed to prevent structural damage caused by shrinking and swelling of the soil. In addition, backfilling around the foundation with a suitable coarse material also protects the building against structural damage. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

Subsurface seepage trenches for treatment of effluent from septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Wilmonton soil is in capability class I.

390—Spillville loam, frequently flooded. This is a nearly level, moderately well drained soil in broad areas that are adjacent to streams and rivers. Areas of this soil are dissected by stream channels. Individual areas are oblong or irregular in shape and are 10 to about 300 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsurface layer is about 40 inches thick. It is a very dark gray loam in the upper part and very dark grayish brown fine sandy loam in the lower part. The underlying material to a depth of about 60 inches is very dark grayish brown fine sandy loam. In some places, thin layers of sand are in the profile. In some places, the lower part of the subsurface layer is calcareous.

Included in mapping are small areas of Delft, Webster, Coland, and Zumbro soils. Delft and Webster soils are poorly drained. They are on toe slopes. Coland soils are poorly drained. They are on low flats. Zumbro soils are moderately well drained. They are on alluvial fans. Zumbro soils are more sandy than the Spillville soil. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Spillville soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus and potassium are low to medium. The seasonal high water table is at a depth of 3 to 5 feet.

In most areas, this soil is used for pasture or is idle and is used as habitat for wildlife. It has fair suitability for these uses. This soil generally supports a wide variety of wetland plants. During the summer months, these soils are dry and do not attract wetland wildlife. The suitability of this soil for habitat for wetland wildlife can be increased by developing the shallow water areas. This soil is also well suited to habitat for woodland and openland wildlife.

This soil provides grazing when it is not flooded. Flooding occurs early in the spring and after heavy rains. If the existing stands of native grasses are fertilized, they provide good grazing. Rotation grazing and proper stocking utilize existing forage crops most efficiently. This soil is poorly suited to crops unless control structures are installed to reduce the frequent flooding.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Excess soil moisture in the spring can reduce plant growth. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil is generally not suited to use as sites for buildings or septic tank absorption fields because of the flooding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by flooding and low soil strength.

This Spillville soil is in capability subclass Vw.

392—Biscay loam. This is a nearly level, poorly drained soil on slightly concave slopes on outwash plains and terraces. Individual areas of this soil are irregular in shape and range from 4 to about 30 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 12 inches thick. The subsoil is about 11 inches thick. It is dark grayish brown, mottled, friable loam in the upper part and grayish brown, mottled, friable sandy loam in the lower part. The underlying material to a depth of about 60 inches is olive gray gravelly loamy coarse sand. In some places, the underlying material has strata of sandy loam, fine to medium sand, and loamy sand. Glacial till is at a depth of 4 feet or less in some places. Also, in some places, the surface layer is more than 24 inches thick.

Included in mapping are small areas of Linder and Mayer soils. Linder soils are somewhat poorly drained. Mayer soils are poorly drained. Both soils are on slight rises. Also included are very poorly drained Mayer soils in depressions. The included soils make up from 5 to 15 percent of the map unit.

The permeability of the Biscay soil is moderate in the subsoil and rapid in the underlying material. Surface runoff is slow. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 1 to 3 feet.

In most areas, this soil is used for corn and soybeans. If adequately drained, this soil has good potential for the crops commonly grown in the county. The major limitation is wetness. Tile drainage is difficult to install because of the high water table and because of the instability of the gravelly or sandy underlying material. The tile should be placed at or just into the underlying material for most satisfactory results. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase the organic matter content of the soil and maintain good soil tilth. If this soil is tilled when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

This soil is poorly suited to use as septic tank absorption fields because of the seasonal high water table and because the soil does not adequately filter the effluent from septic tank absorption fields. Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Biscay soil is in capability subclass IIw.

399—Biscay loam, depressional. This is a level, very poorly drained soil in depressional areas and drainageways and on outwash plains. Individual areas of this soil generally are circular and range from 4 to about 30 acres in size. This soil is subject to ponding.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is black loam about 21 inches thick. The subsoil is dark grayish brown, friable sandy loam about 4 inches thick. The underlying material to a depth of about 60 inches is grayish brown sand. In some places, the underlying material is loamy glacial till.

Included in mapping are small areas of Mayer soils. Mayer soils are poorly drained. They are on the edges of depressions. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Biscay soil is moderate in the upper part and rapid in the lower part. Surface runoff is slow to ponded. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is near or above the surface layer.

In most areas, this soil is used for corn and soybeans. If adequately drained, it has good potential for the crops commonly grown in the county. The major limitation is wetness. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface help to maintain good soil tilth. Tilling the soil in the fall, allows crops to be planted early in the spring and helps keep the soil in good tilth. If this soil is tilled when it is wet, clods form and compaction is likely.

Trees and shrubs that tolerate excessive moisture should be selected for windbreaks and environmental plantings. Ponding for long periods increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the ponding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by ponding and frost action.

This Biscay soil is in capability subclass IIIw.

421B—Ves loam, 1 to 4 percent slopes. This is a nearly level and gently undulating, well drained soil on low knolls on ground moraines of low relief. The slopes are short and convex. Individual areas of this soil are oblong or circular and range from 4 to about 230 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is dark brown and very dark grayish brown loam about 5 inches thick. The subsoil is about 16 inches thick. It is brown loam in the upper part and light olive brown loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam. In some places, the surface layer is less than 10 inches thick. Also, in some places, the surface layer is sandy loam or sandy clay loam. In some areas, the depth to carbonates is as much as 42 inches, and the combined thickness of the surface layer, subsurface layer, and subsoil are as much as 48 inches.

Included in mapping are small areas of Seaforth, Storden, and Webster soils. Seaforth soils are moderately well drained. They are on convex slopes. Storden soils are well drained, and they are calcareous. These soils are on the summits of slopes. Webster soils are poorly drained. They are in drainageways. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Ves soil is moderate. Surface runoff is medium to slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, the soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county, but erosion is a hazard. In many places the slopes are too complex or irregular for terracing or contour farming. Large amounts of crop residue on the surface help to maintain the organic matter content in the soil and reduce the erosion hazard. Drainageways that are shaped, seeded, and maintained as grassed waterways reduce the hazard of gully erosion.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action. This soil is suitable for use as septic tank absorption fields.

This Ves soil is in capability subclass IIe.

421B2—Ves loam, 3 to 6 percent slopes, eroded. This is a gently undulating, well drained soil on knolls on the till plains and the ground moraines of low relief. The slopes are short and convex. Individual areas of this soil are elongated or irregular in shape and range from 4 to about 90 acres in size.

Typically, the surface layer is very dark gray loam about 10 inches thick. The subsoil is about 19 inches thick. It is brown loam in the upper part and yellowish brown loam in the lower part. The underlying material to a depth of about 60 inches is calcareous, brown and light olive brown loam. In some places, erosion has exposed the subsoil. Also, in some places on side slopes, the surface layer and subsoil are sandy loam or sandy clay loam and lime is at a depth of more than 33 inches.

Included in mapping are small areas of Seaforth, Storden, and Webster soils. Seaforth soils are moderately well drained. They are on slight convex slopes. Storden soils are well drained, and they are calcareous. These soils are on summits and shoulders. Webster soils are poorly drained. They are in drainageways. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Ves soil is moderate. Surface runoff is medium. The available water capacity is high. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is below a depth of 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. The main concern in management is the hazard of erosion. Contour farming and terracing are difficult because of the complex and irregular slopes. Grassed waterways, conservation tillage, and a rotation that includes forage crops help to control runoff and erosion. If this soil is plowed in the fall, leaving a rough surface and some crop residue helps control soil blowing and holds snow on the ground in winter.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited plants, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

This soil is suited to use as sites for buildings and septic tank absorption fields. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

This Ves soil is in capability subclass IIe.

423—Seaforth loam. This is a nearly level, moderately well drained soil on slightly convex slopes on ground moraines. Individual areas of this soil generally are oblong and range from 4 to about 15 acres in size.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is very dark gray loam about 6 inches thick. The subsoil is mottled, grayish brown, friable clay loam about 6 inches thick. The underlying material to a depth of about 60 inches is grayish brown and olive brown, mottled loam. In some places, the surface layer is not calcareous. Erosion has exposed the subsoil in some places. Also, in some places, the surface layer and subsoil are clay loam. Gypsum crystals are in the profile in some places.

Included in mapping are small areas of Storden and Ves soils. The soils are well drained. They are on convex knolls. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Seaforth soil is moderate. Surface runoff is medium or slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is at a depth of 3 to 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. Liberal applications of potash and phosphate are needed to correct the fertility imbalance in the soil, which is caused by a high content of lime. Good management, such as returning crop residue to the soil, help keep this soil in good tilth.

Trees that are tolerant of the high content of lime in the soil should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

Buildings constructed on this soil should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation remove excess subsurface water. The site should be landscaped so that surface water drains away from the building. Constructing roads on well compacted, suitable base material helps prevent damage to the roads by frost damage.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Seaforth soil is in capability subclass IIs.

446—Normania loam. This is a nearly level, moderately well drained soil on slightly concave to slightly convex slopes on ground moraines. Individual areas of this soil generally are oblong and range from 4 to about 300 acres in size.

Typically, the surface layer is black loam about 6 inches thick. The subsurface layer is black and very dark gray loam about 11 inches thick. The subsoil is about 16 inches thick. It is dark grayish brown, friable clay loam in the upper part and grayish brown, mottled loam in the lower part. The underlying material to a depth of about 60 inches is light brownish gray, mottled loam. In some places, the depth to carbonates is less than 18 inches or more than 36 inches and the underlying material is at a depth of more than 40 inches.

Included in mapping are small areas of Ves and Webster soils. Ves soils are well drained. They are on knolls and crests of slopes. Webster soils are poorly drained. They are in swales and drainageways. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Normania soil is moderate. Surface runoff is medium or slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 3 to 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. Returning all crop residue to the soil and tilling the soil at the proper moisture content help to maintain good soil tilth.

This soil is well suited to trees and shrubs for windbreaks and environmental plantings. Most climatically suited species, except those that require abundant moisture, survive and grow well. Competing plants can be controlled by cultivation or by herbicides.

Buildings constructed on this soil should have the lower or basement level constructed above the seasonal high water table. Tile drains around the foundation remove excess subsurface water. The site should be landscaped so that surface water drains away from the building. Constructing roads on well compacted, suitable base material helps prevent damage caused by frost action.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some cases, both subsurface drainage and an elevated bed may be necessary.

This Normania soil is in capability class I.

562—Knoke silty clay loam. This is a level, very poorly drained soil on plane or slightly concave slopes in lake basins on glacial till plains. Individual areas of this soil are circular or oblong and range from 5 to about 200 acres in size. This soil is subject to ponding.

Typically, the surface layer is black silty clay loam about 9 inches thick. The subsurface layer is about 33 inches thick. It is black and very dark gray silty clay loam. The subsoil to a depth of about 60 inches is very dark gray, mottled clay loam. In some areas, there are no free carbonates in the surface layer.

Included in mapping are small areas of Canisteo soils. These soils are poorly drained. They are on the rims of depressions. Also included are some areas of poorly drained sandy soils. They are on slight rises along the edges of depressions. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Knoke soil is moderately slow. Surface runoff is very slow or ponded. The available water capacity is high. The organic matter content is very high. The available phosphorus is low, and the available potassium is high. The seasonal high water table is near or above the surface layer.

In most areas, this soil is used for corn and soybeans or is in pasture. If adequately drained, this soil has good potential for the crops commonly grown in the county. The soil can be extensively cropped. Wetness is a hazard. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface help to maintain the soil in good tilth. If this soil is tilled in the fall, it can be planted earlier in the spring. Liberal applications of potash and phosphate generally are needed to correct the infertility imbalance, which is caused by a high content of lime in the soil.

Trees and shrubs that are tolerant of the high content of lime in the soil and excessive moisture should be selected for windbreaks and environmental plantings. Ponding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings because of the ponding hazard and structural damage can result from the shrinking and swelling of the soil. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by ponding, low strength, and the shrinking and swelling of the soil.

This soil generally is also not suited to use as septic tank absorption fields because of the high water table and the ponding. Also, because of the moderately slow permeability of this soil, it cannot readily absorb effluent in septic tank absorption fields. Soils that are better suited generally are nearby.

This Knoke soil is in capability subclass IIIw.

574—Du Page loam. This is a nearly level, moderately well drained soil on flood plains of rivers and streams. Individual areas of this soil are irregular in shape and range from 4 to about 80 acres in size. This soil is occasionally flooded.

Typically, the surface layer is black loam about 9 inches thick. The subsurface layer is about 23 inches thick. The upper part is black loam and the lower part is very dark grayish brown loam. The underlying material to a depth of about 60 inches is dark grayish brown loam. In some places, the surface layer is more than 40 inches thick. Also, in some places, the surface layer is sandy loam. In some places, the subsoil is a coarser texture, or 1 to 3 feet of noncalcareous sediment is on the surface of the soil.

Included in mapping are small areas of Millington and Zumbro soils. Millington soils are poorly drained. They are in swales. Zumbro soils are moderately well drained. They are on slight rises that are adjacent to streams and rivers. Also included are some areas that have 1 to 3 feet of recent sediment on top of the original soil. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Du Page soil is moderate. Surface runoff is slow to medium. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 4 to 6 feet.

In most areas, this soil is used for corn and soybeans. It has good potential for the crops commonly grown in the county. The major hazard is occasional flooding, generally in the spring and after heavy rains early in summer. Flooding can be controlled by constructing dikes along the river or stream to help keep the floodwater within the channel. Liberal applications of potash and phosphate generally are needed to correct the fertility imbalance in the soil, which is caused by a high content of lime. Leaving large amounts of crop residue on the surface of the soil increases the organic matter content and maintains good soil tilth.

Trees and shrubs that are tolerant of the high content of lime in the soil should be selected for windbreaks and environmental plantings. Excessive soil moisture in the spring can reduce plant growth. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding. Soils that are better suited to these uses are generally nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by flooding and low soil strength.

This Du Page soil is in capability subclass IIw.

575—Nishna clay loam. This is a level, poorly drained soil on flood plains. Individual areas of this soil are oblong or circular and range from 4 to about 250 acres in size. This soil is occasionally flooded.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is black clay loam and silty clay about 36 inches thick. The underlying material to a depth of about 60 inches is dark gray silty clay. In some places, the surface layer is loam or sandy loam. Also, in some places, there are no free carbonates in the surface layer. The surface layer is more than 48 inches thick in some places.

Included in mapping are small areas of Millington, Oshawa, Du Page, and Zumbro soils. Millington soils are poorly drained. They are on slight rises. They are less clayey than the Nishna soil. Oshawa soils are very poorly drained. They are in swales. Du Page and Zumbro soils are moderately well drained. They are on rises along streams and rivers. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Nishna soil is slow. Surface runoff is slow or ponded. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 1 to 3 feet.

In most areas, this soil is used for corn and soybeans. If flooding is controlled and the soil is adequately drained, it has good potential for the crops commonly grown in the county. Flooding can be controlled by constructing dikes along the stream or river to keep the floodwater within the channel. Flooding occurs for short periods, mainly in the early spring and during periods of heavy rain in June. Tile drainage reduces wetness. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase organic matter content and maintain good soil tilth. If the soil is tilled when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of the high content of lime in the soil and excessive moisture should be selected for windbreaks and environmental plantings. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings and septic tank absorption fields because of the flooding and the seasonal high water table. Also, the shrinking and swelling of the soil can cause structural damage. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by flooding, low soil strength, and shrinking and swelling of the soil.

This Nishna soil is in capability subclass IIIw.

654—Revere clay loam. This is a nearly level, poorly drained soil on the rim of depressions and on slightly convex slopes on ground moraines. Individual areas of this soil are irregular in shape and range from 4 to about 70 acres in size.

Typically, the surface layer is black clay loam about 9 inches thick. The subsurface layer is very dark gray clay loam about 6 inches thick. The subsoil is about 20 inches thick. It is dark grayish brown, mottled clay loam in the upper part and olive gray, mottled clay loam in the lower part. The underlying material to a depth of about 60 inches is olive gray, mottled loam. There is no gypsic horizon in some places.

Included in mapping are small areas of Glencoe, Okoboji, Seaforth, and Webster soils. Glencoe and Okoboji soils are very poorly drained. They are in depressions. Seaforth soils are moderately well drained. They are on convex rises. Webster soils are poorly drained and are noncalcareous. They are in slightly concave positions. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Revere soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at a depth of 1 to 3 feet.

In most areas, this soil is used for corn and soybeans. If the soil is adequately drained and fertilized, it has good potential for the crops commonly grown in the county. The major limitation is wetness, but soil blowing is a management concern in open areas. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase the organic matter content and maintain good soil tilth. If the soil is tilled in the fall, it can be planted early in the spring. Liberal applications of potash and phosphate generally are needed to correct the fertility imbalance in the soil, which is caused by the high content of lime and gypsum. If this soil is plowed when it is wet, clods form and compaction is likely.

Trees and shrubs that are tolerant of the high content of lime in the soil should be selected for windbreaks and environmental plantings. Excessive soil moisture in the spring can reduce plant growth. Competing plants can be controlled by cultivation or by herbicides.

This soil is poorly suited to use as sites for buildings because of wetness. If buildings are constructed on this soil, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on this soil unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Revere soil is in capability subclass IIw.

818—Lemond-Linder-Estherville complex. This complex consists of nearly level soils in beach areas of former lakes. Individual areas are elongated and range from 4 to about 80 acres in size.

This complex is 50 to 60 percent Lemond soil, 20 to 35 percent Linder soil, and 20 to 30 percent Estherville soil. The Lemond soil is poorly drained. It is on plane to slightly concave slopes. The Linder soil is somewhat poorly drained. It is on plane to slightly convex slopes. The Estherville soil is well drained. It is on slightly convex knolls. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Lemond soil has a black gravelly sandy loam surface layer and subsurface layer about 17 inches thick. The subsoil is grayish brown, mottled sandy loam about 11 inches thick. The next layer, to a depth of 44 inches, is olive gray and light olive gray loamy sand and sand. The underlying material to a depth of about 60 inches is olive gray sandy loam.

Typically, the Linder soil has a black loam surface layer about 10 inches thick. The subsurface layer is very dark gray loam about 8 inches thick. The subsoil is about 10 inches thick. It is dark grayish brown, friable sandy loam in the upper part and grayish brown, friable sandy loam in the lower part. The underlying material to a depth of about 60 inches is grayish brown coarse sand.

Typically, the Estherville soil has a black sandy loam surface layer about 9 inches thick. The subsurface layer is very dark grayish brown sandy loam about 5 inches thick. The subsoil is dark brown coarse sandy loam. The underlying material to a depth of about 60 inches is yellowish brown gravelly coarse sand.

Included in mapping are small areas of Knoke and Okoboji soils. These soils are very poorly drained. They are in depressions. Knoke and Okoboji soils formed in finer textured lacustrine sediments than the soils that make up the complex. Also included are small areas of soils that have moderately steep slopes. The included soils make up 5 to 15 percent of the map unit.

The Lemond and Estherville soils are moderately rapidly permeable in the upper part and are rapidly permeable in the lower part. The permeability of the Linder soil is moderately rapid in the upper part and very rapid in the lower part. Surface runoff is slow on all of these soils. The available water capacity is moderate in Lemond and Linder soils and low in the Estherville soil. The organic matter content is high in the Lemond soil and moderate in the Estherville and Linder soils. The available phosphorus is low in all of these soils and the available potassium is medium. The seasonal high water table is at a depth of 0 to 3 feet in the Lemond soil and 2 to 4 feet in the Linder soil, and it is at a depth of more than 6 feet in the Estherville soil.

In most areas, the soils are used for corn and soybeans. If adequately drained, they have fair potential for the crops commonly grown in the county. Wetness is the major limitation. In some of the more sandy areas, the soils are not farmed and are left idle. Liberal applications of potash and phosphate generally are needed to correct the fertility imbalance in the Lemond soil, which is caused by the high content of lime. Soil blowing is a management concern in large open areas. Leaving all or part of the crop residue on the surface and restricting field operations during periods of wetness help maintain good soil tilth, increase organic matter content, and reduce soil blowing.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Plants that are tolerant of the excessive soil moisture in Lemond and Linder soils, the droughtiness of the Estherville soils, the high content of lime in Lemond soils should be selected. The soil conditions limit the choice of plants but are variable enough to warrant onsite investigation before selecting. Competing plants can be controlled by cultivation or by herbicides.

The Lemond and Linder soils are poorly suited for use as sites for buildings because of wetness. If buildings are constructed on these soils, the lower or basement level should be constructed above the seasonal high water table, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. The Estherville soil is suitable for use as sites for buildings. Constructing roads on raised well compacted base material and providing adequate side ditches and culverts help minimize wetness problems.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on Lemond and Linder soils unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

The soils in this complex are in capability subclass IIIw.

882—Millington-Zumbro complex. This complex consists of nearly level, poorly drained and moderately well drained soils on alluvial fans that are adjacent to streams and rivers (fig. 9). These soils are subject to frequent flooding. Individual areas are long and narrow and range from 4 to about 200 acres in size.

Millington soil makes up 50 to 70 percent of this complex, and Zumbro soil makes up 10 to 20 percent. The Millington soil is poorly drained. It is in nearly level areas on the flood plains. The Zumbro soil is moderately well drained. It is on rises or natural levees on the flood plains. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately. However, a few areas of this complex are made up entirely of the Millington soil.

Typically, the Millington soil has a black loam surface layer about 8 inches thick. The subsurface layer is about 30 inches thick. It is black loam in the upper part and very dark grayish brown loam with thin loamy sand strata in the lower part. The underlying material to a depth of about 60 inches is dark gray and very dark gray loam

Figure 9.—An area of the Millington-Zumbro complex that is used as pasture although it is frequently flooded.

with strata of loamy sand. In some places, the surface soil has strata of loamy sand.

Typically, the Zumbro soil has a very dark brown loamy sand surface layer about 10 inches thick. The subsurface layer is very dark gray fine sandy loam and very dark grayish brown loamy fine sand about 32 inches thick. The underlying material to a depth of about 60 inches is dark grayish brown fine sand. In some places the subhorizons are stratified sandy and loamy deposits. In some places, the surface soil is stratified with sand lenses that were recently deposited. In some places, the surface layer is sand.

Included in mapping are small areas of Oshawa soils. These soils are very poorly drained. They are in swales. The included soils make up 5 to 10 percent of the map unit.

The permeability of the Millington soil is moderate, and the permeability of the Zumbro soil is rapid. Surface runoff is slow on both soils. The available water capacity is high in the Millington soil and low or moderate in the Zumbro soil. The organic matter content is high in the Millington soil and moderate in the Zumbro soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is at a depth of 0 to 2 feet in the Millington soil and is at a depth of more than 6 feet in the Zumbro soil.

The soils generally are not suited to crops. The main hazard is frequent flooding. They are fairly suited to pasture and to habitat for wetland wildlife. In most areas, the soils are used for pasture. When the soils are not flooded, they can be grazed. Flooding generally occurs in the early spring and after heavy rains. If fertilized, the native grasses provide good grazing. Rotation grazing and proper stocking utilizes existing forage crops most efficiently.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Flooding and droughtiness are hazards in sandy areas. Also, the soils in these areas are subject to blowing, which can damage seedlings. Optimum growth and survival are not expected. The soil conditions limit the choice of plants but are variable enough to warrant onsite investigations before selecting. Competing plants can be controlled by cultivation or by herbicides.

The soils generally are not suited to use as sites for buildings and as septic tank absorption fields because of the flooding and the seasonal high water table. Also, the Zumbro soil does not adequately filter the effluent in septic tank absorption fields. Soils that are better suited to these uses generally are nearby. Constructing roads on raised well compacted base material and providing adequate side ditches and culverts help prevent damage caused by flooding, wetness, and low soil strength.

The soils in this complex are in capability subclass Vw.

883—Du Page-Zumbro complex. This complex consists of nearly level, moderately well drained soils on flood plains and on natural levees that are adjacent to streams and rivers. Individual areas are oblong or irregular in shape and range from 5 to about 160 acres in size.

Du Page soil makes up 50 to 70 percent of this complex, and Zumbro soil makes up 15 to 25 percent. The Du Page soil is on nearly level flood plains. The Zumbro soil is on natural levees of flood plains that are adjacent to streams and rivers where the coarser, sandy sediments are generally deposited. These soils are subject to occasional flooding. These soils are in areas that are intricately mixed or so small that it was not practical to map them separately.

Typically, the Du Page soil has a surface layer of black loam about 9 inches thick. The subsurface layer is about 31 inches thick. It is black loam in the upper part and very dark gray and very dark grayish brown sandy loam in the lower part. The underlying material to a depth of about 60 inches is dark gray sandy loam with thin strata of loamy sand. In some places, the surface layer is sandy loam.

Typically, the Zumbro soil has a surface layer of very dark brown loamy sand about 10 inches thick. The subsurface layer is very dark grayish brown sand about 40 inches thick. The subsoil to a depth of about 60 inches is dark brown sand. In some places, the underlying material is loamy.

Included in mapping these soils are small areas of Millington and Oshawa soils. Millington soils are poorly drained. They are in drainageways. Oshawa soils are very poorly drained. They are in old abandoned stream channels and in river channels. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Du Page soil is moderate, and the permeability of the Zumbro soil is rapid. Surface runoff on these soils is slow. The available water capacity in the Du Page soil is high, and it is low in the Zumbro soil. The organic matter content in the Du Page soil is high, and it is low in the Zumbro soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is at a depth of 4 to 6 feet in the Du Page soil and is at a depth of more than 6 feet in the Zumbro soil.

In most areas, the soils are used for corn and soybeans. They have good potential for most crops commonly grown in the county. The flooding damages crops. The moderate to low available water capacity of the Zumbro soil limits corn and soybean yields, especially during periods of prolonged dryness. Small grain yields are good if they mature before late July or August. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase organic matter content and maintain good soil tilth.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Optimum growth and survival are not expected. Droughtiness is a hazard in sandy areas. Also, the soils in these areas are subject to flooding and soil blowing, which can damage seedlings. These soil conditions limit the choice of plants but are variable enough to warrant onsite investigation before selecting. Competing plants can be controlled by cultivation or by herbicides.

The soils generally are not suited to use as sites for buildings and as septic tank absorption fields because of the flooding. Also, the Zumbro soil does not adequately filter the effluent from septic tank absorption fields. Soils that are better suited to these uses generally are nearby. Constructing roads on raised well compacted base material and providing adequate side ditches and culverts help prevent damage caused by flooding and low soil strength.

The soils in this complex are in capability subclass IIw.

884—Delft-Webster complex. This complex consists of nearly level, poorly drained soils on toe slopes and foot slopes on till plains and outwash plains. The slopes are concave. Individual areas are narrow and irregular in shape and range from 3 to about 40 acres in size.

Delft soil makes up 50 to 60 percent of this complex, and Webster soil makes up 15 to 50 percent. The Delft soil is on concave toe slopes and foot slopes. Webster soil is in swales and drainageways. These soils are in areas that are intricately mixed or so small that is was not practical to map them separately.

Typically, the Delft soil has a black loam surface layer about 10 inches thick. The subsurface layer is black clay loam about 10 inches thick. The subsurface layer is black and very dark gray loam about 18 inches thick. The subsoil is dark grayish brown and grayish brown, mottled, friable loam about 19 inches thick. The underlying material to a depth of about 60 inches is grayish brown, mottled loam. In some places, the surface layer is silt loam.

Typically, the Webster soil has a black clay loam surface layer about 10 inches thick. The subsoil is about 19 inches thick. It is friable, dark grayish brown clay loam in the upper part and friable, grayish brown clay loam in the lower part. The underlying material to a depth of about 60 inches is grayish brown, mottled loam. In some places, the surface layer is sandy loam, and the underlying material has sandy or silty strata.

Included in mapping are small areas of Canisteo, Normania, and Terril soils. Canisteo soils are poorly drained and are calcareous. They are on slight rises. Normania and Terril soils are moderately well drained. These soils are on upper toe slopes and foot slopes. The included soils make up 10 to 25 percent of the map unit.

The permeability of the Delft soil is moderately slow, and the permeability of the Webster soil is moderate. In both soils, surface runoff is slow and the available water capacity is high. The organic matter content is also high in these soils. The available phosphorus is low in both soils, and the available potassium is low to medium. The seasonal high water table is at a depth of 1 to 2 feet.

In most areas, the soils are used for corn and soybeans. If the soils are adequately drained, they have good potential for the crops commonly grown in the county. The major limitation is wetness. Crops, especially corn and alfalfa, do not grow well in wet years if the soils are not adequately drained. Conservation tillage and restricting tillage during periods of wetness enhance optimum infiltration, permeability, and tilth. If the soils are tilled in the fall, good soil tilth is maintained and crops can be planted early in the spring. If the soil is tilled when it is wet, clods form and soil compaction is likely.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

The soils are poorly suited to use as sites for buildings because of wetness. If buildings are constructed on these soils, they should be built without a basement, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

Subsurface seepage trenches for treatment of effluent in absorption fields cannot be used on these soils unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed on an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

The soils in this complex are in capability subclass IIw.

894B2—Everly-Storden complex, 3 to 6 percent slopes, eroded. This complex consists of gently undulating, well drained soils on glacial moraines. The slopes are convex. Individual areas are oblong or irregular in shape and range from 4 to about 40 acres in size.

Everly soil makes up 30 to 50 percent of this complex, and Storden soil makes up 30 to 45 percent. The Everly soil is on side slopes, and the Storden soil is on summits. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Everly soil has a very dark gray clay loam surface layer about 10 inches thick. The subsoil is about 25 inches thick. It is dark brown clay loam in the upper part and dark yellowish brown clay loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown loam.

Typically, the Storden soil has a dark grayish brown loam surface layer about 10 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown loam. In some places, the surface soil is less than 10 inches thick.

Included in mapping are small areas of Letri, Terril, Wilmonton, and Seaforth soils. Letri soils are poorly drained. They are in drainageways. Terril and Wilmonton soils are moderately well drained. These soils are on foot slopes. Seaforth soils are also moderately well drained. They are in lower positions on the landscape than the Everly and Storden soils. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Everly soil is moderately slow, and the permeability of the Storden soil is moderate. In both soils, surface runoff is medium and the available water capacity is high. The organic matter content is low in the Storden soil and moderate in the Everly soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is below a depth of 6 feet.

In most areas, the soils are used for corn and soybeans. They have good potential for the crops commonly grown in the county. The major limitation is the moderate erosion hazard. In many areas, contour farming and terracing are difficult because of the short, complex and irregular slopes. Returning crop residue to the soil and fertilizing help to maintain organic matter content and reduce the hazard of erosion. If these soils are plowed in the fall, leaving a rough surface and some crop residue helps to reduce runoff and control erosion and holds snow on the ground in the winter. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

The soils are generally well suited to trees and shrubs for windbreaks and environmental plantings. Optimum growth and survival are not expected in some areas of the Storden soil because of its high content of lime and low fertility. These soil conditions limit the choice of plants but are variable enough to warrant onsite investigation before selecting. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on these soils, foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the Everly soil. In addition, backfilling around the foundation with a suitable coarse material also protects the building against structural damage. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

The Everly soil cannot readily absorb the effluent from a septic tank absorption field because of its slow permeability. This limitation can be overcome by installing a larger field than average.

The soils in this complex are in capability subclass IIe.

894C2—Storden-Everly complex, 6 to 12 percent slopes, eroded. This complex consists of rolling, well drained soils on glacial moraines. The slopes are convex and dissected by waterways. Individual areas of this complex are oblong or irregular in shape and range from 4 to about 40 acres in size.

Storden soil makes up 30 to 60 percent of this complex, and Everly soil makes up 30 to 45 percent. The Storden soil is on summits and shoulders, and the Everly soil is on side slopes. These soils are in areas that are so intricately mixed or so small that is was not practical to map them separately.

Typically, the Storden soil has a dark grayish brown loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown loam.

Typically, the Everly soil has a very dark gray clay loam surface layer about 10 inches thick. The subsoil is about 14 inches thick. It is brown clay loam in the upper part and yellowish brown clay loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam. In some places, the surface layer is less than 10 inches thick.

Included in mapping are small areas of Delft, Seaforth, and Terril soils. Delft soils are poorly drained. They are in drainageways. Seaforth soils are moderately well drained. They are in lower positions on the landscape than the Storden and Everly soils. Terril soils are moderately well drained. They are on foot slopes. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Storden soil is moderate, and the permeability of the Everly soil is moderately slow. In both soils, surface runoff is rapid and the available water capacity is high. The organic matter content is low in the Storden soil and moderate in the Everly soil. The available phosphorus is low in both soils and the available potassium is medium to high. The seasonal high water table is below a depth of 6 feet.

In most areas, the soils are used for corn, soybeans, and small grains. They have good potential for the crops commonly grown in the county. The main management concern is the moderate to severe hazard of erosion. In many areas, terracing and contour farming are difficult because of the complex and irregular slopes. Large amounts of crop residue left on the surface, grassed waterways, and a rotation system that includes small grains and forage crops help to control erosion and runoff. Applying fertilizer also helps to maintain the organic matter content and good soil tilth. If these soils are tilled in the fall, leaving a rough surface and some crop residue helps to control soil blowing, reduces runoff, and holds snow on the ground in the winter. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

The soils are generally well suited to trees and shrubs for windbreaks and environmental plantings. Optimum growth and survival are not expected on the Storden soil because of its high content of lime and low fertility. Soil conditions limit the choice of plants but are variable enough to warrant onsite investigation before selecting. Planting on the contour or maintaining a mulch of crop residue on the surface helps to control erosion. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on the soils, they should be designed to conform to the natural slopes. Land shaping may be necessary. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the Everly soil. In addition, backfilling around the foundation with a suitable coarse material also protects the buildings against structural damage. The slope and the low soil strength of the Everly soil are the main limitations for use as roads. Roads constructed on these soils should be placed on the contour, when possible, and road banks should be planted to well adapted grasses to minimize erosion. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength.

The Everly soil cannot readily absorb effluent from a septic tank absorption field because of the slope and the slow permeability. These limitations can be overcome by installing a larger field than average and by placing the distribution lines across the slope.

The soils in this complex are in capability subclass IIIe.

894D2—Storden-Everly complex, 12 to 18 percent slopes, eroded. This complex consists of hilly, well drained soils on glacial moraines. The slopes are convex and are dissected by waterways. Individual areas of this complex are oblong or irregular in shape and range from 4 to about 25 acres in size.

Storden soil makes up 40 to 60 percent of this complex, and Everly soil makes up 20 to 40 percent. The Storden soil is on summits and shoulders, and the Everly soil is on side slopes. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Storden soil has a dark grayish brown loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is dark brown and light olive brown loam.

Typically, the Everly soil has a very dark gray clay loam surface layer about 10 inches thick. The subsoil is about 16 inches thick. It is dark brown, friable clay loam in the upper part and brown, friable clay loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam. In some places, the surface soil is less than 10 inches thick.

Included in mapping are small areas of Delft, Seaforth, and Terril soils. Delft soils are poorly drained. They are in drainageways. Seaforth soils are moderately well drained. They are in lower positions on the landscape than the Storden and Everly soils. Terril soils are moderately well drained. They are on foot slopes. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Storden soil is moderate, and the permeability of the Everly soil is moderately slow. In both soils, surface runoff is rapid and the available water capacity is high. The organic matter content is low in the Storden soil and moderate in the Everly soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is below a depth of 6 feet.

In most areas, the soils are used for corn, soybeans, and small grains. They have fair potential for small grains and forage crops and poor potential for corn and soybeans. The major concern in management is the moderate to severe hazard of erosion. In many areas, terracing and contour farming are difficult because of the complex and irregular slopes. Large amounts of crop residue left on the surface, grassed waterways, and a rotation system that includes small grains and forage crops help to control erosion and runoff. Applying fertilizer helps to maintain organic matter content and good soil tilth. If these soils are tilled in the fall, leaving a rough surface and some crop residue helps to control soil blowing, reduces runoff, and holds snow on the ground in the winter. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by the high content of lime.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Optimum growth and survival are not expected. In some places, the soils have a high content of lime. The soil conditions limit the choice of plants but is variable enough to warrant onsite investigation before selecting. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on the soils, they should be designed to conform to the natural slope. Land shaping may be necessary. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the Everly soil. In addition, backfilling around the foundation with a suitable coarse material protects the building against structural damage. The slope and low soil strength are the main limitations for use of the Everly soil for roads. Roads constructed on the soils should be placed on the contour, when possible, and road banks should be planted to well adapted grasses to minimize erosion. Constructing roads on well compacted, suitable base material help prevent damage caused by low soil strength.

The Everly soil cannot readily absorb the effluent from septic tank absorption fields because of the slope of the soil and its slow permeability. These limitations can be overcome by installing a larger field than average and by placing the distribution lines across the slope.

The soils in this complex are in capability subclass IVe.

954B2—Ves-Storden loams, 3 to 6 percent slopes, eroded. This map unit consists of gently undulating, well drained soils on upland ridges and side slopes. Individual areas generally are oblong and range from 4 to about 80 acres in size.

The Ves soil makes up 40 to 70 percent of the map unit, and the Storden soil makes up 20 to 50 percent. The Ves soil is on side slopes, and Storden soil is on summits and shoulders. Both soils are on convex slopes. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Ves soil has a very dark gray loam surface layer about 10 inches thick. The subsoil is about 16 inches thick. It is dark brown and dark yellowish brown, friable loam in the upper part and yellowish brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam. In some places on back slopes and foot slopes, the surface layer, subsoil, and underlying material are silt loam or fine sandy loam. Erosion has exposed the subsoil in spots.

Typically, the Storden soil has a calcareous, dark grayish brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is grayish brown, yellowish brown, and light olive brown loam. On some summits and shoulders the surface layer is darker than typical. Erosion has exposed the subsoil in spots.

Included in mapping are small areas of Delft, Webster, Seaforth, Terril, and Normania soils. Delft and Webster soils are poorly drained. These soils are in drainageways. Seaforth soils are moderately well drained. These soils are in lower positions on the landscape than the Ves and Storden soils. Terril and Normania soils are moderately well drained. These soils are on foot slopes. The included soils make up 5 to 20 percent of the map unit.

The permeability of the Ves and Storden soils is moderate. Surface runoff is medium. The available water capacity is high for both soils. The organic matter content is low in the Storden soil and moderate in the Ves soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is below a depth of 6 feet.

In most areas, the soils are used for corn and soybeans. They have a good potential for all crops commonly grown in the county. Erosion is a moderate hazard and is the major management concern. Contour farming and terracing are difficult in many areas because of the complex and irregular slopes. Large amounts of crop residue left on the surface and grassed waterways help to control erosion and reduce runoff. If the soils are plowed in the fall, leaving a rough surface and some crop residue helps to reduce runoff and control erosion and holds snow on the ground in winter. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

The soils generally are well suited to trees and shrubs for windbreaks and environmental plantings. Optimum growth and survival are not expected in some areas of the Storden soil because of its high content of lime and low fertility. The soil conditions limit the choice of plants but are variable enough to warrant onsite investigation before selecting. Competing plants can be controlled by cultivation or by herbicides.

The soils are suited to use as sites for buildings and septic tank absorption fields. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action.

The soils in this complex are in capability subclass IIe.

954C2—Storden-Ves loams, 6 to 12 percent slopes, eroded. This map unit consists of rolling, well drained soils on upland ridges and side slopes. In some areas the soils are dissected by shallow drainageways. Individual areas of this complex generally are oblong and range from 4 to about 60 acres in size.

Storden soil makes up 40 to 60 percent of this complex, and Ves soil makes up 20 to 40 percent. The Storden soil is on summits and shoulders, and the Ves soil is on side slopes. Both of these soils are on convex slopes. These soils are in areas that are intricately mixed or so small that it was not practical to map them separately.

Typically, the Storden soil has a dark grayish brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is brown and pale brown loam. Erosion has exposed the subsoil in spots.

Typically, the Ves soil has a very dark gray loam surface layer about 10 inches thick. The subsoil is about 14 inches thick. It is dark brown, friable loam in the upper part and brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam. In some places on shoulders, the surface layer is less than 10 inches thick and the depth to the underlying material is less than 18 inches. In some places, the surface layer is sandy loam. Erosion has exposed the subsoil in spots.

Included in mapping are small areas of Delft, Webster, Seaforth, and Terril soils. Delft and Webster soils are poorly drained. They are in drainageways. Seaforth soils are moderately well drained. They are in lower positions on the landscape than the Storden and Ves soils. Terril soils are moderately well drained. They are on foot slopes. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Storden and Ves soils is moderate. In both soils, surface runoff is medium to rapid and the available water capacity is high. The organic matter content is low in the Storden soil and moderate in the Ves soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is below a depth of 6 feet.

In most areas, the soils are used for corn, soybeans, and small grains. These soils have good potential for the crops commonly grown in the county. The major management concern is the moderate to severe hazard of erosion. In many areas, terracing and contour farming are difficult because of the complex and irregular slopes. Large amounts of crop residue left on the surface, grassed waterways, and a rotation system that includes small grains and forage crops help to control erosion and reduce runoff. If these soils are plowed in the fall, leaving a rough surface and some crop residue helps reduce runoff and control erosion and holds snow on the ground in the winter. Soil blowing and water erosion are severe hazards if the surface is left bare. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

The soils are generally well suited to trees and shrubs for windbreaks and environmental plantings. Optimum growth and plant survival are not expected in some areas of the Storden soil because of its high content of lime and low fertility. These soil conditions limit the choice of plants for use in the Storden soil. Soil conditions are variable enough to warrant onsite investigation before selecting the plants. Planting on the contour or maintaining a mulch of crop residue on the surface helps to control erosion. Competing plants can be controlled by cultivation or by herbicides.

Buildings constructed on these soils should be designed to conform to the natural slope, and land shaping may be necessary. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength and frost action. Roads should be run on the contour, if possible, and roadbanks should be planted to well adapted grasses to minimize erosion.

If septic tank absorption fields are to function properly on the soils, land shaping is necessary in most places and the distribution lines should be installed across the slope.

The soils in this complex are in capability subclass IIIe.

954D2—Storden-Ves loams, 12 to 18 percent slopes, eroded. This map unit consists of hilly, well drained soils on upland ridges and side slopes. These soils are dissected by shallow drainageways. Individual areas of this complex generally are oblong and range from 4 to about 30 acres in size.

Storden soil makes up 50 to 70 percent of this complex, and Ves soil makes up 15 to 30 percent. The Storden soil is on summits and shoulders, and the Ves soil is on side slopes. Both of these soils are on convex slopes. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Storden soil has a dark grayish brown loam surface layer about 8 inches thick. The underlying material to a depth of about 60 inches is brown and pale brown loam. Erosion has exposed the subsoil in spots.

Typically, the Ves soil has a very dark gray loam surface layer about 10 inches thick. The subsoil is about 16 inches thick. It is dark brown and brown, friable loam in the upper part and brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is calcareous, yellowish brown loam. In some places, the surface layer is less than 10 inches thick and depth to the underlying material is less than 18 inches. In some places, the surface layer and subsoil are sandy loam. Erosion has exposed the subsoil in spots.

Included in mapping are small areas of Delft, Seaforth, and Terril soils. Delft soils are poorly drained. They are in drainageways. Seaforth soils are moderately well drained. They are on low knolls. Terril soils are moderately well drained. They are on foot slopes. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Storden and Ves soils is moderate. In both soils, surface runoff is rapid and the available water capacity is high. The organic matter content is low in the Storden soil and moderate in the Ves soil. The available phosphorus is low in both soils, and the available potassium is medium to high. The seasonal high water table is at a depth of 6 feet.

In most areas, the soils are used for corn, soybeans, and small grains. They have fair potential for small grains, forage crops, corn, and soybeans. The major management concern is the moderate to severe hazard of erosion. In many areas, contour farming is difficult because of the complex and irregular slopes. Large amounts of crop residue left on the surface, grassed waterways, and a rotation system that includes small grains and forage crops help control erosion and reduce runoff. Applying fertilizer also helps to maintain the organic matter content and good soil tilth. If the soils are plowed in the fall, leaving a rough surface and some crop residue helps to control soil blowing, reduces runoff, and holds snow on the ground in the winter. Soil blowing and water erosion can be severe if the surface is left bare. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Optimum growth and survival are not expected. In some areas, a high content of lime in the soil limits the choice of plants. Soil conditions are variable enough to warrant onsite investigation before selecting the plants. Competing plants can be controlled by cultivation or by herbicies.

Slope is the main limitation to use of this soil as sites for buildings. Extensive land shaping generally is needed, and buildings should be designed to conform to the natural slope. Large amounts of cut and fill material generally are needed in constructing roads on this soil. Roads should be run on the contour and roadbanks planted to well adapted grasses to minimize erosion.

If septic tank absorption fields are to function properly on these soils, land shaping is necessary in most places and the distribution lines should be installed across the slopes.

The soils in this complex are in capability subclass IVe.

992E—Rock outcrop-Copaston complex, 2 to 40 percent slopes. This complex consists of shallow, gently undulating to very steep soils and Rock outcrops. Areas are adjacent to the Minnesota River Valley. Individual areas of this complex generally are elongated or circular and range from 4 to about 600 acres in size.

Rock outcrops make up 30 to 70 percent of this complex, and Copaston soil makes up 15 to 50 percent. The Copaston soil is on plane to slightly convex slopes. The areas of the Rock outcrop and Copaston soil are so intricately mixed or so small that it was not practical to map them separately.

Rock outcrop consists of igneous and metamorphic bedrock exposed at the surface. In some places, weathering and decomposition have formed soil on the Rock outcrop. In these places, the material is black gravelly or cobbly sandy loam. In some places, the decomposed and weathered bedrock material is several feet thick and contains many stones.

Typically, the Copaston soil has a black sandy loam surface layer about 9 inches thick. The subsurface layer is very dark brown and very dark grayish brown sandy loam about 5 inches thick. The subsoil is dark brown sandy loam about 4 inches thick. Igneous or metamorphic bedrock is at a depth of about 18 inches. In some places, the Copaston soil is more than 20 inches thick.

Included in mapping are small areas of Oshawa Variant, Wadena Variant, and Tilfer soils. Oshawa Variant soils are very poorly drained. They are in swales. Wadena Variant soils are well drained. They are in depressions. Tilfer soils are poorly drained and very poorly drained. They are in swales and drainageways. The included soils make up 5 to 20 percent of the map unit.

The permeability of the Copaston soil is moderate or moderately rapid. Surface runoff is rapid. The available water capacity is low. The organic matter content is moderate. The available phosphorus is low, and the available potassium is medium. The seasonal high water table is below a depth of 6 feet.

In most areas, this complex is used for pasture, woodland, habitat for wildlife, and recreation. The wooded areas are mostly cedar. Areas of this complex generally are not suited to crops and are poorly suited to pasture. Rock outcrops, low available water capacity, and the steep slopes are the main limitations. Grazing is limited to the spring and the late summer. In many areas that are now in woodland, the soils are well suited to habitat for woodland wildlife.

The soils generally are not suited to trees and shrubs for windbreaks and environmental plantings. The main limitations are the shallow depth to bedrock and the low available water capacity of the soils. Hand planting generally is required. Seedling mortality is high.

Areas of this complex are poorly suited to use as sites for buildings because of the slope and the shallow depth to bedrock. Extensive land shaping and blasting of the bedrock generally are necessary. Large amounts of cut and fill material and blasting of bedrock generally are needed for road construction. If possible, roads should be relocated in nearby areas that are better suited to this use.

The soils are poorly suited to use as septic tank absorption fields because of the underlying bedrock and the steep slopes. Septic tank absorption fields can be placed in some less sloping areas that are suitable for filling and mounding.

This complex is in capability subclass VIIs.

999B2—Ves-Estherville-Storden complex, 3 to 6 percent slopes, eroded. This complex consists of gently undulating, well drained soils. These soils are on upland ridges and side slopes. Individual areas generally are oblong and range from 4 to about 30 acres in size.

Ves soil makes up 20 to 45 percent of this complex, Estherville soil makes up 20 to 40 percent, and Storden soil makes up 10 to 30 percent. Ves soil is on summits and side slopes; Estherville soil is on summits, shoulders, and back slopes; and Storden soil is on the summits and shoulders. These soils are in areas that are so intermingled that it was not practical to map them separately.

Typically, the Ves soil has a very dark gray loam surface layer about 11 inches thick. The subsoil is about 19 inches thick. It is dark brown, friable loam in the upper part and light olive brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown loam. In some places, the surface layer is thicker than typical and the underlying material is at a depth of more than 40 inches. In some places, the surface layer and subsoil consist of coarser material, or there are stones about 1 foot in diameter on the surface and in the subsoil. Erosion has exposed the subsoil or the underlying material in spots.

Typically, the Estherville soil has a very dark gray sandy loam surface layer about 10 inches thick. The subsoil is dark brown, friable sandy loam about 9 inches thick. The underlying material to a depth of about 60 inches is grayish brown and yellowish brown gravelly coarse sand. In some places, the underlying material is only a few feet thick and is underlain by glacial till, or the surface layer is more than 24 inches thick, or there are stones about 1 foot in diameter on the surface and in the subsoil. Erosion has exposed the subsoil or the underlying material in spots.

Typically, the Storden soil has a dark grayish brown loam surface layer about 10 inches thick. The underlying material to a depth of about 60 inches is pale brown loam. In some places on summits, the surface layer is less than 7 inches thick, and in some places on back slopes it is up to 12 inches thick. Also, in some places, the underlying material is stratified or there are stones about 1 foot in diameter on the surface and in the subsoil. Erosion has exposed the subsoil or the underlying material in spots.

Included in mapping are small areas of Salida and Terril soils. Salida soils are excessively drained; they are on summits. Terril soils are moderately well drained; they are on foot slopes. The included soils make up 10 to 15 percent of the map unit.

The permeability of Storden and Ves soils is moderate. The permeability of the Estherville soil is moderately rapid in the upper part; it is rapid in the underlying material. Surface runoff is medium on all the soils. The available water capacity of Ves and Storden soils is high, and that of the Estherville soil is low. The organic matter content is low in the Storden soil and moderate in Estherville and Ves soils. The available phosphorus in all the soils is low, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, the soils are used for corn, soybeans, and small grains. The soils have fair potential for most crops but are best suited to early maturing crops, such as oats, wheat, and forage crops. These crops mature before the hot, dry part of summer. Corn and soybean yields are fair in years of ample and timely rainfall. Erosion is a moderate hazard. Because of the irregular and complex slopes, terracing and contour farming are difficult in many areas. Large amounts of residue left on the surface and grassed waterways help to control erosion and runoff. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Optimum growth and survival are not expected. The high content of lime in some areas and the low available water capacity in the Estherville soil restrict the kinds of plants that will grow. Onsite investigation may be necessary before selecting plants. Competing plants can be controlled by cultivation or by herbicides.

The soils are suited to use as sites for buildings. Constructing roads on well compacted, suitable base material helps to prevent damage caused by low soil strength and frost action.

Areas of this complex are poorly suited to septic tank absorption systems because the Estherville soil does not adequately filter the effluent. There must be at least 6 inches of sandy loam between the tile lines and the layer of sand. For adequate treatment of the effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

The soils in this complex are in capability subclass IIIe.

999C2—Storden-Estherville-Ves complex, 6 to 12 percent slopes, eroded. This complex consists of rolling, well drained soils on upland ridges and side slopes. Some areas of these soils are dissected by shallow drainageways. Individual areas of this complex generally are oblong and range from 4 to about 25 acres in size.

Storden soil makes up 25 to 40 percent of this complex, Estherville soil makes up 20 to 40 percent, and Ves soil makes up 20 to 35 percent. Storden soil is on summits and shoulders. Estherville soil is on summits, shoulders, and back slopes. Ves soil is on back slopes and saddles. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Storden soil has a dark grayish brown loam surface layer about 11 inches thick. The underlying material to a depth of about 60 inches is dark brown, brown, and dark yellowish brown loam. In some places, the surface layer is less than 7 inches thick. Also, in some places, the surface layer and the upper part of the underlying material are gravelly sandy loam or gravelly loam. Erosion has exposed the subsoil or the underlying material in spots. In some places, stones about 1 foot in diameter are on the surface and in the subsoil.

Typically, the Estherville soil has a very dark gray sandy loam surface layer about 10 inches thick. The subsoil is about 13 inches thick. It is dark brown, friable loam in the upper part and dark yellowish brown, friable loamy coarse sand in the lower part. The underlying material to a depth of about 60 inches is dark yellowish brown gravelly coarse sand. In some places, the underlying material is only a few feet thick and is underlain by glacial till. Erosion has exposed the subsoil or the underlying material in spots. In some places, stones about 1 foot in diameter are on the surface and in the subsoil.

Typically, the Ves soil has a very dark gray loam surface layer about 10 inches thick. The subsoil is about 12 inches thick. It is dark brown, friable loam in the upper part and yellowish brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is brown and yellowish brown loam with lens of sandy loam. In some places on saddles and foot slopes, the surface layer and subsoil are sandy loam. Erosion has exposed the subsoil or the underlying material in spots. In some places, stones about 1 foot in diameter are on the surface and in the subsoil.

Included in mapping are small areas of Terril and Salida soils. Terril soils are moderately drained. They are on foot slopes. Salida soils are excessively drained. They are on summits. The included soils make up 10 to 15 percent of the map unit.

The permeability of Storden and Ves soils is moderate. The permeability of the Estherville soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium to rapid on all the soils. The available water capacity of the Estherville soil is low, and that of Storden and Ves soils is high. The organic matter content is low in the Storden soil and moderate in Estherville and Ves soils. The available phosphorus is low in all the soils, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, the soils in this complex are used for corn, soybeans, or small grains. The soils have fair potential for most crops but are best suited to early maturing crops, such as small grains or forage crops. These crops mature before the hot, dry part of summer. Corn and soybean yields are fair in years of ample and timely rainfall. Erosion is a moderate hazard. In many areas, terracing and contour farming are difficult because of irregular and complex slopes. Large amounts of crop residue left on the surface and grassed waterways help to control erosion and runoff. Applying fertilizer helps to maintain the content of organic matter and the good tilth. In the Storden soil, liberal applications of potash and phosphate are needed to correct the fertility imbalance, which is caused by a high content of lime.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Optimum growth and survival are not expected. The high content of lime in some areas and the low available water capacity in the Estherville soil restrict the kinds of plants that will grow. Erosion is a management concern. Site preparation should be limited to the area within 2 feet of the plantings to minimize erosion. Soil conditions are variable enough to warrant onsite investigation before selecting plants. Competing plants can be controlled by cultivation or by herbicides.

Buildings constructed on the soils in this complex should be designed to conform to the natural slope, and land shaping may be necessary. Constructing roads on well compacted, suitable base material helps to prevent damage caused by low soil strength and frost action. Roads should be run on the contour, if possible, and roadbanks should be planted to well adapted grasses to minimize erosion.

The soils making up this complex are poorly suited to septic tank absorption systems because of the slope. The Estherville soil does not adequately filter effluent. The poor filtering capacity can result in the pollution of ground water. Distribution lines should be installed across the slope. There must be at least 6 inches of sandy loam between the tile lines and the sand layer. For adequate treatment of the effluent, either shallow trenches, no deeper than 18 inches, or elevated beds or mounds are required.

The soils in this complex are in capability subclass IVe.

999D2—Storden-Estherville-Ves complex, 12 to 18 percent slopes, eroded. This complex consists of hilly, well drained soils on upland ridges and side slopes. Most areas of these soils are dissected by drainageways. Individual areas of this complex generally are oblong and range from 4 to about 30 acres in size.

Storden soil makes up 35 to 45 percent of this complex, Estherville soil makes up 25 to 45 percent, and Ves soil makes up 15 to 35 percent. Storden soil is on summits and shoulders. Estherville soil is on summits, shoulders, and back slopes. Ves soil is on back slopes and saddles. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Storden soil has a dark grayish brown loam surface layer about 7 inches thick. The underlying material to a depth of about 60 inches is calcareous, brown and yellowish brown loam. In some places, the surface layer is less than 7 inches thick, or the surface layer and upper part of the underlying material are gravelly sandy loam or gravelly loam. Erosion has exposed the subsoil or the underlying material in spots.

Typically, the Estherville soil has a very dark gray sandy loam surface layer about 9 inches thick. The subsoil is about 7 inches thick. It is brown to yellowish brown, friable sandy loam. The underlying material to a depth of about 60 inches is dark yellowish brown and yellowish brown gravelly coarse sand. In some places on summits and shoulders, erosion has exposed the subsoil or the gravel or gravelly underlying material. In some places, the underlying material is only a few feet thick and is underlain by glacial till. Erosion has exposed the subsoil or the underlying material in spots.

Typically, the Ves soil has a very dark gray loam surface layer about 10 inches thick. The subsoil is about 10 inches thick. It is dark brown, friable loam in the upper part and light olive brown, friable loam in the lower part. The underlying material to a depth of about 60 inches is yellowish brown and light olive brown loam. In some places the surface layer and subsoil are sandy loam. Erosion has exposed the subsoil or the underlying material in spots.

Included in mapping are small areas of Salida and Terril soils. Salida soils are excessively drained. They are on summits. Terril soils are moderately well drained. They are on foot slopes and toe slopes and in drainageways. The included soils make up 5 to 20 percent of the map unit.

The permeability of Storden and Ves soils is moderate. The permeability of the Estherville soil is moderately rapid in the upper part and rapid in the lower part. Surface runoff is medium to rapid on all the soils. The available water capacity of the Estherville soil is low and that of Storden and Ves soils is high. The organic matter content is moderate in Estherville and Ves soils and low in the Storden soil. The available phosphorus is low in all the soils, and the available potassium is medium to high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, the soils in this complex are used for oats and wheat or for pasture. The soils have poor potential for most crops, but may be suited to early maturing crops such as small grains or forage plants. These crops mature before the hot and dry part of summer. Moderate to severe erosion is a hazard. Contour farming and terracing are difficult because of the irregular and complex slopes. Large amounts of crop residue left on the surface and grassed waterways help to control erosion and runoff. Rotation grazing and proper stocking utilize forage crops most efficiently.

Trees and shrubs need to be carefully selected for windbreaks and environmental plantings. Optimum growth and survival are not expected. The high content of lime in some areas and the low available water capacity in the Estherville soil restrict the kinds of plants that will grow. Erosion is a management concern. Site preparation should be limited to the area within 2 feet of the plantings to minimize erosion. Soil conditions are variable enough to warrant onsite investigation before selecting plants. Competing plants can be controlled by cultivation or by herbicides.

Slope is the main limitation of the soils for use as sites for buildings. Buildings constructed on the soils in this complex should be designed to conform to the natural slope. Extensive land shaping generally is needed. Large amounts of cut and fill generally are needed in constructing roads on the soils in this complex. Roads should be run on the contour, if possible, and roadbanks should be planted to well adapted grasses to minimize erosion.

The soils making up this complex are poorly suited to septic tank absorption systems because of the steep slopes. The Estherville soil does not adequately filter effluent. The poor filtering capacity can result in the pollution of ground water. Distribution lines should be installed across the slope.

The soils in this complex are in capability subclass VIe.

1016—Udorthents, loamy. These are nearly level to sloping, moderately well drained and well drained soils in or around urban areas throughout Redwood County. These soils are in cut or graded areas along highways, in dumps and landfills that have been filled in, and on leveled gravel pits. They are also in some poorly drained or very poorly drained areas that have been filled with loamy soil material. Individual areas of this map unit are uniform in shape and range from 4 to about 20 acres in size.

Permeability ranges from slow to moderate. Surface runoff is slow to rapid. The available water capacity is variable. Reaction varies considerably. Fertility is generally low. The organic matter content is moderate or low.

In most areas, the soils making up this map unit are used as sites for residential or commercial buildings or for highways. They have poor potential for cropland. The soils have a wide range of characteristics, so that onsite investigation is necessary to determine the suitability for a particular use.

Udorthents, loamy, are not assigned to a capability subclass.

1029—Pits, gravel. This map unit consists of open excavations from which sand and gravel is being or has been removed. The shape of the pits are quite variable and depends on the quantity of materials being removed. Individual areas of this map unit range from 4 to about 70 acres in size. Some of the deeper pits are ponded. Many pits have been abandoned because of the poor quality or reduced quantity of the sand and gravel.

This map unit is generally within areas of Estherville, Wadena, or Salida soil. The surface layer has been stripped away for use as topsoil or has been piled around the edge of the pit. The gravel and coarse sand materials have been removed from the area, leaving an open pit.

Abandoned pits have good suitability for habitat for wildlife. The potential of pits that can be leveled is fair to poor for crops and pasture. The suitability of pits for recreational development is good to fair (fig. 10).

The soils making up this unit have a wide range of characteristics, so that onsite investigation is necessary to determine their suitability for a particular use.

This unit has not been assigned to a capability subclass.

1053—Aquolls, ponded. These are level, very poorly drained soils in undrained, closed depressions (marshes). Individual areas are nearly circular or irregular in shape and range from about 4 to 100 acres in size.

Commonly, the soils are covered by 1 to 3 feet of water except in dry years. Aquolls include ponded phases of Knoke, Glencoe, and Okoboji soils.

Included in mapping on the edges of areas are small areas of Canisteo soils, which are poorly drained.

The soils making up this unit are used mainly as habitat for wildlife. Cattails, reeds, sedges, and other water-associated plants grow well in these marshy areas. The soils generally are not suited to cultivated crops, pasture, recreation, or most engineering uses. Their suitability as habitat for wetland wildlife is good.

Aquolls, ponded, are in capability subclass VIIIw.

1833—Coland clay loam, occasionally flooded. This is a nearly level, poorly drained soil on flood plains. Individual areas are elongated or irregular in shape and range from 4 to about 80 acres in size.

Typically the surface layer is a black clay loam about 10 inches thick. The subsurface layer is black clay loam about 29 inches thick. The underlying material to a depth of about 60 inches is very dark gray and dark olive gray clay loam. In some places, the profile has a higher clay content than typical.

Included in mapping are small areas of Millington, Nishna, and Spillville soils. Millington soils are poorly drained and are calcareous. Nishna soils have more clay in the profile than that of the Coland soil. Millington and Nishna are in similar positions on the landscape to the Coland soil. Spillville soils are moderately well drained. They are on small rises. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Coland soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 1 to 3 feet.

In most areas, this soil is used for corn and soybeans. If properly drained, it has good potential for most crops grown in the county. Flooding during the growing season can damage crops. The flooding hazard can be reduced by constructing dikes along the stream or river to keep the floodwaters within the channels. Most of the flooding is of short duration and occurs early in the spring and during periods of heavy rain in June. Tile drainage helps reduce wetness. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase organic matter content and maintain good soil tilth. If the soil is tilled in the fall, good soil tilth can be maintained and crops can be planted early in the spring.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side

Figure 10.—This area of Pits, gravel, has been developed for recreational use.

ditches and culverts help prevent damage caused by flooding, low soil strength, and frost action.

This Coland soil is in capability subclass IIw.

1834—Coland clay loam, frequently flooded. This is a nearly level, poorly drained soil on flood plains. Individual areas are elongated and range from 4 to about 60 acres in size.

Typically the surface layer is black clay loam about 10 inches thick. The subsurface layer is black clay loam about 32 inches thick. The underlying material to a depth of about 60 inches is very dark grayish brown clay loam. In some places, the surface layer is sandy, or the underlying material has a higher clay content than typical.

Included in mapping are small areas of Oshawa and Spillville soils. Oshawa soils are very poorly drained. They are in swales. Spillville soils are moderately well drained. They are in drainageways. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Coland soil is moderate. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is medium to high. The seasonal high water table is at a depth of 1 to 3 feet.

In most areas, this soil is used for pasture or habitat for wildlife. It has fair suitability for pasture and good suitability for habitat for wetland wildlife. This soil provides fair grazing when it is not flooded. Flooding occurs early in the spring and after heavy rains. If the existing stands of native grasses are fertilized, they provide good grazing. Rotation grazing and proper stocking utilize existing forage crops most efficiently. This soil generally is not suited to crops because of the frequent flooding. The suitability of this soil for habitat for wetland wildlife can be increased by developing the shallow water areas and planting aquatic plants.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Flooding increases seedling mortality. Competing plants can be controlled by cultivation or by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of the flooding. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by flooding, low soil strength, and frost action.

This Coland soil is in capability subclass Vw.

1850—Oshawa Variant stony clay loam. This is a nearly level, very poorly drained soil on high terraces above the Minnesota River Valley. Granitic cobbles and stones that are 3 to 24 inches in diameter cover about 5 percent of the surface. Individual areas of this map unit generally are elongated and range from 4 to about 70 acres in size. This soil is wet because of seepage. It is subject to rare flooding.

Typically, the surface layer is black stony clay loam about 13 inches thick. The subsurface layer is very dark gray loam and dark olive gray clay loam about 29 inches thick. The underlying material to a depth of about 60 inches is dark gray silty clay loam.

Included in mapping are small areas of Millington and Blue Earth soils. Millington soils are poorly drained. They are downslope. Blue Earth soils are very poorly drained. They are in higher positions on the landscape than the Oshawa Variant soil. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Oshawa Variant soil is moderately slow. Surface runoff is slow. The available water capacity is high. The organic matter content is high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at or near the surface of the soil.

This soil generally is not suited to corn or soybeans or the other crops commonly grown in the county. Stones and wetness are hazards. If the summer is dry, this soil provides limited grazing. The many stones on this soil, however, hamper the use of farm machinery.

In most areas this soil is used as habitat for wetland wildlife. It is fairly suited to this use. Because most areas are dry during midsummer, aquatic plants do not grow well on this soil. The suitability of this soil for habitat for wetland wildlife can be maintained by developing the shallow water areas.

This soil generally is not suited to trees and shrubs for windbreaks and environmental plantings. Trees and shrubs that are tolerant of the high content of lime and the excessive moisture should be selected for these uses. Ponding for long periods increases seedling mortality. Because of the many stones on the surface of the soil, hand planting generally is required. Competing plants can be controlled by herbicides.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of wetness. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by low soil strength and frost action.

This Oshawa Variant soil is in capability subclass VIIw.

1851B—Blue Earth mucky clay loam, sloping. This is a gently sloping, very poorly drained soil on high foot slopes in the Minnesota River Valley (fig. 11). This soil is subject to side-slope seepage. Individual areas generally are elongated and range from 3 to about 150 acres in size.

Typically, the surface layer is very dark gray mucky clay loam about 10 inches thick. The underlying material is black mucky clay loam over very dark gray mucky clay loam and dark gray clay loam which extends to a depth of about 60 inches.

Included in mapping are small areas of Millington and Oshawa Variant soils. Millington soils are poorly drained. Oshawa Variant soils are very poorly drained. These soils are downslope. Oshawa Variant soils have stones on the surface and in the profile. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Blue Earth soil is moderately slow. Surface runoff is slow. The available water capacity is high. The organic matter content is very high. The available phosphorus is low, and the available potassium is low to medium. The seasonal high water table is at or near the surface because of seepage from the adjacent uplands.

This soil is well suited to use as habitat for wetland wildlife, and it is used mainly for that purpose. There are numerous shallow-water areas and a good supply of aquatic plants suitable for wildlife use.

This soil generally is not suited to corn, soybeans, or other commonly grown crops because of wetness, which is caused by seepage.

This soil generally is not suitable for windbreaks and environmental plantings because of the high content of lime and excessive moisture in the soil. If these limitations are reduced, some trees and shrubs can be grown.

This soil generally is not suited to use as sites for buildings or septic tank absorption fields because of wetness. Soils that are better suited to these uses generally are nearby. Constructing roads on raised suitable base material and providing adequate side ditches and culverts help prevent damage caused by low soil strength and frost action.

This Blue Earth soil is in capability subclass VIIw.

Figure 11.—An area of Blue Earth mucky clay loam, sloping, in the Minnesota River Valley.

1852F—Terril-Swanlake loams, 25 to 70 percent slopes. This map unit consists of very steep, moderately well drained and well drained soils on convex slopes along streams and in larger drainageways on glacial moraines. Most areas of these soils are dissected by drainageways and gullies. Individual areas of this complex are oblong or irregular in shape and range from 5 to about 450 acres in size.

Terril soil makes up 50 to 60 percent of the map unit, and Swanlake soil makes up 25 to 30 percent. The Terril soil is moderately well drained. It is on side slopes and foot slopes. The Swanlake soil is well drained. It is on summits and shoulders. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the surface layer of Terril soil is black loam about 10 inches thick. The subsurface layer is about 26 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil is dark brown, mottled loam about 18 inches thick. The underlying material to a depth of about 60 inches is olive brown, mottled loam. In some places, the underlying material is silty. Also, in some places, the thickness of the dark surface layer ranges from less than 24 inches to more than 36 inches. The surface layer, subsoil, and underlying material, in some places, have a coarser texture than typical.

Typically, the surface layer of the Swanlake soil is black loam about 9 inches thick. The underlying material to a depth of about 60 inches is brown and light olive brown loam. In some places along the Minnesota River, the underlying material is kaolinitic clay. Erosion has exposed the underlying material in some places, especially on side slopes.

Included in mapping are small areas of Estherville soils on terraces and Delft soils on foot slopes. Estherville soils are well drained, and Delft soils are poorly drained. The included soils make up 3 to 15 percent of the map unit.

Permeability of the Terril and Swanlake soils is moderate. Surface runoff is rapid, and the available water capacity is high. The organic matter content is high in the Terril soil and moderate in the Swanlake soil. Both soils are low in available potassium and are medium to high in available phosphorus. The seasonal high water table is below a depth of 6 feet.

The soils making up this complex generally are not suitable for crops because of the very steep slopes. In most areas, the soils are used for pasture and habitat for woodland wildlife. The soils have fair suitability for pasture. The very steep slopes and the erosion hazard are the main management concerns. Grazing is limited to the late spring and the summer. Rotation grazing and proper stocking utilize the existing forage crop most efficiently.

The soils generally are not suited to trees and shrubs for windbreak plantings, but they are suitable for environmental plantings. The steep slopes are the main management concern. Hand planting generally is required. Optimum growth and plant survival are not expected.

Slope is the main limitation for use of the soils as sites for buildings. Extensive land shaping generally is needed. Buildings should be designed to conform to the natural slope. The soils in this complex are poorly suited to roads because of the slope and the low soil strength. Large amounts of cut and fill material are generally needed and a well compacted, suitable base material should be used to help prevent damage caused by low soil strength. Placing roads on the contour, if possible, and planting roadbanks to well adapted grasses minimize the erosion hazard.

The soils in this complex generally are not suitable for septic tank absorption fields.

This Terril-Swanlake complex is in capability subclass VIIe.

1853A—Wadena Variant loam, 0 to 2 percent slopes. This is a moderately deep, nearly level, moderately well drained soil. It is on broad, slightly concave areas on terraces that are underlain by bedrock. Individual areas of this soil are irregular in shape and range from 4 to about 100 acres in size.

Typically, the surface layer is black loam about 11 inches thick. The subsoil is dark grayish brown, friable loam about 7 inches thick. The underlying material to a depth of about 32 inches is light yellowish brown and pale brown loam underlain by weathered igneous and metamorphic bedrock. In some areas, the bedrock is weathered to a depth of more than 50 inches. Also, in some places, many stones are on the surface and throughout the profile.

Included in mapping are small areas of Rock outcrop and Copaston and Tilfer soils. Rock outcrop and Copaston soils are on slight rises and knolls. Copaston soils are well drained. Tilfer soils are poorly drained and very poorly drained. They are in swales and drainageways. The included soils make up 5 to 15 percent of the map unit.

The permeability of the Wadena Variant soil is moderate or moderately rapid. Surface runoff is medium. The available water capacity is low. The organic matter content is moderate. The available phosphorus is low, and the available potassium is high. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn, soybeans, and small grains. It has fair potential for corn and soybeans and has good potential for small grains. If the summer is dry, this soil becomes droughty. It is best suited to crops that mature before the hot, dry season. Leaving large amounts of residue on the surface helps to maintain organic matter content and good soil tilth.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The limited available water capacity, the coarse textured underlying material, and the shallow depth to bedrock limit the kinds of plants that will grow well on this soil. Competing plants can be controlled by cultivation or by herbicides.

Excavating for buildings is difficult because of the underlying bedrock. Large machinery generally is required. Constructing roads on well compacted, coarse textured base material helps prevent damage caused by low soil strength. The underlying bedrock hinders road construction, and large machinery is required in some areas.

The distribution lines for septic tank absorption fields are difficult to install because of the underlying bedrock. Septic tank absorption fields should be placed in areas where the soil is sufficiently deep.

This Wadena Variant soil is in capability subclass IIs.

1853B—Wadena Variant loam, 2 to 6 percent slopes. This is a moderately deep, gently undulating, well drained soil. It is on terraces that are underlain by bedrock. Individual areas of this soil are irregular in shape and range from 4 to about 145 acres in size.

Typically, the surface layer is black loam about 10 inches thick. The subsurface layer is very dark grayish brown fine sandy loam about 3 inches thick. The subsoil is about 18 inches thick. It is dark grayish brown fine sandy loam in the upper part and brown and pale brown fine sandy loam in the lower part. Below this, to a depth of about 31 inches, is weathered igneous and metamorphic bedrock. In some places, the bedrock is decomposed to a depth of more than 50 inches.

Included in mapping are small areas of Rock outcrop and Copaston and Tilfer soils. Rock outcrop and Copaston soils are on rises and knolls. Copaston soils are well drained. Tilfer soils are poorly drained and very poorly drained. They are in swales and drainageways. In some places, stones on the surface make tillage impractical. The included soils make up 3 to 15 percent of the map unit.

The permeability of the Wadena Variant soil is moderate or moderately rapid. Surface runoff is slow. The available water capacity is low. The organic matter content is moderate. The available potassium is medium to high, and the available phosphorus is low. The seasonal high water table is at a depth of more than 6 feet.

In most areas, this soil is used for corn, soybeans, and small grains. It has fair potential for crops. The hazard of erosion and low available water capacity are the main concerns in management. This soil is best suited to some early-maturing crops. If row crops are grown, erosion can be controlled by farming on the contour and by leaving large amounts of crop residue on the surface. Drainageways that are shaped, seeded, and maintained as grassed waterways reduce the hazard of gully erosion.

Trees and shrubs that are tolerant of droughty conditions should be selected for windbreaks and environmental plantings. The limited available water capacity, the coarse textured underlying material, and the shallow depth to bedrock in this soil limit the kinds of plants that will grow well on the soil. Competing plants can be controlled by cultivation or by herbicides.

Excavating for buildings is difficult because of the underlying bedrock. Large machinery generally is required. Constructing roads on well compacted, coarse textured base material helps prevent damage caused by low soil strength. The underlying bedrock can hinder road construction. Large machinery generally is required in some areas.

The underlying bedrock in this soil also can hinder the installation of distribution lines for septic tank absorption fields. Septic tank absorption fields should be placed in areas where the soil is sufficiently deep.

This Wadena Variant soil is in capability subclass IIe.

1897—Seaforth-Wilmonton clay loams. This map unit consists of nearly level, moderately well drained soils on dissected ground moraines. Individual areas generally are oblong or irregular in shape and range from 4 to about 40 acres in size.

Seaforth soil makes up 35 to 50 percent of this map unit, and Wilmonton soil makes up 20 to 35 percent. The Seaforth soil is on convex knolls and rises. The Wilmonton soil is in slightly concave to plane areas. These soils are in areas that are so intricately mixed or so small that it was not practical to map them separately.

Typically, the Seaforth soil has a black clay loam surface layer about 8 inches thick. The subsurface layer is very dark gray clay loam about 4 inches thick. The subsoil is about 18 inches thick. It is brown, friable loam in the upper part and mottled, light yellowish brown, friable clay loam in the lower part. The underlying material to a depth of about 60 inches is light olive brown and grayish brown, firm loam. In some places, erosion has exposed the subsoil.

Typically, the Wilmonton soil has a black clay loam surface layer about 8 inches thick. The subsurface layer is black clay loam about 6 inches thick. The subsoil is about 23 inches thick. It is dark grayish brown and olive brown, friable clay loam in the upper part and light olive brown, friable to firm clay loam in the lower part. The underlying material to a depth of about 60 inches is light yellowish brown clay loam.

Included in mapping are small areas of Letri and Okoboji soils. Letri soils are poorly drained. They are in drainageways. Okoboji soils are very poorly drained. They are in depressions. The included soils make up 15 to 20 percent of the map unit.

The permeability of the Seaforth soil is moderate, and the permeability of the Wilmonton soil is moderately slow. In both soils, surface runoff is medium or slow and the available water capacity is high. The matter content is high in both soils. The available phosphorus is low in both soils, and the available potassium is low to medium. The seasonal high water table is at a depth of 2.5 to 5 feet in the Wilmonton soil and at a depth of 3 to 6 feet in the Seaforth soil.

In most areas, the soils are used for corn and soybeans. They have good potential for the crops commonly grown in the county. The Seaforth soil generally needs liberal applications of potash and phosphate to correct the fertility imbalance caused by the high content of lime in the soil. Restricting field operations during periods of wetness and leaving large amounts of crop residue on the surface increase organic matter content and maintain good soil tilth.

Trees and shrubs that are tolerant of the high content of lime in the Seaforth soil should be selected for windbreaks and environmental plantings. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on these soils, the lower or basement level should be constructed above the seasonal high water table, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the Wilmonton soil. In addition, backfilling around the foundation with a suitable coarse material also protects the building against structural damage. Constructing roads on well compacted, suitable base material helps prevent damage caused by frost action and by low soil strength in the Wilmonton soil.

Subsurface seepage trenches for treatment of effluent in septic tank absorption fields cannot be used on the soils unless drainage is provided to maintain the necessary 3-foot separation between the bottom of the seepage trench and the highest level of saturated soil. In some places, the septic tank absorption field could be placed in an elevated bed or mound that consists of a minimum of 1 foot of suitable fill material. In some places, both subsurface drainage and an elevated bed may be necessary.

This Seaforth-Wilmonton complex is in capability subclass IIs.

1899B—Wilmonton Variant loam, 2 to 12 percent slopes. This is a gently sloping to sloping, moderately well drained soil. It is on terraces that are adjacent to streams and rivers. Individual areas of this soil are oblong and range from 4 to about 200 acres in size.

Typically, the surface layer is black loam about 12 inches thick. The subsurface layer is black loam about 7 inches thick. Ironstone fragments are throughout the subsurface layer. The subsoil is about 22 inches thick. The upper part is brown clay, and the lower part is dark grayish brown, mottled clay. The underlying material to a depth of about 60 inches is dark gray, mottled clay. In some places, about 2 feet of sandy loam glacial material overlies the clay subsoil. In some places, the ironstone fragments are cemented and are nearly continuous. Rocks and stones are on the surface in some uncultivated areas.

Included in mapping are small areas of Delft, Terril, and Estherville soils. Delft soils are poorly drained. They are on foot slopes. Terril soils are moderately well drained. They are also on foot slopes. Estherville soils are well drained. They are on knolls. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Wilmonton Variant soil is very slow. Surface runoff is medium to rapid. The available water capacity is moderate. The organic matter content is high. The available phosphorus is low, and the available potassium is high. A perched seasonal high water table is at a depth of 2 to 3 feet.

In most areas, the soil is used for corn and soybeans or for hay. It has good potential for these crops. The hazard of erosion is the main concern in management. If row crops are grown, erosion can be controlled by farming on the contour and by leaving large amounts of crop residue on the surface. Drainageways that are shaped, seeded, and maintained as grassed waterways reduce the hazard of gully erosion.

Trees and shrubs that are tolerant of excessive moisture should be selected for windbreaks and environmental plantings. Excessive soil moisture in the spring can reduce plant growth. The hazard of erosion is a management concern. Site preparation should be limited to the area within 2 feet of the plantings to minimize erosion. Competing plants can be controlled by cultivation or by herbicides.

If buildings are constructed on this soil, the lower or basement level should be constructed above the seasonal high water table, and the site should be landscaped so that surface water drains away from the building. Tile drains around the foundation remove excess subsurface water. Foundations and footings should be designed to prevent structural damage caused by the shrinking and swelling of the soil. In addition, backfilling around the foundation with a suitable coarse material also protects the building against structural damage. Constructing roads on well compacted, suitable base material helps prevent damage caused by low soil strength.

This soil is not suitable for septic tank absorption fields. The soil cannot readily absorb the effluent from septic tank absorption fields because of its slow permeability.

This Wilmonton Variant soil is in capability subclass IIIe.

1899E—Wilmonton Variant sandy clay loam, 12 to 40 percent slopes. This is a moderately steep to very steep, moderately well drained soil. It is on terrace escarpments that are adjacent to major rivers. Individual areas of this soil are oblong and range from 4 to about 30 acres in size.

Typically, the surface layer is very dark gray sandy clay loam about 9 inches thick. The subsoil is brown clay loam in the upper 11 inches and grayish brown in the lower 9 inches. The underlying material to a depth of about 60 inches is olive gray clay. In some places, a cemented ironstone layer is below the surface layer.

Included in mapping are small areas of Estherville, Dickman, and Terril soils. Estherville and Dickman soils are well drained. These soils are on knolls. Terril soils are moderately well drained. They are on foot slopes. Terril soils have a thicker surface layer than the Wilmonton Variant soil. The included soils make up 10 to 15 percent of the map unit.

The permeability of the Wilmonton Variant soil is very slow. Surface runoff is rapid. The available water capacity is moderate. The organic matter content is moderate. The available phosphorus is low, and the available potassium is high. A perched seasonal high water table is at a depth of 2 to 3 feet.

In most areas, this soil is used for pasture. It has fair suitability for pasture and has poor potential for crops because of the steep slope and the hazard of erosion. Native grass yields are fair if the soil is fertilized. Rotation grazing and proper stocking utilize existing forage crops most efficiently.

This soil generally is not suited to trees and shrubs for windbreak plantings, but they are suitable for environmental plantings. The hazard of erosion is a management concern. Site preparation should be limited to an area within 2 feet of the plantings to minimize the erosion hazard. Competing plants can be controlled by cultivation or by herbicides.

Slope is the main limitation to use of the soil as sites for buildings. Extensive land shaping generally is needed, and buildings should be designed to conform to the natural slope. This soil is poorly suited to roads because of the slope and the low soil strength. Large amounts of cut and fill material generally are needed, and a well compacted, suitable base material should be used to help prevent damage caused by low soil strength. Placing roads on the contour, if possible, and planting roadbanks to well adapted grasses minimize erosion.

This soil is not suited to use as septic tank absorption fields because of the slope. Also, the soil cannot readily absorb the effluent in septic tank absorption fields because of its very slow permeability. Soils that are better suited to this use generally are nearby.

This Wilmonton Variant soil is in capability subclass VIIe.

Prime Farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Redwood County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in meeting the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal imputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may currently be in use as cropland, pasture, or woodland, or they may be in other uses. They either are used for producing food or fiber or are available for these uses. Urban or built-up land and water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not subject to frequent flooding during the growing season. The slope ranges mainly from 0 to 6 percent.

Soils that have a high water table, are subject to flooding, or are droughty may qualify as prime farmland soils if the limitations or hazards are overcome by drainage, flood control, or irrigation. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

About 431,000 acres in Redwood County, or nearly 77 percent of the county, is prime farmland. Prime farmland areas are scattered throughout the county. Nearly all of the prime farmland is used for crops.

A recent trend in land use in some parts of the county has been the conversion of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are more erodible, droughty, or difficult to cultivate and which generally are less productive than prime farmland.

The following map units, or soils, make up prime farmland in Redwood County. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed Soil Map Units." This list does not constitute a recommendation for a particular land use.

27A	Dickinson fine sandy loam, 0 to 2 percent slopes
27B	Dickinson fine sandy loam, 2 to 6 percent slopes
39A	Wadena loam, 0 to 2 percent slopes
39B	Wadena loam, 2 to 6 percent slopes
86	Canisteo clay loam (where drained)
94B	Terril loam, 2 to 6 percent slopes
113	Webster clay loam (where drained)
128A	Grogan loam, 0 to 2 percent slopes
128B	Grogan loam, 2 to 6 percent slopes
149B	Everly clay loam, 2 to 4 percent slopes
149B2	Everly clay loam, 3 to 6 percent slopes, eroded
227	Lemond loam (where drained)
241	Letri clay loam (where drained)
247	Linder loam
255	Mayer loam (where drained)
269	Millington loam (where drained)
282	Hanska fine sandy loam (where drained)
313	Spillville loam, occasionally flooded
345	Wilmonton clay loam
392	Biscay loam (where drained)
421B	Ves loam, 1 to 4 percent slopes
421B2	Ves loam, 3 to 6 percent slopes, eroded
423	Seaforth loam
446	Normania loam

574	Du Page loam
654	Revere clay loam (where drained)
883	Du Page-Zumbro complex
884	Delft-Webster complex (where drained)
894B2	Everly-Storden complex, 3 to 6 percent slopes, eroded
954B2	Ves-Storden loams, 3 to 6 percent slopes, eroded
1833	Coland clay loam, occasionally flooded (where drained)
1853A	Wadena Variant loam, 0 to 2 percent slopes
1853B	Wadena Variant loam, 2 to 6 percent slopes
1897	Seaforth-Wilmonton clay loams

Use and Management of the Soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and Pasture

Lowell P. Noeske, district conservationist, Soil Conservation Service, helped prepare this section.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

This section provides information about the agricultural potential and the conservation practices needed in the survey area. The information is useful to equipment dealers, land improvement contractors, fertilizer companies, land assessors, realtors, planners, and others. Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed Soil Map Units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 527,000 acres in the county was used as cropland according to the 1978 statistics compiled by the Redwood County Agricultural Stabilization and Conservation Service. Of this cropland total, 440,000 acres was used for row crops, mainly corn, soybeans, sugar beets, and sunflowers; 34,000 acres for close-grown crops, mainly wheat, oats, and barley; 14,000 acres for rotation hay and pasture; and about 39,000 acres for other crops. Approximately 20,000 acres was used as permanent pasture. The remaining acreage in the county consists of roads, farmsteads, urban areas, and other lands.

The potential of the soils in Redwood County for the production of crops on tillable land is high. Using the latest crop production technology, food production can be increased. The information in this soil survey can facilitate the application of such technology.

The acreage in crops is slowly decreasing as more land is used for urban development. Approximately 150 to 250 acres of cropland is lost to such development each year. This soil survey can help planners make land use decisions that will insure that urban development will not expand into areas that are best suited to use as prime and unique farmlands.

Soil drainage is the major management need on over one-half of the acreage used for crops in the county. Some soils are naturally so wet that the production of crops is possible only if the soil is artificially drained. These very poorly drained soils are the Knoke, Glencoe, Biscay depressional, and Okoboji soils. These soils make up about 68,000 acres of the survey area.

Figure 12.—Soil erosion in an area of Letri clay loam after an intense rainfall. A grassed waterway would reduce erosion.

Unless artificially drained, the poorly drained soils are so wet that crops are damaged in most years. The Biscay, Canisteo, Hanska, Lemond, Letri, Mayer, Millington, Nishna, Revere, and Webster soils are all poorly drained soils. They make up about 218,000 acres of the county.

In some small areas, the wetter soils that are in drainageways and swales are commonly included in areas of the well drained Everly, Normania, Seaforth, Terril, Ves, and Wilmonton soils. Artificial drainage is needed in some of these wetter areas.

Both legal and private surface drainage mains extend for more than 500 miles across the county and provide drainage for most of the major wet soils. Legal subsurface tile mains extend beyond the open ditch systems in many areas. These subsurface mains serve as collectors for private farm drainage.

The design of surface and subsurface drainage systems varies with the kinds of soils. A combination of surface drainage and tile drainage is needed in most areas of the poorly drained and very poorly drained soils. Tile drains have to be more closely spaced in soils that are slowly permeable than in the more permeable soils. Tile drainage is slow in the Okoboji and Nishna soils. Information about drainage systems for each kind of soil is available from the local office of the Soil Conservation Service.

Soil erosion is a major problem on about one-third of the cropland in Redwood County (fig. 12). It is a hazard on the undulating and steeper soils, such as the Everly, Storden, and Ves soils.

Productivity is reduced where the surface layer is lost to erosion and the subsoil is subsequently incorporated into the plow layer. Erosion is especially damaging if the subsoil has low available water capacity or restricts root growth, as in the Dickman, Estherville, and Salida soils. Soil erosion also causes sediment to enter streams. Erosion control minimizes sediment pollution, improves water quality, and reduces channel maintenance costs.

Erosion control practices reduce runoff and increase water infiltration. A cropping system that keeps a plant cover on the soil for extended periods helps control erosion and maintains the productive capacity of the soils. Contour tillage or terracing is difficult because slopes are generally short and irregular. A cropping system that provides substantial plant cover and that uses the proper type of tillage minimizes soil erosion.

Incorporating crop residue into the soil by conservation tillage or plowing on alternate years on the more level soils, such as Biscay, Canisteo, Du Page, Everly, Grogan, Linder, Normania, Seaforth, and Ves soils maintains soil tilth while reducing soil erosion. A less intensive cropping system and reduced tillage are needed on the steeper or droughty soils, such as the Dickinson, Dickman, Estherville, Salida, and Storden soils.

Soil blowing is a hazard on the Dickinson, Dickman, Estherville, and Linder soils. When winds are strong and the surface layer of these soils is dry and bare of vegetation, severe damage can occur within a few hours. Reduced tillage that leaves crop residue on the surface throughout the year generally can eliminate soil blowing. Windbreaks of suitable shrubs and trees are effective in reducing the risk of soil blowing.

Information about the design of erosion control practices for each kind of soil is available from local offices of the Soil Conservation Service.

Soil fertility is naturally medium or high on most soils in the county. *Soil reaction* in all the soils is naturally slightly acid, neutral, or alkaline. Crops on most of the soils in the county respond to fertilizer. The need for fertilizer as specified in the section "Detailed Soil Map Units" is based on the fertility of the subsoil. The soils are especially low in phosphorus but do contain an ample amount of lime. The need for fertilizer depends on the kind of soil, past and present management, and the kind of crop that is grown on the soil. Soil tests provide part of the information that is needed in choosing the proper kinds and amount of fertilizer to add to the soil.

The Canisteo, Lemond, Mayer, and Millington soils are examples of poorly drained soils that contain excess lime, which causes a fertility imbalance. Excess lime conditions also exist on the moderately well drained Seaforth soils and the well drained Storden soils. Applying fertilizer generally improves plant growth in these soils.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils with good tilth are granular and porous. Regular additions of crop residue, manure, and other organic matter can improve soil structure and the water infiltraion rate of the soil.

Since many of the soils in the county are wet or intermingled with wet soils, soil tilth is affected when the soil is tilled when it is too moist. The poorly drained and very poorly drained soils often stay wet until late in the spring. If the soils are wet when tilled, they tend to become very cloddy when dry, and good seedbeds are difficult to prepare.

Field crops that are suited to the soils and climate of this area include some that are not now commonly grown. Corn and soybeans are the principal row crops. Grain sorghum, sunflowers, edible beans, peas, sugar beets, sweet corn, and similar crops are grown in small acreages.

Oats, wheat, and alfalfa are the most common of the close-grown crops. Flax, rye, barley, and buckwheat can be grown. Several forage crops can be grown for seed, including alfalfa, sweet clover, red clover, and native grasses.

Special crops grown in the county are vegetables and nursery plants. They mostly are grown by home gardeners and two commercial nurseries in the county. Most vegetables and fruits are grown on soils that have good natural drainage, that warm up early in the spring, and that are protected. The most current information about growing special crops can be obtained from the local offices of the Agricultural Extension Service and the Soil Conservation Service.

Yields Per Acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils for those crops.

Land Capability Classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops *(9)*. Crops that require special management are excluded.

The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

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

Class I soils have few limitations that restrict their use.

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

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

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

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

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation. The capability classification of each map unit is given in the section "Detailed Soil Map Units."

Windbreaks and Environmental Plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field. The interval depends on the erodibility of the soil. Field windbreaks protect cropland and crops from wind, help keep snow on the fields, and provide food and cover for wildlife.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 6 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 6 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

Recreation

The major recreational areas in the county are the Minnesota River, Ramsey Park in Redwood Falls, and the newly developed lake in Plum Creek Park near Walnut Grove.

Redwood County is mainly agricultural and has fair potential for outdoor recreational development. The natural, scenic, and historic areas along the Minnesota River have the highest potential for further recreational development. The southwestern part of the county, south of the Cottonwood River, has potential for development of water impoundments. The water impoundment at Plum Creek Park has increased the recreational potential in the area. Increasing the water resources in the county naturally opens up new potentials for other related recreational activities *(6)*.

The soils of the survey area are rated in table 7 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 7, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 7 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 10 and interpretations for dwellings without basements and for local roads and streets in table 9.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking and horseback riding should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife Habitat

The soils of Redwood County provide good habitat for the various species of wildlife. Soils vary in their ability to produce habitat for specific kinds of wildlife, and there is a distinct relationship between the plants that a soil can support and the wildlife that is associated with these plants.

Intensive agriculture is the land use pattern that reflects the species of wildlife in Redwood County. The once abundant pothole sloughs have been drained and tilled for agricultural use. These very poorly drained soils were once marginal for use as cropland, but now corn and soybeans yields on these soils are good. The present land use pattern has caused the pheasant and duck population to decrease because habitat for nesting and winter cover has been reduced. The soils and topography of the Minnesota River Valley provide good habitat for woodland and wetland game species, such as deer, raccoon, squirrels, cottontails, ducks, and geese. Agriculture is limited because of frequent flooding, rock outcrops, and steep slopes. The potential of the soils in this area for future development of wildlife habitat is high.

Redwood County has 17 state-owned wildlife management areas, which occupy 3,141 acres. These management areas provide habitat for small game, deer, waterfowl, and upland game and nongame wildlife, and they are open to the public for hunting and trapping.

Redwood County has the potential for the development of ponds and wildlife areas. Landowners that are interested in developing wildlife areas should contact the local office of the Soil Conservation Service for assistance in planning such facilities.

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water. Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 8, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, bluegrass, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, indiangrass, needlegrass, smartweed, foxtail, ragweed, and leadplant.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, chokecherry, American plum, maple, cottonwood, green ash, and sumac. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, American plum, honeysuckle, and crabapple.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, reed canarygrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include Hungarian partridge, pheasant, meadowlark, field sparrow, mourning dove, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include woodcock, thrushes, woodpeckers, squirrels, gray fox, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, racoon, and beaver.

Engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil Properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations.

For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to evaluate the potential of areas for residential, commercial, industrial, and recreation uses; make preliminary estimates of construction conditions; evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; plan detailed onsite investigations of soils and geology; locate potential sources of gravel, sand, earthfill, and topsoil; plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

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

Building Site Development

Table 9 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic-supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary Facilities

Table 10 shows the degree and kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 10 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and that good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 10 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 10 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excessive gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction Materials

Table 11 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 11, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water Management

Table 12 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and for embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Soil Properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering Index Properties

Table 13 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil Series and Their Morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If the content of particles coarser than sand is more than 15 percent, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system *(2)* and the system adopted by the American Association of State Highway and Transportation Officials *(1)*.

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as PT. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an ovendry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and Chemical Properties

Table 14 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 14, the estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

Soil and Water Features

Table 15 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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

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

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes are not considered flooding.

Table 15 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 15 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 15.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are the most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Classification of the Soils

The system of soil classification used by the National Cooperative Soil Survey has six categories *(10)*. 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. Table 16 shows the classification of the soils in the survey area. The categories are defined in the following paragraphs.

ORDER. Ten 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 Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of the Mollisols that have 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 Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly 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, depth 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 Haplaquolls.

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.

Soil Series and Their Morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other 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 *(8)*. Many of the technical terms used in the descriptions are defined in Soil Taxonomy *(10)*. 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 of each soil series are described in the section "Detailed Soil Map Units."

Biscay Series

The Biscay series consists of deep, poorly drained soils on glacial outwash plains and terraces. The soils are moderately permeable over rapidly permeable. They formed in a loamy mantle underlain by calcareous sand and gravelly sediments. The slope ranges from 0 to 2 percent.

Biscay soils are similar to the Hanska soils and are commonly adjacent to Estherville and Wadena soils. Estherville and Wadena soils are well drained and are in higher positions on the landscape than Biscay soils.

Hanska soils are poorly drained; they have less clay and more sand in the solum.

Typical pedon of Biscay loam, 750 feet north and 2,350 feet east of the southwest corner of sec. 36, T. 113 N., R. 36 W.

Ap—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; mildly alkaline; abrupt smooth boundary.

A1—10 to 17 inches; black (N 2/0) loam, very dark gray (10YR 3/1) dry; weak subangular blocky structure; friable; about 3 percent coarse fragments; mildly alkaline; clear smooth boundary.

A2—17 to 22 inches; very dark gray (10YR 3/1) loam, moderate dark gray (10YR 4/1) dry; fine subangular blocky structure; friable; about 1 percent coarse fragments; mildly alkaline; clear wavy boundary.

Bg—22 to 30 inches; dark grayish brown (2.5Y 4/2) loam; few fine distinct olive yellow (2.5Y 5/6) mottles; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; mildly alkaline; clear smooth boundary.

BCg—30 to 33 inches; grayish brown (2.5Y 5/2) sandy loam; common fine distinct olive yellow (2.5Y 6/6) mottles; weak fine subangular blocky structure; friable; about 6 percent coarse fragments; moderately alkaline; clear smooth boundary.

2C—33 to 60 inches; olive gray (5Y 4/2, 5Y 5/2) gravelly loamy coarse sand; single grained; loose; about 20 percent coarse fragments; slight effervescence; moderately alkaline.

The solum is 26 to 40 inches thick. Loamy sand or coarser textured materials are at a depth of 26 to 40 inches. The depth to free carbonates typically ranges from 26 to 40 inches. A few pedons have a calcareous A1 horizon and noncalcareous B horizon. The mollic epipedon is 16 to 24 inches thick. The solum is 5 to as much as 35 percent coarse fragments. The 2C horizon is 5 to 50 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. It is dominantly loam, but the range includes clay loam, sandy clay loam, or silty clay loam with a moderate content of sand. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 through 3. The Bg horizon is commonly loam, sandy clay loam, or clay loam. The BC horizon is sandy loam, gravelly loam, or gravelly sandy loam. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is coarse sand, sand, or gravelly sand. A horizon that has thin discontinuous strata of fine and medium sand or loamy sand is within the defined range for the Biscay series.

The Biscay loam, depressional, soil has a thick, dark surface and subsurface layer. This is outside the defined range for the Biscay series but does not affect the use or behavior of the soil.

Blue Earth Series

The Blue Earth series consists of deep, very poorly drained soils on high foot slopes. The soils are above flood level in the Minnesota River Valley. Permeability is moderately slow. These soils formed in coprogenous earth and loamy alluvium. The slope ranges from 1 to 4 percent.

Blue Earth soils commonly are adjacent to Millington and Oshawa Variant soils. Millington soils are poorly drained and are in lower positions on the flood plains than Blue Earth soils. Oshawa Variant soils have stones on the surface and in the profile; they also are in lower positions on the flood plains.

Typical pedon of Blue Earth mucky clay loam, sloping, 300 feet south and 300 feet east of the northwest corner of sec. 27, T. 114 N., R. 37 W.

A—0 to 10 inches; very dark gray (10YR 3/1) mucky clay loam (coprogenous earth), dark gray (10YR 4/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; very friable; common snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg1—10 to 17 inches; black (10YR 2/1) mucky clay loam (coprogenous earth), very dark gray (10YR 3/1) dry; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; common snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2g—17 to 34 inches; black (10YR 2/1) mucky clay loam (coprogenous earth), dark gray (10YR 4/1) dry; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; very friable; common snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg3—34 to 41 inches; very dark gray (5Y 3/1) mucky clay loam (coprogenous earth), gray (10YR 5/1) dry; common medium prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; many snail shell fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Cg4—41 to 52 inches; very dark gray (5Y 3/1) mucky clay loam (coprogenous earth), gray (10YR 6/1) dry; few medium prominent strong brown (7.5YR 5/8) mottles; massive; friable; few snail shell fragments; violent effervescence; moderately alkaline; clear smooth boundary.

2Cg5—52 to 60 inches; dark gray (N 4/0) clay loam; massive; friable; violent effervescence; moderately alkaline.

Depth to the 2C horizon ranges from 24 to 60 inches. The solum and the C horizon have 0 to 25 percent coarse fragments, mostly snail shell fragments.

The Cg horizon has hue of 10YR, 2.5Y, or 5Y; value of 1 to 3; and chroma of 1 to 3. The texture is mucky silt loam, mucky silty clay loam, mucky loam, or mucky clay loam. The 2C horizon has hue of 2.5Y or 5Y, value of 3 to 5, and chroma of 1 or 2, or it is N 3/0 through N 5/0. The texture is silty clay loam, silt loam, or clay loam, but it is coarser in some pedons.

Canisteo Series

The Canisteo series consists of deep, poorly drained soils on glacial moraines. The soils are moderately permeable. They formed in calcareous, loamy glacial till. The slope ranges from 0 to 2 percent.

Canisteo soils commonly are adjacent to Glencoe, Normania, Ves, and Webster soils. Glencoe soils are cumulic and are in depressions. Unlike the Canisteo soils, Normania and Ves soils are noncalcareous. Also, these soils are better drained and are in higher positions on the landscape. Webster soils are noncalcareous in the surface layer and upper part of the subsoil. They and the Canisteo soils are in similar positions on the landscape.

Typical pedon of Canisteo clay loam, 2,440 feet south and 500 feet east of the northwest corner of sec. 18, T. 110 N., R. 37 W.

Ap—0 to 9 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 2 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—9 to 18 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak to moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

AB—18 to 22 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak to moderate fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Bg—22 to 29 inches; grayish brown (2.5Y 5/2) clay loam; dark grayish brown (2.5Y 4/2) ped faces; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

C1—29 to 39 inches; grayish brown (2.5Y 5/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—39 to 60 inches; light brownish gray (2.5Y 6/2) loam; many medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. It has 2 to 8 percent coarse fragments of mixed lithology. In some pedons, there are no coarse fragments in the upper 20 to 30 inches. The mollic epipedon is 14 to 24 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or is neutral (N 2/0). It is loam, clay loam, silt loam, or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. The C horizon has hue of 2.5Y or 5Y, value of 5 or 6, and chroma of 2 through 4. It is clay loam or loam.

Coland Series

The Coland series consists of deep, poorly drained soils on the flood plains. The soils are moderately permeable. They formed in dark, noncalcareous, loamy sediments. The slope ranges from 0 to 2 percent.

Coland soils are similar to Millington soils and are commonly adjacent to Spillville and Terril soils. Millington soils are calcareous throughout. Spillville soils are moderately well drained and are in higher positions on the flood plain than the Coland soils. Terril soils are moderately well drained. They are in higher positions on the landscape and are not subject to flooding.

Typical pedon of Coland clay loam, occasionally flooded, 1,700 feet west and 800 feet north of the southeast corner of sec. 14, T. 109 N., R. 37 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine and very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—10 to 27 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak very fine subangular blocky structure; friable; neutral; clear smooth boundary.

A2—27 to 39 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; firm; neutral; clear smooth boundary.

C1g—39 to 46 inches; very dark gray (5Y 3/1) clay loam; weak fine and medium subangular blocky structure; firm; neutral; clear smooth boundary.

C2g—46 to 54 inches; very dark gray (5Y 3/1) clay loam; massive; friable; strong effervescence; mildly alkaline; clear smooth boundary.

C3g—54 to 60 inches; very dark gray (5Y 3/1) and dark olive gray (5Y 3/2) clay loam; massive; friable; about

2 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is 36 to 48 inches thick.

The A horizon has value of 2 or 3 and chroma of 1, or it is N 2/0. It is silty clay loam or clay loam. The C horizon has hue of 2.5Y or 5Y, value of 2 through 5, and chroma of 1 or less. It ranges from clay loam to loam with thin strata ranging from silty clay to loamy sand.

Copaston Series

The Copaston series consists of shallow, well drained soils on rock-cored terraces. The soils are moderately permeable and moderately rapidly permeable. They formed in a thin loamy mantle of glacial drift or alluvium underlain by bedrock. The slope ranges from 2 to 40 percent.

Copaston soils are commonly adjacent to Blue Earth, Tilfer, and Wadena Variant soils. Blue Earth soils are very poorly drained and are on foot slopes and in the swales of rock-cored terraces. Tilfer soils are poorly drained and also are on foot slopes and in the swales of rock-cored terraces. Wadena Variant soils are moderately deep and are in lower positions on the rock-cored terraces than the Copaston soils.

Typical pedon of Copaston sandy loam in an area of Rock outcrop-Copaston complex, 2 to 40 percent slopes, 1,375 feet south and 2,000 feet east of the northwest corner of sec. 11, T. 113 N., R. 36 W.

A1—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; neutral; clear smooth boundary.

A2—9 to 12 inches; very dark brown (10YR 2/2) sandy loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; neutral; clear smooth boundary.

AB—12 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, dark grayish brown (10YR 4/2) dry; moderate fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; neutral; clear smooth boundary.

Bw—14 to 18 inches; dark brown (10YR 4/3) sandy loam; very dark grayish brown (10YR 3/2) ped faces; moderate fine and medium subangular blocky structure; friable; about 10 percent coarse fragments; neutral; clear smooth boundary.

R—18 inches; igneous and metamorphic bedrock.

The solum is 8 to 20 inches thick. Bedrock is at a depth of 8 to 20 inches. Coarse fragments range from 0 to 20 percent throughout the profile.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is sandy loam, fine sandy loam, sandy clay loam, loam, or silt loam. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 1 through 4. It is sandy loam, fine sandy loam, or loam.

Delft Series

The Delft series consists of deep, poorly drained soils on the foot slopes of glacial moraines and on outwash plains. The soils are moderately slowly permeable. They formed in loamy alluvium derived from glacial drift. The slope ranges from 1 to 3 percent.

Delft soils are similar to Letri and Webster soils and are commonly adjacent to Everly, Glencoe, Ves, and Webster soils. Everly soils are well drained and are on steeper slopes than the Delft soils. Glencoe soils are very poorly drained and are in depressions and swales. Letri and Webster soils are poorly drained; they have a mollic epipedon that is less than 24 inches thick. Unlike Delft soils, Ves soils are well drained and are on steeper slopes.

Typical pedon of Delft loam in an area of Delft-Webster complex, 2,350 feet north and 80 feet west of the southeast corner of sec. 20, T. 110 N., R. 34 W.

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

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

AB—24 to 28 inches; very dark gray (10YR 3/1) loam, dark grayish brown (2.5Y 4/2) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bg1—28 to 41 inches; dark grayish brown (2.5Y 4/2) loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bg2—41 to 47 inches; grayish brown (2.5Y 5/2) loam; common fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Cg—47 to 60 inches; grayish brown (2.5Y 5/2) loam; many common distinct light gray (10YR 7/2) mottles; massive; friable; about 3 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is 30 to 55 inches thick. Free carbonates are at a depth of 30 to 60 inches. The mollic epipedon is 24 to 36 inches thick. Coarse fragments make up 1 to 5 percent of the solum and 0 to 10 percent of the C horizon.

The A horizon has hue of 10YR through 5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. It is loam or clay loam. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is loam, clay loam, or silt loam. The C horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is silt loam, loam, or sandy loam.

Dickinson Series

The Dickinson series consists of deep, well drained soils on stream benches, outwash plains, and uplands. The soils are moderately rapidly permeable over rapidly permeable. They formed in a mantle of loamy sediments underlain by sandy material. The slope ranges from 0 to 6 percent.

Dickinson soils are similar to Dickman, Grogan, and Estherville soils and are commonly adjacent to Dickman and Estherville soils. Dickman soils have more sand and less clay in the solum than the Dickinson soils and are in higher positions on the landscape. Estherville soils are underlain by a coarser material than the Dickinson soils and are in higher positions on the landscape. Grogan soils have less sand in the solum than Dickinson soils.

Typical pedon of Dickinson fine sandy loam, 0 to 2 percent slopes, 150 feet south and 1,340 feet west of the northeast corner of sec. 19, T. 114 N., R. 37 W.

Ap—0 to 7 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine and very fine subangular blocky structure; friable; neutral; abrupt smooth boundary.

A1—7 to 13 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A2—13 to 17 inches; very dark gray (10YR 3/1) fine sandy loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw1—17 to 23 inches; dark brown (10YR 4/3) fine sandy loam; very dark grayish brown (10YR 3/2) ped faces; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

Bw2—23 to 36 inches; dark yellowish brown (10YR 4/4) fine sandy loam; weak fine and medium subangular blocky structure; friable; neutral; gradual smooth boundary.

C—36 to 60 inches; yellowish brown (10YR 5/4) fine sand; single grained; loose; neutral.

The solum is 24 to 50 inches thick. Loamy sand or coarser textures are at a depth of 24 to 42 inches. The mollic epipedon is 10 to 20 inches thick. There are no coarse fragments to a depth of 40 inches or more. The lower part of the solum and the C horizon have 0 to 5 percent, by volume, coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam, sandy loam, or loam. The B horizon has value of 3 or 4 and chroma of 2 or 3 in the upper part and value of 4 or 5 and chroma of 4 or 6 in the lower part. It is typically fine sandy loam or sandy loam; but, in some pedons, the horizon may grade to loamy fine sand, loamy sand, fine sand, or sand in the lower part. The C horizon has value of 4 or 5 and chroma of 3 through 6. It typically is fine sand or sand.

Dickman Series

The Dickman series consists of deep, well drained soils on outwash plains, terraces, and uplands. The soils are moderately rapidly permeable. They formed in a loamy mantle underlain by sandy sediments. The slope ranges from 0 to 6 percent.

Dickman soils are similar to Dickinson and Estherville soils, which are in similar positions on the landscape. Dickman soils are commonly adjacent to Dickinson, Estherville, Hanska, and Lemond soils. Dickinson soils are well drained; they formed in a thick, loamy mantle underlain by sand. Estherville soils are well drained; they have more gravel. Hanska and Lemond soils are poorly drained and are in lower positions on the landscape than the Dickman soils.

Typical pedon of Dickman sandy loam, 0 to 2 percent slopes (fig. 13), 2,440 feet west and 2,500 feet south of the northeast corner of sec. 25, T. 113 N., R. 36 W.

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

A—10 to 12 inches; very dark gray (10YR 3/1) sandy loam, dark brown (10YR 3/3) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw1—12 to 16 inches; dark brown (10YR 4/3) sandy loam; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw2—16 to 19 inches; dark brown (10YR 4/3) sandy loam; dark grayish brown (10YR 4/2) faces on peds; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

Bw3—19 to 33 inches; dark brown (10YR 4/3) loamy sand; single grained; loose; neutral; clear smooth boundary.

C—33 to 60 inches; yellowish brown (10YR 5/4) coarse sand; single grained; loose; neutral.

The solum is 30 to 50 inches thick. Loamy fine sand or coarser textures are at a depth of 12 to 20 inches. The mollic epipedon is 10 to 18 inches thick. The solum and the upper part of the C horizon typically do not have coarse fragments; but in some pedons, there is as much

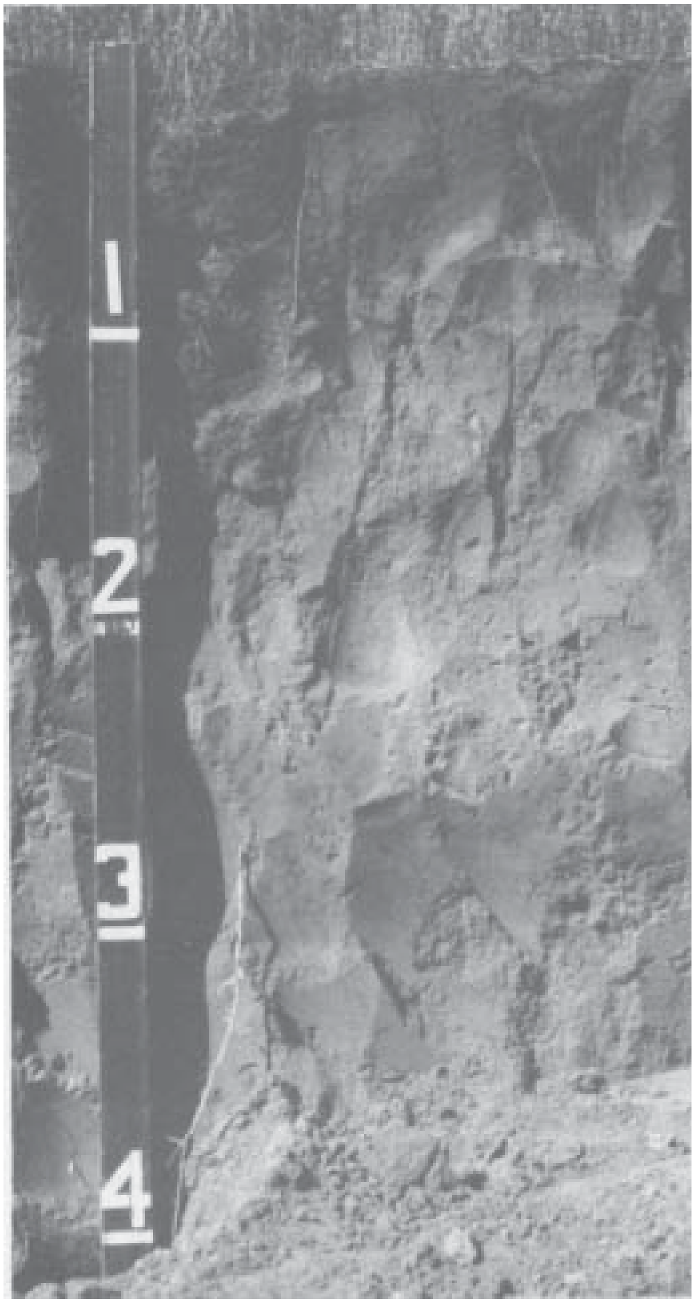


Figure 13.—Profile of Dickman sandy loam, 0 to 2 percent slopes. About 20 inches of sandy loam is underlain by sand. Depth is marked in feet.

as 10 percent coarse fragments in the solum and the C horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is fine sandy loam or sandy loam. The B horizon has hue of 10YR or 7.5YR, value of 3 or 4 in the upper part and value of 4 or 5 in the lower part, and chroma of 3 or 4. The Bw horizon is sandy loam or fine sandy loam in the upper part and is loamy sand, fine sand, or sand in the lower part. The C horizon has hue of 7.5YR, 10YR, or 2.5Y, value of 5 or 6, and chroma of 3 or 4. It is fine or coarse sand.

Du Page Series

The Du Page series consists of deep, moderately well drained soils on flood plains. The soils are moderately permeable. They formed in loamy, calcareous alluvium. The slope ranges from 0 to 2 percent.

Du Page soils are similar to Spillville soils and are commonly adjacent to Millington and Oshawa soils. Millington soils are poorly drained and are in lower positions on the flood plains than the Du Page soils. Oshawa soils are very poorly drained and are in old oxbows and swales. Spillville soils are noncalcareous.

Typical pedon of Du Page loam, 90 feet east and 375 feet north of the center of sec. 29, T. 113 N, R. 35 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—9 to 15 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual smooth boundary.

A2—15 to 20 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual wavy boundary.

A3—20 to 32 inches; very dark grayish brown (10YR 3/2) loam, gray (10YR 5/1) dry; weak very fine and fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual wavy boundary.

C—32 to 60 inches; dark grayish brown (10YR 4/2) loam; few fine distinct light olive brown (2.5Y 5/6) mottles; massive; friable; slight effervescence; moderately alkaline.

The thickness of the solum and that of the A horizon range from 24 to 50 inches. The lower part of the solum and the lower part of the C horizon generally do not have coarse fragments, but, in some pedons, there are thin strata of 0 to 50 percent coarse fragments.

The A horizon is 24 to 40 inches thick and has value of 2 or 3 and chroma of 1 or 2. It is silt loam or loam. In some pedons, there is a B horizon. The C horizon has chroma of 1 through 4. It is loam, sandy loam, sandy clay loam, or gravelly analogs of those textures.

Estherville Series

The Estherville series consists of deep, well drained soils on broad outwash plains, terraces, and glacial moraines. Permeability of the soils is moderately rapid over rapid. They formed in loamy glacial outwash underlain by sandy gravelly sediments. The slope ranges from 0 to 18 percent.

Estherville soils are similar to Dickman soils and are commonly adjacent to Mayer, Salida, and Wadena soils. Dickman soils contain less gravel than Estherville soils. Mayer soils have a thicker surface layer than Estherville soils. Mayer soils are poorly drained and are in lower positions on the landscape. Salida soils have coarser texture and are on gravelly knolls. Wadena soils are deeper to sand and gravelly sand and have more clay in the upper mantle. Wadena soils and Estherville soils are in similar positions on the landscape.

Typical pedon of Estherville sandy loam, 0 to 2 percent slopes (fig. 14), 1,300 feet north and 150 feet west of the southeast corner of sec. 16, T. 112 N., R. 34 W.

Ap—0 to 9 inches; black (10YR 2/1) sandy loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments; slightly acid; abrupt smooth boundary.

A—9 to 14 inches; very dark grayish brown (10YR 3/2) sandy loam, dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 12 percent coarse fragments; slightly acid; gradual wavy boundary.

Bw—14 to 19 inches; brown (10YR 4/3) coarse sandy loam; weak fine and medium subangular blocky structure; friable; about 15 percent coarse fragments; neutral; clear smooth boundary.

2C—19 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grained; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 15 to 24 inches thick. The depth to free carbonates and to the 2C horizon ranges from 15 to 24 inches. The mollic epipedon is 9 to 18 inches thick. The loamy mantle is 10 to 20 inches thick. Coarse fragments range from 0 to 15 percent in the loamy mantle and 10 to 35 percent in the underlying sediments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The texture is sandy loam or loam. The B horizon has value of 3 or 4 and chroma of 3 or 4. Its texture is coarse sandy loam, sandy loam, or loam. In some pedons there is a BC horizon. The 2C horizon has value of 4 through 6 and chroma of 2 through 6. It is coarse sand, sand, or the gravelly analogs of those textures.

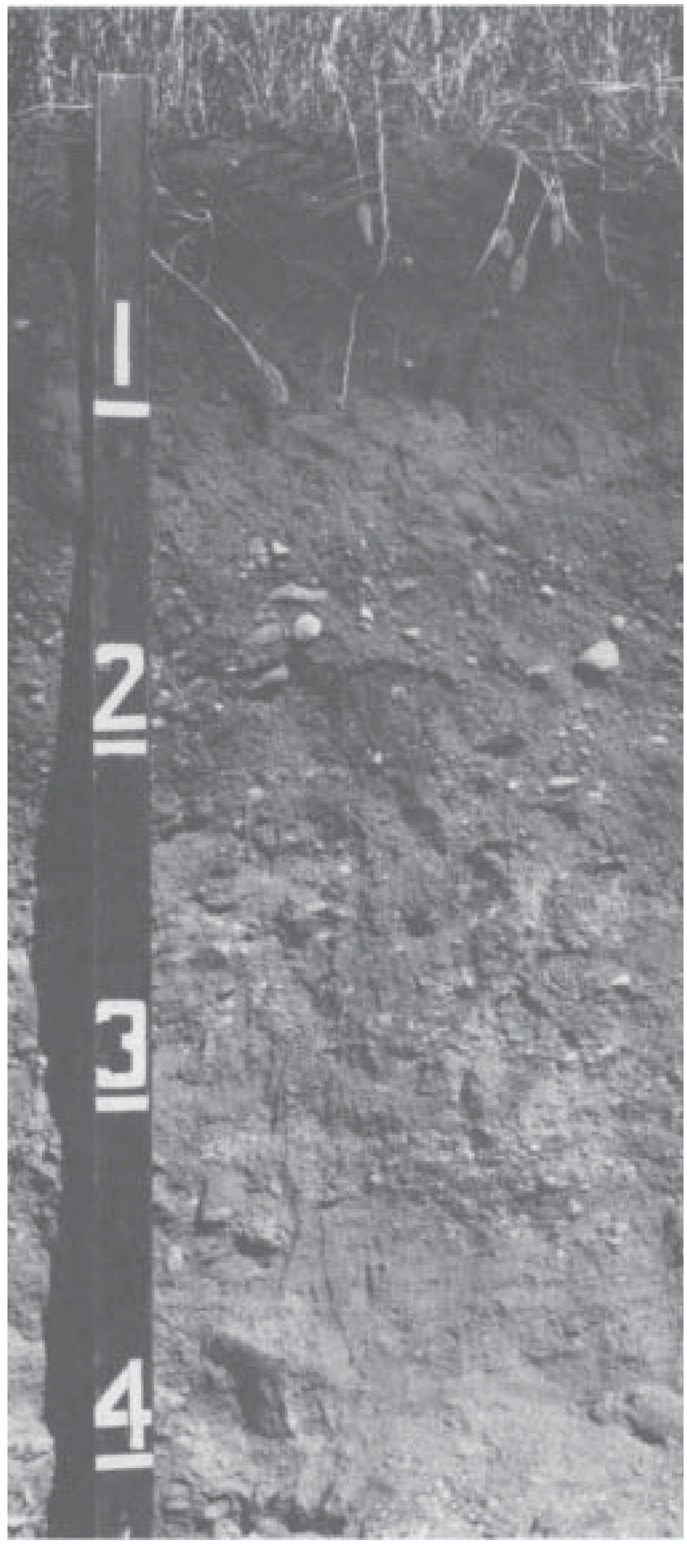


Figure 14.—Profile of Estherville sandy loam, 0 to 2 percent slopes. About 19 inches of sandy loam is underlain by gravelly coarse sand. Depth is marked in feet.

Everly Series

The Everly series consists of deep, well drained soils on glacial moraines. The soils are slowly permeable. They formed in loamy glacial till. The slope ranges from 2 to 18 percent.

Everly soils formed entirely in glacial till and have more coarse fragments in the upper part of the solum. This is outside of the defined range for the Everly series but does not affect the use or behavior of the soils.

Everly soils are similar to Ves soils and are commonly adjacent to Letri and Wilmonton soils. Unlike Everly soils, Letri soils are poorly drained and are in lower concave positions on the landscape. Ves soils are well drained. They have less clay than Everly soils and are underlain by a friable material. Wilmonton soils are moderately well drained and are in lower, slightly concave positions on the landscape than Everly soils.

Typical pedon of Everly clay loam, 2 to 4 percent slopes, 600 feet north and 865 feet west of the southeast corner of sec. 33, T. 109 N., R. 38 W.

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

AB—8 to 14 inches; very dark grayish brown (10YR 3/2) clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; about 4 percent coarse fragments; black (10YR 2/1) worm casts; medium acid; clear irregular boundary.

Bw—14 to 28 inches; dark brown (10YR 4/3) clay loam; dark grayish brown (10YR 4/2) ped faces; moderate and medium subangular blocky structure; friable; about 6 percent coarse fragments; slightly acid; clear smooth boundary.

Bck—28 to 40 inches; yellowish brown (10YR 5/4) clay loam; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; medium, generally, rounded segregated soft calcium carbonate masses; strong effervescence; mildly alkaline; clear smooth boundary.

Ck—40 to 60 inches; yellowish brown (10YR 5/4) clay loam; common medium distinct gray (10YR 5/1) mottles; massive; firm; about 4 percent coarse fragments; medium, generally, rounded segregated calcium masses; strong effervescence; moderately alkaline.

The solum is 24 to 42 inches thick. The 2C horizon has 2 to 10 percent coarse fragments. The mollic epipedon is 10 to 20 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, clay loam, or silty clay loam. The B horizon has value of 4 or 5 and chroma of 3 or 4. It is loam or clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 4 to 6, and chroma of 3 or 4. It is loam or clay loam.

Glencoe Series

The Glencoe series consists of deep, very poorly drained soils in closed depressions and swales on glacial moraines. The soils are moderately permeable or moderately slowly permeable. They formed in loamy alluvial sediments and loamy glacial till. The slope ranges from 0 to 1 percent.

Glencoe soils are similar to Okoboji soils and are commonly adjacent to Canisteo, Normania, Ves, and Webster soils. Okoboji soils have more clay and less sand in the profile than the Glencoe soils. Canisteo soils are poorly drained. They are on calcareous rims of depressions. Normania soils are moderately well drained. They have a thinner surface layer than Glencoe soils and are in higher positions on the landscape. Ves soils are well drained and also have a thinner surface layer than Glencoe soils and are in higher positions on the landscape. Webster soils are poorly drained. They are in higher, nearly level positions on the landscape.

Typical pedon of Glencoe silty clay loam, 2,600 feet south and 1,500 feet east of the northwest corner of sec. 36, T. 112 N., R. 35 W.

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

A—10 to 16 inches; black (N 2/0) silty clay loam, black (10YR 2/1) dry; moderate fine subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

AB—16 to 26 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bg—26 to 33 inches; olive gray (5Y 4/2) silty clay loam; common medium distinct olive (5Y 5/6) mottles; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

C1—33 to 42 inches; olive (5Y 5/3) clay loam; common medium distinct olive (5Y 5/6) mottles; massive; friable; about 4 percent coarse fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg2—42 to 60 inches; light olive brown (2.5Y 5/4) clay loam; many large distinct olive gray (5Y 5/2) mottles; massive; friable; about 6 percent coarse fragments; few iron and manganese stains; few calcium carbonate masses in seams and threads; strong effervescence; mildly alkaline.

The solum is 30 to 60 inches thick. The depth to free carbonates is 30 to 60 inches. The mollic epipedon is 24 to 36 inches thick. The solum has 0 to 5 percent coarse fragments, and the C horizon has 2 to 8 percent coarse fragments.

The A horizon has hue of 10YR through 5Y, value of 2 or 3 and chroma of 1, or it is N 2/0. It is silty clay loam, clay loam, or loam. The B horizon has hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam or clay loam. The C horizon has hue of 5Y or 2.5Y, value of 4 through 6, and chroma of 2 through 4. It is clay loam or loam.

Grogan Series

The Grogan series consists of deep, moderately well drained and well drained soils on glacial lake plains. The soils are moderately rapidly permeable. They formed in loamy, calcareous, lacustrine sediments. The slope ranges from 0 to 6 percent.

Grogan soils are similar to Dickinson soils and are commonly adjacent to Dickinson, Normania, Ves, and Wadena Variant soils. Dickinson soils have more sand in the solum than the Grogan soils. Normania and Ves soils have finer texture than the Grogan soils and are in slightly higher positions on the landscape. Wadena Variant soils have bedrock within 40 inches of the surface and are in lower positions on the landscape.

Typical pedon of Grogan loam, 2 to 6 percent slopes, 1,400 feet north and 850 feet east of the southwest corner of sec. 17, T. 114 N., R. 37 W.

Ap—0 to 9 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine and very fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

AB—9 to 15 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak fine and very fine subangular blocky structure; friable; neutral; clear smooth boundary.

Bw1—15 to 30 inches; dark yellowish brown (10YR 4/4) loam; moderate fine subangular blocky structure; friable; neutral; clear smooth boundary.

BC—30 to 34 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; very friable; strong effervescence; mildly alkaline; gradual smooth boundary.

C1—34 to 41 inches; yellowish brown (10YR 5/4) very fine sandy loam with bands of silt loam; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

C2—41 to 60 inches; yellowish brown (10YR 5/4) very fine sandy loam with bands of silt loam; common medium distinct grayish brown (2.5Y 5/2) mottles; massive; friable; slight effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. The depth to free carbonates is 20 to 40 inches. The mollic epipedon is 10 to 18 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 through 3. It is silt loam or loam. The B horizon has value of 4 or 5 and chroma of 3 through 5. It is typically silt loam or loam, but very fine sandy loam or loamy very fine sand are within the defined range for the Grogan series. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 3 through 6. It is very fine sandy loam or loamy very fine sand with strata of silt loam or with strata of coarser textured material.

Hanska Series

The Hanska series consists of deep, poorly drained soils on glacial outwash plains and terraces. The soils are moderately rapidly permeable over rapidly permeable. They formed in a loamy mantle underlain by sandy sediments. The slope ranges from 0 to 2 percent.

Hanska soils are similar to Biscay soils and are commonly adjacent to Dickman and Linder soils. Biscay soils have more clay in the solum than Hanska soils. Dickman soils are well drained. They have more sand and less clay than Hanska soils and are in higher positions on the landscape. Linder soils are somewhat poorly drained and are in higher positions on the landscape.

Typical pedon of Hanska fine sandy loam, 2,240 feet west and 2,270 feet south of the northeast corner of sec. 25, T. 113 N., R. 36 W.

Ap—0 to 9 inches; black (N 2/0) fine sandy loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; slightly acid; abrupt smooth boundary.

A1—9 to 15 inches; black (10YR 2/1) fine sandy loam, very dark gray (10YR 3/1) dry; very dark brown (10YR 2/2) ped faces; moderate fine and medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.

A2—15 to 18 inches; very dark gray (10YR 3/1) fine sandy loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; slightly acid; gradual wavy boundary.

Bg—18 to 38 inches; grayish brown (2.5Y 5/2) sandy loam; few fine distinct dark grayish brown (2.5Y 4/4) mottles; moderate fine and medium subangular blocky structure; friable; neutral; gradual wavy boundary.

2Cg—38 to 60 inches; grayish brown (2.5Y 5/2) sand with bands of silt loam; common medium distinct dark yellowish brown (10YR 4/4) mottles; single grained; loose; slight effervescence; mildly alkaline.

The solum is 24 to 46 inches thick. The depth to free carbonates ranges from 30 to 55 inches. The control section is 0 to 5 percent coarse fragments. The mollic epipedon is 12 to 24 inches thick.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. It is loam, fine sandy loam, or sandy loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is sandy loam, coarse sandy loam, or loam. The 2C horizon has hue of 2.5Y or 5Y. It is sand but ranges to coarse sand with thin discontinuous bands of sandy loam, loam, or silt loam. Coarse fragments range from 0 to 10 percent.

Knoke Series

The Knoke series consists of deep, very poorly drained soils in glacial lake basins. The soils are moderately slowly permeable. They formed in calcareous glacial sediment. The slope ranges from 0 to 1 percent.

Knoke soils are similar to Nishna soils and are commonly adjacent to Glencoe, Normania, and Ves soils. Glencoe soils have less clay in the solum than Knoke soils. They are in depressions and swales. Nishna soils formed in alluvial sediments on flood plains. Normania and Ves soils are better drained than the Knoke soils and are in higher positions on the landscape.

Typical pedon of Knoke silty clay loam, 1,700 feet east and 80 feet south of the northwest corner of sec. 6, T. 112 N., R. 39 W.

Ap—0 to 9 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few snail shell fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—9 to 15 inches; black (N 2/0) silty clay loam, very dark gray (10YR 3/1) dry; few fine distinct dark grayish brown (10YR 4/2) mottles; weak fine and medium subangular blocky structure; friable; few snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

Ag1—15 to 37 inches; very dark gray (5Y 3/1) silty clay loam, gray (10YR 5/1) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak fine and medium subangular blocky structure; friable; common snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

Ag2—37 to 42 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (10YR 4/1) dry; few fine distinct dark grayish brown (2.5Y 4/2) mottles; weak medium subangular blocky structure; friable; few snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

Bg—42 to 60 inches; very dark gray (5Y 3/1) clay loam; common fine distinct dark grayish brown (2.5Y 4/2) mottles; massive; friable; few shell fragments; strong effervescence; mildly alkaline.

The solum is 30 to 60 inches thick.

The Ap or A horizon is mucky silt loam or silty clay loam. The Ag and B horizons are silty clay loam or clay loam. The B horizon has value of 2 or 3 and chroma of 0 or 1 in the upper part and hue of N, 2.5Y, or 5Y, value of 4 or 5, and chroma of 0, 1, or 2 in the lower part. Some pedons have a C horizon at a depth of less than 60 inches.

Lemond Series

The Lemond series consists of deep, poorly drained soils on the rims of depressions and broad flats on glacial outwash plains and terraces. The soils are moderately rapidly permeable over rapidly permeable. They formed in a loamy mantle of glacial outwash underlain by sandy sediments. The slope ranges from 0 to 2 percent.

Lemond soils are similar to Mayer soils and are commonly adjacent to Dickman and Mayer soils. Dickman soils are well drained. They are noncalcareous and are in higher areas than Lemond soils. Mayer soils are poorly drained and are underlain by gravelly loamy sand. They are in similar positions on the landscape to Lemond soils.

Typical pedon of Lemond loam, 2,000 feet west and 150 feet south of the northeast corner of sec. 26, T. 113 N., R. 36 W.

Ap—0 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

A—12 to 18 inches; very dark gray (10YR 3/1) sandy loam, dark gray (10YR 4/1) dry; weak medium and coarse subangular blocky structure; friable; slight effervescence; mildly alkaline; clear irregular boundary.

Bg1—18 to 24 inches; grayish brown (2.5Y 5/2) sandy loam; common medium distinct light olive brown (2.5Y 5/4) mottles; weak medium and coarse subangular blocky structure; very friable; strong effervescence; mildly alkaline; gradual wavy boundary.

Bg2—24 to 26 inches; grayish brown (2.5Y 5/2) sandy loam; many coarse distinct light olive brown (2.5Y 5/4) mottles; weak medium and coarse subangular blocky structure; very friable; slight effervescence; mildly alkaline; gradual smooth boundary.

Bg3—26 to 32 inches; olive gray (5Y 5/2) sandy loam; many coarse distinct light olive brown (2.5Y 5/4) mottles; weak medium and coarse subangular blocky structure; very friable; slight effervescence; mildly alkaline; gradual smooth boundary.

2Cg—32 to 60 inches; olive gray (5Y 4/2) loamy coarse sand; common fine distinct light olive brown (2.5Y 5/4) mottles; single grained; loose; about 5 percent coarse fragments; strong effervescence; mildly alkaline.

The solum is 20 to 40 inches thick. The mollic epipedon is 14 to 24 inches thick. The solum has 0 to 5 percent coarse fragments. The 2C horizon has 0 to 10 percent coarse fragments.

The A horizon has hue of 10YR or 2.5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. It is loam, sandy loam, or coarse sandy loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2 with hue of 2.5Y or chroma of 1 through 3 with hue of 5Y. It is loam, sandy loam, or coarse sandy loam in the upper part and loamy sand, loamy coarse sand, sandy loam, or coarse sandy loam in the lower part. The 2C horizon has hue of 2.5Y or 5Y. Its texture is sand, coarse sand, loamy sand, or loamy coarse sand.

Letri Series

The Letri series consists of deep, poorly drained soils on dissected till plains. The soils are moderately slowly permeable. They formed in a mantle of erosional sediments underlain by firm, loamy glacial till. The slope ranges from 0 to 2 percent.

Letri soils are similar to Webster and Delft soils and are commonly adjacent to Everly and Wilmonton soils. Everly soils are well drained and Wilmonton soils are moderately well drained. Both of these soils are in higher positions on the landscape than Letri soils. Webster and Delft soils are poorly drained; they formed in friable glacial till.

Typical pedon of Letri clay loam, 550 feet north and 375 feet east of the southwest corner of sec. 20, T. 109 N., R. 39 W.

Ap—0 to 12 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

A—12 to 18 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bg—18 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; moderate fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

2BCg—28 to 33 inches; grayish brown (2.5Y 5/2) clay loam; common fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; firm; about 4 percent coarse fragments; about 2 percent gypsum crystals; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg—33 to 52 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; firm; about 8 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2C—52 to 60 inches; light olive brown (2.5Y 5/4) loam; common medium distinct yellowish brown (10YR 5/6) and light gray (2.5Y 7/2) mottles; massive; firm; about 8 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 20 to 36 inches. The depth to free carbonates ranges from 16 to 30 inches. The mollic epipedon is 14 to 24 inches thick. The upper sediment is 0 to 5 percent coarse fragments, and the glacial till is 2 to 8 percent coarse fragments.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. It is clay loam or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or silty clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 4. It is clay loam or loam.

Linder Series

The Linder series consists of deep, somewhat poorly drained, soils on glacial outwash plains and stream benches. The soils are moderately rapidly permeable over very rapidly permeable. They formed in thin, loamy glacial outwash underlain by calcareous sandy and gravelly sediments. The slope ranges from 0 to 2 percent.

Linder soils are commonly adjacent to Estherville and Mayer soils. Estherville soils are well drained and are less than 24 inches or less deep to underlying gravelly sand. They are in higher positions on the landscape than the Linder soils. Mayer soils are poorly drained and are in lower positions on the landscape.

Typical pedon of Linder loam, 120 feet north and 2,600 feet west of the southeast corner of sec. 36, T. 111 N., R. 34 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak very fine subangular blocky structure; friable; about 4 percent coarse fragments; neutral; clear smooth boundary.

A—10 to 18 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; moderate fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; neutral; clear smooth boundary.

Bw—18 to 24 inches; dark grayish brown (2.5Y 4/2) sandy loam; moderate fine and medium subangular blocky structure; friable; about 6 percent coarse fragments; neutral; clear smooth boundary.

Bg—24 to 28 inches; grayish brown (2.5Y 5/2) sandy loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 8 percent coarse fragments; mildly alkaline; clear smooth boundary.

2Cg1—28 to 40 inches; grayish brown (2.5Y 5/2) coarse sand; common strata of loamy sand; few fine distinct yellowish brown (10YR 5/6) mottles; single grained; friable; about 10 percent coarse fragments; many shale fragments; strong effervescence; mildly alkaline; clear smooth boundary.

2Cg2—40 to 60 inches; grayish brown (2.5Y 5/2) coarse sand; common medium distinct brownish yellow (10YR 6/6) mottles; single grained; friable; about 10 percent coarse fragments; many shale fragments; strong effervescence; mildly alkaline.

The solum is 20 to 42 inches thick. Loamy sand or coarser textures are at a depth of 22 to 36 inches. The solum is 0 to 15 percent coarse fragments. The C horizon is 5 to 30 percent coarse fragments.

The Ap or A horizon has value of 2 and chroma of 1 or 2 or it is N 2/0. It is loam or sandy loam. The B horizon has hue of 2.5Y, value of 4 or 5, and chroma of 2 or 3. It is dominantly sandy loam. The lower few inches of the B2 horizon is loamy sand in some pedons. The C horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 through 4. It is medium or coarse sand.

Mayer Series

The Mayer series consists of deep, poorly drained soils on outwash plains, terraces, and uplands. The soils are moderately permeable over rapidly permeable. They formed in a calcareous, loamy mantle underlain by sandy and gravelly sediments. The slope ranges from 0 to 2 percent.

Mayer soils are similar to Lemond soils and are commonly adjacent to Estherville and Linder soils. Estherville soils are well drained and have sand and gravel at a depth of less than 24 inches. They are in higher positions on the landscape than the Mayer soils. Lemond soils are poorly drained; they have less clay in the upper mantle than the Mayer soils. Linder soils are somewhat poorly drained and are in higher positions on the landscape.

Typical pedon of Mayer loam, 800 feet south and 150 feet west of the northeast corner of sec. 18, T. 112 N., R. 34 W.

Ap—0 to 10 inches; black (N 2/0) loam, black (10YR 2/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—10 to 18 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; black (N 2/0) coatings on faces of peds; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

Ag—18 to 22 inches; very dark gray (5Y 3/1) loam, dark gray (10YR 4/1) dry; few fine distinct gray (5Y 5/1) mottles; weak medium subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

Bg—22 to 32 inches; olive gray (5Y 5/2) loam; fine medium distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 5 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2Cg—32 to 50 inches; olive gray (5Y 5/2) gravelly coarse sand; common medium distinct yellowish brown (10YR 5/6) mottles; single grained; friable; about 15 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

2C—50 to 60 inches; olive (5Y 5/3) stratified gravelly loamy sand and gravelly coarse sand; common medium prominent yellowish brown (10YR 5/6) mottles; single grained; loose; about 20 percent coarse fragments; strong effervescence; moderately alkaline.

The solum and the loamy mantle are 20 to 40 inches thick. The mollic epipedon is 14 to 24 inches thick. The loamy mantle is 0 to 10 percent coarse fragments, and the underlying sediments are 10 to 50 percent coarse fragments.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 2 or 3, and chroma of 1, or it is N 2/0 or N 3/0. Its texture is loam or silt loam. The B horizon has value of 4 or 5. It has chroma of 1 on 10YR, chroma of 2 on 2.5Y, or chroma of 1 through 3 on 5Y, or it is N 4/0 or N 5/0. The texture is loam, silt loam, or sandy clay loam. The 2C horizon has hue of 10YR, 5Y, or 2.5Y, value of 3 through 5, and chroma of 1 through 3. Its texture is gravelly sand, gravelly coarse sand, or gravelly loamy sand. The 2C horizon has strata of sand in some pedons.

Millington Series

The Millington series consists of deep, poorly drained soils on flood plains. The soils are moderately permeable. They formed in calcareous, loamy alluvium that is stratified. The slope ranges from 0 to 2 percent.

Millington soils are similar to Coland soils and are commonly adjacent to Du Page, Terril, and Spillville soils. Coland and Spillville soils are noncalcareous. Du Page soils are moderately well drained and are in slightly higher positions on the bottom lands than Millington soils. Spillville soils are moderately well drained and are in higher positions on the bottom lands. Terril soils are moderately well drained and are on foot slopes. They formed in colluvium.

Typical pedon of Millington loam, 500 feet east and 2,400 feet south of the northwest corner of sec. 19, T 110 N., R. 38 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; few snail shell fragments; slight effervescence; mildly alkaline; clear smooth boundary.

A1—8 to 18 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; few snail shell fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

A2—18 to 24 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak to moderate fine subangular blocky structure; friable; few snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

A3—24 to 36 inches; black (10YR 2/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Cg—36 to 60 inches; stratified dark gray (10YR 4/1) loam and very dark gray (2.5Y 3/0) sandy clay loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; massive; friable; few snail shell fragments; strong effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The profile is made up of 0 to 7 percent coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Its texture is loam, clay loam, silt loam, or silty clay loam. Some pedons have a B horizon. The C horizon has value of 3 or 4 and chroma of 0 to 2. It is stratified with textures ranging from sandy loam to silty clay loam.

Nishna Series

The Nishna series consists of deep, poorly drained soils on first bottoms of the flood plains. The soils are slowly permeable. They formed in loamy and clayey alluvial sediments. The slope ranges from 0 to 1 percent.

Nishna soils have more clay throughout the profile and more sand in the upper part of the profile than is defined for the Nishna series. These differences, however, do not affect the use or behavior of these soils.

Nishna soils are similar to Knoke soils and are commonly adjacent to Du Page and Millington soils. Du Page soils are moderately well drained and are in higher positions on the flood plains than Nishna soils. Knoke soils are very poorly drained. They formed in glacial sediments in lake basins. Millington soils are poorly drained and are in higher positions on the flood plains than the Nishna soils.

Typical pedon of Nishna clay loam, 250 feet south and 60 feet west of the northeast corner of sec. 23, T. 112 N., R. 39 W.

Ap—0 to 9 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; cloddy parting to weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A1—9 to 14 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; slight effervescence; mildly alkaline; gradual wavy boundary.

A2—14 to 25 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure; firm; slight effervescence; mildly alkaline; gradual wavy boundary.

A3—25 to 45 inches; black (N 2/0) silty clay, dark gray (10YR 4/1) dry; weak moderate subangular blocky structure; firm; common fine snail shell fragments; slight effervescence; mildly alkaline; gradual wavy boundary.

Cg—45 to 60 inches; dark gray (5Y 4/1) silty clay; massive; firm; few fine snail fragments; fine, generally rounded soft masses of calcium carbonate; strong effervescence; mildly alkaline.

The solum is 30 to 46 inches thick. The mollic epipedon is 24 to 46 inches thick.

The A horizon has value of 2 and chroma of 1, or it is N 2/0. Its texture below a depth of about 14 inches is silty clay loam or silty clay, but there is clay loam in the upper 14 inches. Some pedons have a Bg horizon. The C horizon has hue of 10YR or 5Y, value of 3 or 4, and chroma of 1, or it is N 3/0 or N 4/0.

Normania Series

The Normania series consists of deep, moderately well drained soils on till plains and ground moraines. The soils are moderately permeable. They formed in loamy glacial till. The slope ranges from 1 to 3 percent.

Normania soils are similar to Wilmonton soils and are commonly adjacent to Canisteo, Ves, and Webster soils. Canisteo soils are poorly drained and are calcareous throughout. These soils are in lower positions on the landscape than the Normania soils. Ves soils are well drained and have a thinner surface layer than Normania soils. Webster soils are in low, nearly level areas and in drainageways. Wilmonton soils are moderately well drained. They formed in firm glacial till.

Typical pedon of Normania loam (fig. 15), 2,600 feet north and 200 feet west of the southeast corner of sec. 35, T. 112 N., R. 38 W.

Ap—0 to 6 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; neutral; about 3 percent coarse fragments; abrupt smooth boundary.

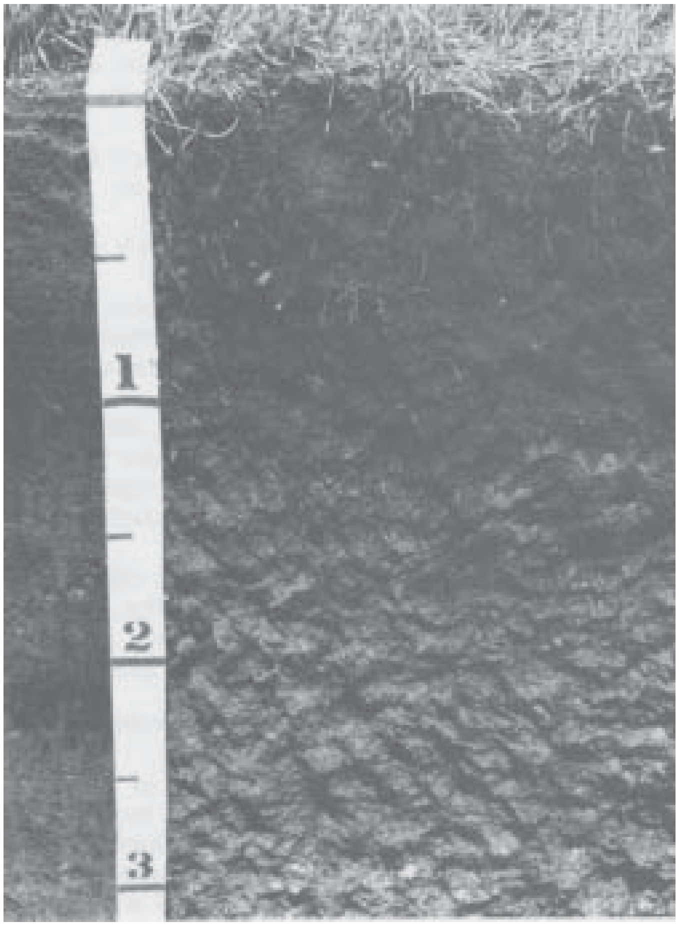


Figure 15.—Profile of Normania loam. The surface layer is about 15 inches thick. Limy material is at a depth of about 33 inches. Depth is marked in feet.

A1—6 to 12 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual smooth boundary.

A2—12 to 17 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 3/2) dry; very dark grayish brown (10YR 3/2) ped faces; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bw—17 to 28 inches; dark grayish brown (2.5Y 4/2) clay loam; moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; gradual wavy boundary.

Bkg—28 to 33 inches; grayish brown (2.5Y 5/2) loam; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; fine segregated threads and soft masses of calcium carbonate; violent effervescence; mildly alkaline; gradual wavy boundary.

Ckg—33 to 60 inches; light brownish gray (2.5Y 6/2) loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 4 percent coarse fragments; fine segregated threads and soft masses of calcium carbonate; violent effervescence; mildly alkaline.

The solum is 18 to 40 inches thick. The mollic epipedon is 10 to 20 inches thick. The depth to carbonates ranges from 18 to 36 inches. The solum and the C horizon are 3 to 8 percent coarse fragments. Shale fragments make up 20 to 50 percent of these fragments.

The A horizon has value of 2 or 3 and chroma of 1. Its texture commonly is loam or clay loam, but the range includes silt loam, sandy clay loam, and sandy loam. The B horizon has hue of 2.5Y, value of 3 or 4, and chroma of 2 through 4. In the upper part of some pedons, the B horizon has hue of 10YR. The Bk horizon has value of 4 or 5 and chroma of 2 through 4. The texture of the B horizon commonly is loam or clay loam but the range includes silt loam, sandy clay loam, and sandy loam. The C horizon has hue of 2.5Y, value of 4 through 6, and chroma of 1 through 3. In the lower part of some pedons, the C horizon has hue of 5Y.

Okoboji Series

The Okoboji series consists of deep, very poorly drained soils in closed depressions on glacial moraines. The soils are moderately slowly permeable. They formed primarily in silty alluvium washed from till from the surrounding slopes. The slope ranges from 0 to 1 percent.

Okoboji soils are similar to Glencoe soils and are commonly adjacent to Canisteo, Letri, and Webster soils. Canisteo soils are poorly drained. They are calcareous throughout and are on the rims of depressions. Glencoe soils are very poorly drained; they have less clay and more sand in the profile than Okoboji soils. Letri soils are poorly drained and formed in firm glacial till. They are in higher positions on the landscape than the Okoboji soils. Webster soils are poorly drained. They formed in glacial till. These soils have a surface layer that is less than 24 inches thick. Webster soils are in higher positions on the landscape than the Okoboji soils.

Typical pedon of Okoboji silty clay loam, 500 feet south and 170 feet east of the northwest corner of sec. 27, T. 112 N., R. 36 W.

Ap—0 to 8 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; abrupt smooth boundary

A1—8 to 28 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; neutral; clear smooth boundary.

A2—28 to 43 inches; black (N 2/0) silty clay loam, dark gray (10YR 4/1) dry; weak fine prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; clear smooth boundary.

A3—43 to 48 inches; black (10YR 2/1) silty clay loam, dark gray (5Y 5/1) dry; few fine distinct olive (5Y 4/3) mottles; weak fine prismatic structure parting to weak fine and medium subangular blocky; friable; neutral; gradual smooth boundary.

C—48 to 60 inches; olive gray (5Y 5/2) silty clay loam; common medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; slight effervescence; mildly alkaline.

The solum is 40 to 60 inches thick. The depth to free carbonates ranges from 20 to 50 inches. The A horizon is 24 to 60 inches thick.

The A horizon has hue of 10YR, value of 2, and chroma of 1, or it is N 2/0. Its texture is silty clay loam or mucky silty clay loam. Some pedons have a B horizon with hue of 5Y or 2.5Y, value of 4 or 5, and chroma of 1 or 2. It is silty clay loam or silty clay in the upper part of the horizon. The C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is typically silty clay loam but can have bands of silt loam or loam that are high in sand.

Oshawa Series

The Oshawa series consists of deep, very poorly drained soils in old oxbows or swales on the flood plains of rivers. The soils are moderately slowly permeable. They formed in calcareous, loamy and silty alluvium. The slope ranges from 0 to 1 percent.

Oshawa soils are similar to Millington soils and are commonly adjacent to Du Page and Millington soils. Du Page soils are moderately well drained and are in higher positions on the flood plains than Oshawa soils. Millington soils are poorly drained and are in higher positions on the flood plains.

Typical pedon of Oshawa silty clay loam, 1,200 feet south and 700 feet west of the northeast corner of sec. 10, T. 113 N., R. 36 W.

A1—0 to 10 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (N 4/0) dry; many fine distinct dark grayish brown (5Y 4/2) mottles; weak fine subangular blocky structure; friable; strong effervescence; moderately alkaline; clear smooth boundary.

A2—10 to 30 inches; black (5Y 2/1) clay loam, very dark gray (N 3/0) dry; few medium distinct olive (5Y 5/6) mottles; weak very fine and fine subangular blocky structure; friable; strong effervescence; mildly alkaline; gradual smooth boundary.

Ag—30 to 39 inches; very dark gray (5Y 3/1) silty clay loam, very dark gray (N 3/0) dry; many moderate distinct olive gray (5Y 5/2) mottles; weak fine and medium subangular blocky structure; friable; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg—39 to 60 inches; olive gray (5Y 5/2) silt loam; many fine distinct pale yellow (5Y 7/3) mottles; massive; friable; violent effervescence; moderately alkaline.

The A horizon is 24 to 48 inches thick. Some pedons do not have carbonates below a depth of 30 inches in the A horizon.

The A horizon has hue of 5Y, value of 2 or 3, and chroma of 1 or 2. Its texture is silty clay loam, clay loam, loam, or silt loam. The C horizon has hue of 2.5Y or 5Y, value of 3 through 5, and chroma of 1 or 2, or it is N 3/0 through N 5/0. It is loam, silty clay loam, silt loam, or clay loam. There are coarser textured strata in some pedons.

Oshawa Variant

The Oshawa Variant soils consist of deep, very poorly drained soils in high positions on the flood plains of rivers and streams. The soils are moderately slowly permeable. They formed in calcareous, loamy alluvium. The slope ranges from 1 to 3 percent.

Oshawa Variant soils are commonly adjacent to Millington and Blue Earth soils. Millington soils are poorly drained. Unlike Oshawa Variant soils, they have no stones and are in lower positions on the landscape. Blue Earth soils are very poorly drained. They have no stones and are in higher positions on the landscape.

Typical pedon of Oshawa Variant stony clay loam, 600 feet north and 100 feet east of the southwest corner of sec. 22, T. 114 N., R. 37 W.

A1—0 to 13 inches; black (5Y 2/1) stony clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 15 percent coarse fragments consisting mostly of stones; few snail shell fragments; strong effervescence; mildly alkaline; gradual smooth boundary.

A2—13 to 30 inches; very dark gray (5Y 3/1) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; about 10 percent coarse fragments consisting mostly of stones; few snail shell fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

A3g—30 to 42 inches; dark olive gray (5Y 3/2) clay loam, gray (10YR 5/1) dry; few fine distinct yellowish brown (10YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 6 percent coarse fragments; few snail shell fragments; strong effervescence; moderately alkaline; gradual wavy boundary.

Cg—42 to 60 inches; dark gray (5Y 4/1) silty clay loam; few fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 3 percent coarse fragments; few snail shell fragments; strong effervescence; mildly alkaline.

The A horizon is 24 to 50 inches thick. The solum and the C horizon are 2 to 20 percent coarse fragments. These fragments are mostly stones and snail shells. Granitic cobbles and stones are 3 to 24 inches in diameter and cover about 5 percent of the surface.

The A horizon has hue of 10YR, 2.5Y, or 5Y, value of 1 to 3, and chroma of 1 to 3, or it is N 2/0. Its texture is silty clay loam, clay loam, or loam. The C horizon has hue of 2.5Y or 5Y, value of 3 to 5, chroma of 1 or 2, or it is N 3/0 to N 5/0. Its texture is silty clay loam, loam, or clay loam. There are coarser textured strata in some pedons.

Revere Series

The Revere series consists of deep, poorly drained soils on the rims of depressions and on slightly convex slopes on ground moraines. The soils are moderately permeable. They formed in calcareous, loamy glacial till. The slope ranges from 0 to 2 percent.

Revere soils are commonly adjacent to Glencoe, Normania, and Ves soils. There is no gypsum in these soils. Glencoe soils are very poorly drained and are in depressions. Normania soils are moderately well drained, and the Ves soils are well drained. They are in higher positions on the landscape than the Revere soils.

Typical pedon of Revere clay loam (fig. 16), 1,450 feet north and 175 feet west of the southeast corner of sec. 36, T. 109 N., R. 37 W.

Ap—0 to 9 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak very fine subangular blocky structure; friable; about 1 percent coarse fragments; 3 percent gypsum in nests of crystals 1 to 2 millimeters long and in powder in root channels; strong effervescence; mildly alkaline; gradual smooth boundary.

Ay—9 to 15 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; 22 percent gypsum in nests of crystals 2 to 4 millimeters long and in powder in root channels; strong effervescence; mildly alkaline; clear wavy boundary.

Byg1—15 to 23 inches; dark grayish brown (2.5Y 4/2) clay loam; common fine distinct olive gray (5Y 5/2) mottles; weak very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; 20 percent gypsum in nests of crystals 2 to 5 millimeters long; strong effervescence; mildly alkaline; clear wavy boundary.

Figure 16.—Profile of Revere clay loam. At a depth of about 16 inches is a grayish gypsic layer. Depth is marked in feet.

Byg2—23 to 35 inches; olive gray (5Y 5/2) clay loam; common large distinct olive brown (2.5Y 4/4) mottles; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; 7 percent gypsum in nests of crystals 2 to 5 millimeters long; strong effervescence; mildly alkaline; gradual wavy boundary.

Cyg—35 to 44 inches; olive gray (5Y 5/2) loam; common medium distinct olive brown (2.5Y 4/4) mottles; weak fine and medium subangular blocky structure; friable; about 5 percent coarse fragments; 4 percent gypsum in nests of crystals 2 to 7 millimeters long; strong effervescence; mildly alkaline; gradual wavy boundary.

Cg—44 to 60 inches; olive gray (5Y 5/2) loam; common medium distinct light olive brown (2.5Y 5/6) mottles; massive; friable; about 1 percent coarse fragments; trace of gypsum; strong effervescence; mildly alkaline.

The solum is 26 to 48 inches thick. The mollic epipedon is 10 to 24 inches thick. The solum and the C horizon are 1 to 10 percent coarse fragments. The average gypsum content in the solum ranges from 2 to 25 percent. There is as much as 50 percent gypsum in some subhorizons.

The A horizon has hue of 10YR through 5Y, value of 2 or 3, and chroma of 1 or 2, or it is N 2/0. Its texture is clay loam or loam. The B horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 or 2. It is clay loam or loam. The C horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is loam or clay loam.

Salida Series

The Salida series consists of deep, excessively drained soils on terraces, glacial outwash plains, and uplands. These soils are very rapidly permeable. They formed in a thin loamy mantle underlain by sandy and gravelly outwash sediments. The slope ranges from 2 to 35 percent.

Salida soils are commonly adjacent to Biscay, Estherville, and Wadena soils. Biscay soils are poorly drained. They are in wet drainageways and on flats. Sandy and gravelly materials are at a greater depth in these soils than in Salida soils. Estherville and Wadena soils are well drained. These soils are deeper to sandy and gravelly materials and have more silt and clay and less sand in their solum. They are in lower positions on the landscape.

Typical pedon of Salida gravelly sandy loam, 2 to 12 percent slopes, 1,460 feet west and 260 feet south of the center of sec. 32, T. 114 N., R. 36 W.

A—0 to 8 inches; very dark gray (10YR 3/1) gravelly sandy loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 15 percent coarse fragments; slightly acid; clear wavy boundary.

C1—8 to 18 inches; dark grayish brown (10YR 4/2) very gravelly coarse sand; tongues of very dark grayish brown (10YR 3/2); single grained; loose; about 45 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

C2—18 to 32 inches; dark yellowish brown (10YR 4/4) extremely gravelly coarse sand; single grained; loose; about 65 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

C3—32 to 44 inches; dark yellowish brown (10YR 4/4) gravelly coarse sand; single grained; loose; about 35 percent coarse fragments; slight effervescence; mildly alkaline; gradual smooth boundary.

C4—44 to 60 inches; yellowish brown (10YR 5/6) gravelly coarse sand; single grained; loose; about 30 percent coarse fragments; slight effervescence; mildly alkaline.

The solum is 7 to 20 inches thick. The control section typically is 35 to 75 percent coarse fragments.

The A horizon is 7 to 10 inches thick. The A horizon has value of 2 or 3 and chroma of 1 through 3. Its texture is gravelly sandy loam, gravelly loamy sand, or gravelly coarse sandy loam. In some pedons, there is a B horizon. It has value of 3 or 4 and chroma of 3 or 4. It is commonly gravelly loamy sand, gravelly loamy coarse sand, or gravelly coarse sand. The C horizon has hue of 10YR or 7.5YR, value of 3 through 6, and chroma of 2 through 6. It is typically gravelly coarse sand, very gravelly coarse sand, or gravel.

Seaforth Series

The Seaforth series consists of deep, moderately well drained soils on till plains and ground moraines. The soils are moderately permeable. They formed in calcareous, loamy glacial till. The slope ranges from 1 to 3 percent.

Seaforth soils are similar to Normania soils and are commonly adjacent to Canisteo, Glencoe, Ves, and Storden soils. Canisteo soils are poorly drained and are on flats and in drainageways. Glencoe soils are very poorly drained and are in depressions. Normania soils are moderately well drained. They do not have free carbonates in the surface layer. Ves and Storden soils are well drained and are in higher positions on the landscape than the Seaforth soils.

Typical pedon of Seaforth loam, 2,200 feet east and 100 feet south of the northwest corner of sec. 20, T. 111 N., R. 38 W.

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

A—9 to 15 inches; very dark gray (10YR 3/1) loam, dark grayish brown (10YR 4/2) dry; grayish brown (10YR 5/2) faces of peds; weak very fine and fine granular structure; very friable; few medium irregularly shaped soft masses of calcium carbonate; about 3 percent coarse fragments; strong effervescence; moderately alkaline; clear wavy boundary.

Bk—15 to 21 inches; grayish brown (2.5Y 5/2) clay loam; few fine faint light olive brown (2.5Y 5/4) mottles; moderate fine subangular blocky structure; friable; fine irregularly shaped soft masses of calcium carbonate; few fine very dark gray root channels; about 3 percent coarse fragments; violent effervescence; moderately alkaline; clear wavy boundary.

Ck1—21 to 32 inches; grayish brown (2.5Y 5/2) loam; common medium faint light olive brown (2.5Y 5/4) mottles; weak fine subangular blocky structure; friable; fine irregularly shaped soft masses of calcium carbonate; about 4 percent coarse fragments; strong effervescence; moderately alkaline; gradual irregular boundary.

Ck2—32 to 44 inches; grayish brown (2.5Y 5/2) loam; many large distinct light olive brown (2.5Y 5/6) mottles; weak fine subangular blocky structure; friable; irregularly shaped soft masses of calcium carbonate; about 6 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C—44 to 60 inches; olive brown (2.5Y 4/4) loam; many large distinct grayish brown (2.5Y 5/2) mottles; massive; friable; about 8 percent coarse fragments; strong effervescence; moderately alkaline.

The solum is 16 to 36 inches thick. Some pedons are leached of carbonates to a depth of 7 inches. The mollic epipedon is 10 to 20 inches thick. The solum and the C horizon are 3 to 8 percent, by volume, coarse fragments. Shale fragments make up 20 to 50 percent of the coarse fragments 2 to 5 millimeters in diameter.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam, but the range includes silt loam, sandy clay loam, or sandy loam. The B horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 2 through 4. It is loam, clay loam, sandy clay loam, sandy loam, or silt loam. The C horizon typically has hue of 2.5Y (ranging from 5Y to 10YR), value of 4 or 5, and chroma of 2 through 4.

Spillville Series

The Spillville series consists of deep, moderately well drained soils on bottom lands and foot slopes on terraces and glacial outwash plains. These soils are moderately permeable. They formed in loamy alluvium. The slope ranges from 0 to 3 percent.

Spillville soils are similar to Du Page and Terril soils and are commonly adjacent to Estherville and Nishna soils. Du Page soils are calcareous. Terril soils are in higher positions on the landscape than Spillville soils and are not subject to flooding. Estherville soils are well drained. They are underlain by sand and gravel and are in higher positions on the landscape than the Spillville soils. Nishna soils are poorly drained and are in lower positions on the bottom lands.

Typical pedon of Spillville loam, occasionally flooded, 300 feet north and 50 feet west of the southeast corner of sec. 20, T. 109 N., R. 36 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

A1—10 to 19 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; moderate medium subangular blocky structure; friable; neutral; clear smooth boundary.

A2—19 to 32 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak medium subangular blocky structure parting to medium and coarse granular; friable; neutral; clear smooth boundary.

A3—32 to 43 inches; very dark brown (10YR 2/2) loam, dark gray (10YR 4/1) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

A4—43 to 48 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak medium subangular blocky structure; friable; neutral; clear smooth boundary.

C—48 to 60 inches; very dark grayish brown (10YR 3/2) loam; massive; friable; neutral; clear smooth boundary.

The solum is 30 to 56 inches thick.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or silt loam in the upper 36 inches. Below a depth of 36 inches, the A horizon is commonly loam but ranges to sandy loam and fine sandy loam. The C horizon has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 1 or 2.

Storden Series

The Storden series consists of deep, well drained soils on glacial moraines. The soils are moderately permeable. They formed in calcareous, loamy glacial till. The slope ranges from 3 to 40 percent.

Storden soils are similar to Swanlake soils and are commonly adjacent to Canisteo, Estherville, and Ves soils. Canisteo soils are poorly drained and are on the rims of depressions. Estherville soils are well drained and are underlain by sand and gravel. They and Storden soils are in similar positions on the landscape. Swanlake soils are well drained; they have a darker surface layer than Storden soils. Ves soils are well drained and are noncalcareous. They are in lower positions on the landscape than Storden soils.

Typical pedon of Storden loam in an area of Storden-Ves loams, 6 to 12 percent slopes, eroded, 955 feet north and 100 feet east of the southwest corner of sec. 24, T. 113 N., R. 36 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) loam, light gray (10YR 6/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; strong effervescence; moderately alkaline; abrupt smooth boundary.

C1—8 to 37 inches; brown (10YR 5/3) loam; weak fine and medium subangular blocky structure; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline; clear smooth boundary.

C2—37 to 60 inches; pale brown (10YR 6/3) loam; few fine distinct yellowish brown (10YR 5/6) mottles;

massive; friable; about 4 percent coarse fragments; strong effervescence; moderately alkaline.

The solum and the A horizon are 7 to 10 inches thick. There are 2 to 10 percent coarse fragments throughout the profile.

The A horizon has value of 4 or 5 and chroma of 2 or 3. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 6.

Swanlake Series

The Swanlake series consists of deep, well drained soils on dissected glacial moraines and till plains. The soils are moderately permeable. They formed in calcareous, friable, loamy glacial till. The slope ranges from 25 to 70 percent.

Swanlake soils are similar to Storden soils and are commonly adjacent to Terril and Ves soils. Storden soils are well drained and do not have a dark surface layer. Terril soils are moderately well drained and are on foot slopes. They have a thicker surface layer than Swanlake soils. Ves soils are well drained. These soils do not have carbonates in the A horizon and in the upper part of the B horizon. Ves soils and Swanlake soils are in similar positions on the landscape.

Typical pedon of Swanlake loam in an area of Terril-Swanlake loams, 25 to 70 percent slopes, 40 feet south and 1,700 feet west of the northeast corner of sec. 35, T. 114 N., R. 37 W.

A—0 to 9 inches; black (10YR 2/1) loam; very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; friable; about 9 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Ck1—9 to 17 inches; brown (10YR 5/3) loam; many very dark gray (10YR 3/1) coatings on faces of peds; weak very fine subangular blocky structure; friable; fine irregularly shaped segregated calcium carbonate in seams; about 13 percent coarse fragments; strong effervescence; mildly alkaline; gradual wavy boundary.

Ck2—17 to 35 inches; light olive brown (2.5Y5/4) loam; weak very fine subangular blocky structure; friable; about 6 percent coarse fragments; few fine soft masses of calcium carbonate; strong effervescence; moderately alkaline; gradual smooth boundary.

Ck3—35 to 50 inches; light olive brown (2.5Y 5/4) loam; massive; friable; few fine soft masses of calcium carbonate; about 5 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C—50 to 60 inches; light olive brown (2.5Y 5/4) loam; common fine distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 8 percent coarse fragments; strong effervescence; moderately alkaline.

The mollic epipedon is 7 to 14 inches thick. The solum is 1 to 10 percent coarse fragments, and the C horizon is 5 to 20 percent.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Ck horizon has hue of 10YR or 2.5Y, value of 4 or 5, and chroma of 3 through 5. The C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 4 through 6.

Terril Series

The Terril series consists of deep, moderately well drained soils on foot slopes and alluvial fans. The soils are moderately permeable. They formed in loamy local alluvium derived from glacial till. The slope ranges from 2 to 20 percent.

Terril soils are similar to Spillville soils and are commonly adjacent to Ves and Storden soils. Spillville soils are on bottom lands. They formed in alluvium. Storden and Ves soils are well drained and are in higher positions on the landscape than the Terril soils.

Typical pedon of Terril loam, 2 to 6 percent slopes, 250 feet north and 1,340 feet east of the southwest corner of sec. 20, T. 114 N., R. 37 W.

Ap—0 to 10 inches; black (10YR 2/1) loam, very dark brown (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

A1—10 to 24 inches; black (10YR 2/1) loam, very dark gray (10YR 3/1) dry; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

A2—24 to 34 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bw1—34 to 48 inches; dark brown (10YR 3/3) loam; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

Bw2—48 to 60 inches; dark yellowish brown (10YR 4/4) loam; few fine faint yellowish brown (10YR 5/4) mottles; moderate fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral.

The solum is about 36 to 60 inches thick. The A horizon is 24 to 36 inches thick. The solum is 0 to 8 percent coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam, silt loam, or clay loam. The B horizon has value of 3 and chroma of 2 or 3 above a depth of 40 inches. It has value of 4 and chroma of 3 or 4 in the lower part. It is loam or clay loam. Where this soil is upslope from stream benches, its texture ranges from loam to sandy loam below a depth of 40 inches. If there is a C horizon, it has hue of 10YR or 2.5Y, value of 4, and chroma of 3 or 4. It is loam or clay loam.

Tilfer Series

The Tilfer series consists of moderately deep, poorly and very poorly drained soils on low and intermediate stream benches. The soils are moderately permeable. They formed in a mantle of loamy alluvium underlain by residuum of igneous and metamorphic bedrock. The slope ranges from 0 to 2 percent.

The Tilfer soils are underlain by igneous and metamorphic bedrock. This is outside the defined range for the Tilfer series but does not affect the use or behavior of the soils.

Tilfer soils are commonly adjacent to Rock outcrop and Copaston and Wadena Variant soils. Copaston soils are shallow and are underlain by bedrock. These soils are in higher, more sloping positions than the Tilfer soils. The Wadena Variant soils are moderately well drained and well drained. These soils are in higher positions on the landscape than the Tilfer soils.

Typical pedon of Tilfer clay loam, 2,000 feet south and 1,200 feet east of the northwest corner of sec. 19, T. 113 N., R. 35 W.

Ap—0 to 10 inches; black (N 2/0) clay loam, very dark gray (10YR 3/1) dry; cloddy parting to weak fine subangular blocky structure; friable; slight effervescence; mildly alkaline; abrupt smooth boundary.

A—10 to 19 inches; very dark gray (10YR 3/1) clay loam, dark gray (10YR 4/1) dry; moderate very fine and fine subangular blocky structure; friable; slight effervescence; mildly alkaline; clear smooth boundary.

Bg1—19 to 24 inches; grayish brown (2.5Y 5/2) loam; few fine prominent yellowish brown (10YR 5/8) mottles; moderate fine and medium subangular blocky structure; friable; slight effervescence; moderately alkaline; clear smooth boundary.

Bg2—24 to 32 inches; grayish brown (2.5Y 5/2) loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; about 10 percent coarse fragments; mostly residual material from igneous and metamorphic bedrock; friable; strong effervescence; moderately alkaline; abrupt wavy boundary.

Cr—32 inches; igneous and metamorphic bedrock.

The solum is 20 to 40 inches thick. The depth to bedrock ranges from 20 to 40 inches. If there is a B3g horizon and a 2C horizon, they are 10 to 30 percent coarse fragments.

The A horizon has value of 2 and chroma of 1, or it is N 2/0. Its texture is clay loam or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 or 2. It is loam, clay loam, or silty clay loam.

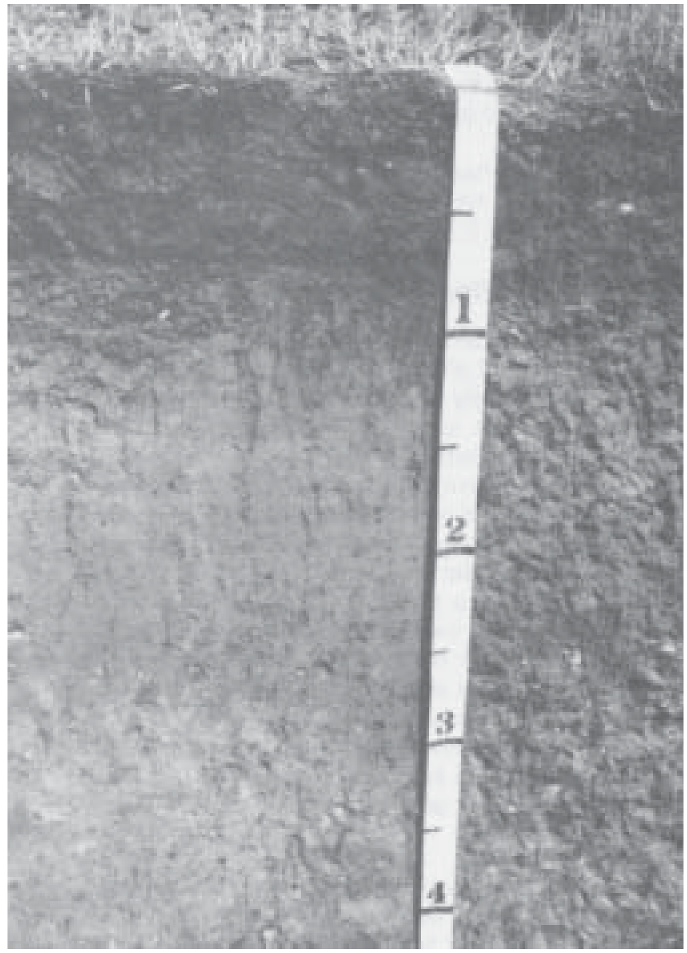


Figure 17.—Profile of Ves loam, 1 to 4 percent slopes. The surface layer is about 10 inches thick. Limy material is at a depth of about 31 inches. Depth is marked in feet.

Ves Series

The Ves series consists of deep, well drained soils on low knolls on till plains and ground moraines. The soils are moderately permeable. They formed in friable, loamy glacial till. The slope ranges from 1 to 18 percent.

Ves soils are similar to Everly soils and are commonly adjacent to Glencoe and Normania soils. Glencoe soils are very poorly drained and are in depressions. Normania soils are moderately well drained and are in slightly lower positions on the landscape than Ves soils. Everly soils are well drained; they have more clay and a firm underlying material.

Typical pedon of Ves loam, 1 to 4 percent slopes (fig. 17), 1,140 feet north and 250 feet west of the southeast corner of sec. 2, T. 112 N., R. 39 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 3 percent coarse fragments; neutral; abrupt smooth boundary.

AB—10 to 15 inches; dark brown (10YR 3/3) and very dark grayish brown (10YR 3/2) loam; moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; common very dark gray (10YR 3/1) worm casts; clear smooth boundary.

Bw—15 to 25 inches; brown (10YR 4/3) loam; moderate very fine prismatic structure parting to weak very fine subangular blocky; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bk—25 to 31 inches; light olive brown (2.5Y 5/4) loam; weak very fine subangular blocky structure; friable; about 3 percent coarse fragments; common soft white masses of calcium carbonate; moderately alkaline; strong effervescence; clear wavy boundary.

Ck—31 to 39 inches; light olive brown (2.5Y 5/4) loam; massive; friable; about 4 percent coarse fragments; few iron oxide stains; many soft white masses of calcium carbonate; moderately alkaline; strong and violent effervescence; clear smooth boundary.

C—39 to 60 inches; light olive brown (2.5Y 5/4) loam; few fine distinct light gray (10YR 6/1) mottles; massive; friable; about 7 percent coarse fragments; few iron oxide stains; moderately alkaline; strong effervescence.

The solum is 18 to 40 inches thick. The mollic epipedon is 10 to 20 inches thick. The depth to free carbonates is 14 to 33 inches. There are 1 to 8 percent coarse fragments throughout. Shale fragments are scattered throughout the profile. They make up 20 to 50 percent of the coarse fragments.

The A horizon has value of 2 or 3. Some pedons do not have an AB horizon. The B horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 3 or 4. It is loam or clay loam. The Bk horizon has hue of 2.5Y or 10YR, value of 4 through 6, and chroma of 4. It has few to many soft masses of lime. The C horizon has hue of 2.5Y or 10YR, value of 4 or 5, and chroma of 3 or 4.

Wadena Series

The Wadena series consists of deep, well drained soils on glacial outwash plains, terraces, and uplands. The soils are moderately permeable over rapidly permeable. They formed in glacial outwash consisting of a loamy mantle underlain by sandy and gravelly sediments. The slope ranges from 0 to 6 percent.

Wadena soils are commonly adjacent to Dickman and Estherville soils. Dickman and Estherville soils have less silt and clay and more sand in the solum than Wadena soils. They and Wadena soils are in similar positions on the landscape.

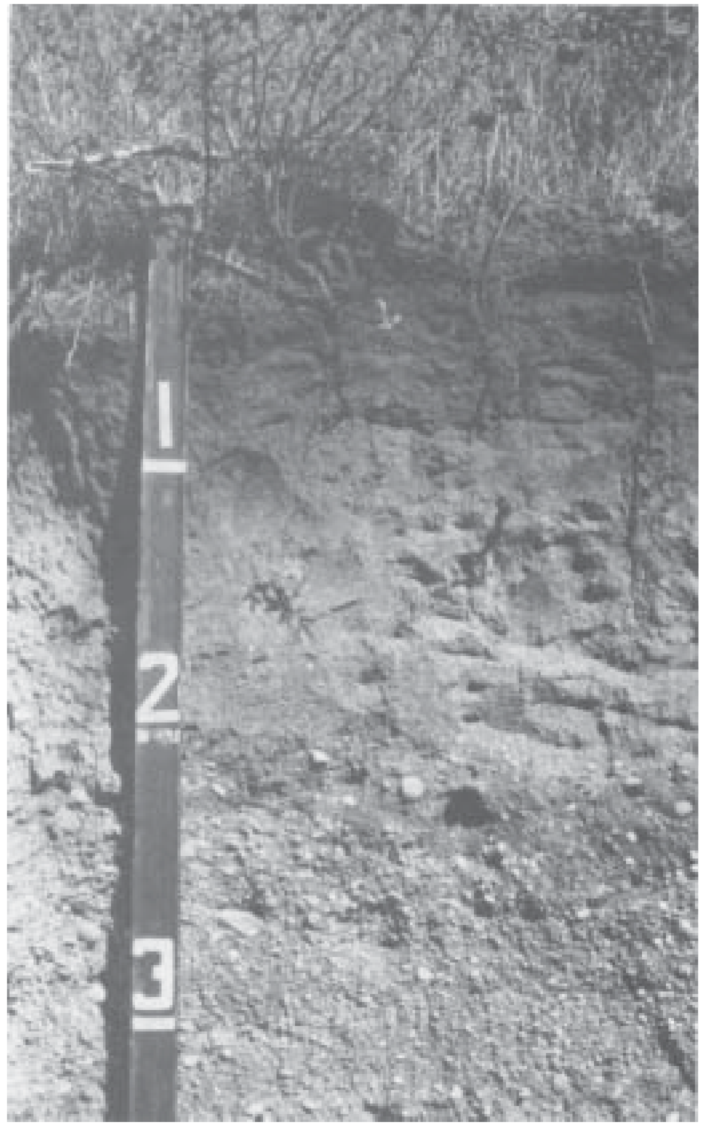


Figure 18.—Profile of Wadena loam, 0 to 2 percent slopes. About 29 inches of loam is underlain by gravelly coarse sand. Depth is marked in feet.

Typical pedon of Wadena loam, 0 to 2 percent slopes (fig. 18), 350 feet south and 600 feet east of the northwest corner of sec. 14, T. 113 N., R. 36 W.

Ap—0 to 8 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine granular structure; friable; about 2 percent coarse fragments; slightly acid; abrupt smooth boundary.

A—8 to 13 inches; very dark gray (10YR 3/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine and medium subangular blocky structure; friable; about 2 percent coarse fragments; slightly acid; clear smooth boundary.

Bw1—13 to 20 inches; dark brown (10YR 3/3) loam; weak medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; gradual wavy boundary.

Bw2—20 to 29 inches; dark brown (10YR 4/3) loam; moderate medium subangular blocky structure; friable; about 2 percent coarse fragments; neutral; clear smooth boundary.

2C1—29 to 33 inches; yellowish brown (10YR 5/4) very gravelly coarse sand; single grained; loose; about 40 percent coarse fragments; strong effervescence; mildly alkaline; clear wavy boundary.

2C2—33 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand; single grained; loose; about 25 percent coarse fragments with 10 percent shale fragments; strong effervescence; mildly alkaline.

The solum is 24 to 40 inches thick. The 2C horizon is at a depth of 24 to 40 inches. The mollic epipedon is 12 to 20 inches thick. Coarse fragments range from 0 to 10 percent in the loamy mantle and 5 to 50 percent in the 2C horizon.

The A horizon has value of 2 or 3 and chroma of 1 or 2. It is loam or clay loam. The B horizon has hue of 10YR or 7.5YR, value of 3 through 5, and chroma of 3 or 4. It is loam in the upper part and sandy loam, coarse sandy loam, or loam in the lower part. The 2C horizon has hue of 10YR or 7.5YR, value of 4 through 6, and chroma of 2 through 4. The fine-earth fraction is coarse sand or sand.

Wadena Variant

The Wadena Variant consists of moderately deep, moderately well drained and well drained soils on rock-cored terraces. The soils formed in loamy alluvium underlain by igneous and metamorphic bedrock. Permeability is moderate in the upper part of the profile and moderately rapid in the lower part. The slope ranges from 0 to 6 percent.

Wadena Variant soils are commonly adjacent to Tilfer and Copaston soils and Rock outcrop. Tilfer soils have a thicker mollic epipedon than Wadena Variant soils and are in lower positions on the landscape. Rock outcrop and Copaston soils are in higher, more sloping areas than Wadena Variant soils.

Typical pedon of Wadena Variant loam, 0 to 2 percent slopes, 1,450 feet east and 850 feet south of the northwest corner of sec. 19, T. 113 N., R. 35 W.

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

Bw—11 to 18 inches; dark grayish brown (10YR 4/2) loam; very dark grayish brown (10YR 3/2) coatings on faces of peds; moderate fine and medium subangular blocky structure; friable; neutral; clear smooth boundary.

C1—18 to 23 inches; light yellowish brown (10YR 6/4) loam; weak very fine and fine subangular blocky structure; friable; about 2 percent coarse fragments; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—23 to 32 inches; pale brown (10YR 6/3) loam; common medium distinct strong brown (7.5YR 5/8) mottles; massive; friable; about 6 percent coarse fragments; partly decomposed residual igneous and metamorphic bedrock in the lower part; strong effervescence; moderately alkaline; abrupt smooth boundary.

Cr—32 inches; weathered igneous and metamorphic bedrock.

The solum is 15 to 40 inches thick. The mollic epipedon is 10 to 20 inches thick. Igneous and metamorphic bedrock is at a depth of 20 to 50 inches.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Its texture is loam or fine sandy loam. The B horizon has value of 3 through 5 and chroma of 2 through 4. It is loam, fine sandy loam, or sandy loam. The C horizon has value of 5 or 6 and chroma of 3 through 8. It is loam or sandy loam. The 2C horizon is 1 to 15 percent coarse fragments. The 2Cr horizon is partly decomposed igneous and metamorphic bedrock that increases in hardness with depth.

Webster Series

The Webster series consists of deep, poorly drained soils on glacial moraines. The soils are moderately permeable. They formed in loamy glacial till. The slope ranges from 0 to 3 percent.

Webster soils are similar to Letri and Delft soils and are commonly adjacent to Glencoe, Normania, and Ves soils. Glencoe soils are very poorly drained and are in depressional areas. Letri soils formed in firm glacial till. Delft soils have a mollic epipedon that is 24 inches or more thick. Normania soils are moderately well drained and Ves soils are well drained. These soils are in higher positions on the landscape than the Webster soils.

Typical profile of Webster clay loam, 2,500 feet south and 1,300 feet east of the northwest corner of sec. 36, T. 112 N., R. 35 W.

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

A1—10 to 16 inches; black (N 2/0) clay loam, black (10YR 2/1) dry; weak to moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

A2—16 to 19 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; few fine distinct light olive brown (2.5Y 5/6) mottles; weak and moderate fine subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

Bg—19 to 29 inches; gray (5Y 5/1) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; weak and moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; few very dark gray (5Y 3/1) root channels; neutral; clear smooth boundary.

BCg—29 to 33 inches; gray (5Y 5/1) clay loam; few fine distinct light olive brown (2.5Y 5/6) mottles; weak and moderate medium subangular blocky structure; friable; about 3 percent coarse fragments; slight effervescence; mildly alkaline; clear smooth boundary.

Cg—33 to 46 inches; light olive gray (5Y 6/2) clay loam; common medium distinct light olive brown (2.5Y 5/6) mottles; weak fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; few white soft masses of calcium carbonate; strong effervescence; mildly alkaline; clear smooth boundary.

C—46 to 60 inches; olive (5Y 5/3) loam; common large distinct yellowish brown (10YR 5/6) mottles; massive; friable; about 4 percent coarse fragments; few white soft masses of calcium carbonate; strong effervescence; moderately alkaline.

The solum is 24 to 50 inches thick. The depth to free carbonates ranges from 24 to 50 inches. The solum and C horizon are 2 to 8 percent coarse fragments.

The A horizon has value of 2 and chroma of 1, or it is N 2/0. Its texture is clay loam or silty clay loam. The B horizon has hue of 2.5Y or 5Y, value of 4 through 6, and chroma of 1 through 3. It is clay loam or loam.

Wilmonton Series

The Wilmonton series consists of deep, moderately well drained soils on dissected ground moraines. The soils are moderately slowly permeable. They formed in loamy erosional sediments and firm glacial till. The slope ranges from 1 to 3 percent.

Wilmonton soils are similar to Normania soils and are commonly adjacent to Everly and Letri soils. Everly soils are well drained. They are in higher positions on the landscape than Wilmonton soils. Letri soils are poorly drained and are in low, nearly level areas and in drainageways. Normania soils formed in friable glacial till.

Typical pedon of Wilmonton clay loam, 1,870 feet south and 350 feet east of the northwest corner of sec. 31, T. 109 N., R. 38 W.

Ap—0 to 8 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak very fine and fine subangular blocky structure; friable; about 4 percent coarse fragments; medium acid; abrupt smooth boundary.

A—8 to 14 inches; black (10YR 2/1) clay loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky structure; friable; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bw1—14 to 18 inches; dark grayish brown (2.5Y 4/2) clay loam; very dark grayish brown (10YR 3/2) crushed; moderate very fine and fine subangular blocky structure; friable; very dark gray (10YR 3/1) worm casts; about 3 percent coarse fragments; slightly acid; clear wavy boundary.

Bw2—18 to 28 inches; olive brown (2.5Y 4/4) clay loam; few fine faint grayish brown (2.5Y 5/2) mottles; moderate fine and medium subangular blocky structure; friable; about 3 percent coarse fragments; neutral; clear smooth boundary.

2Bk—28 to 39 inches; light olive brown (2.5Y 5/4) clay loam; many fine faint grayish brown (2.5Y 5/2) mottles; weak fine and very fine subangular blocky structure; firm; about 4 percent coarse fragments; violent effervescence; moderately alkaline; gradual smooth boundary.

2C—39 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam; many coarse distinct grayish brown (2.5Y 5/2) mottles; massive; firm to friable; about 8 percent coarse fragments; few concentrations of iron and manganese; strong effervescence; moderately alkaline.

The solum is 20 to 40 inches thick. The depth to carbonates ranges from 20 to 40 inches. The mollic epipedon is 14 to 24 inches thick. The sediment in the upper part of the solum is 0 to 5 percent coarse fragments, and the firm glacial till is 2 to 8 percent coarse fragments.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Its texture is loam, clay loam, or silty clay loam. The B horizon has hue of 10YR and 2.5Y, value of 3 through 5, and chroma of 2 through 4. It is clay loam or silty clay loam. The 2C horizon has hue of 10YR or 2.5Y, value of 5 or 6, and chroma of 2 through 4. It is loam or clay loam.

Wilmonton Variant

The Wilmonton Variant consists of deep, moderately well drained soils on terrace escarpments along the Cottonwood River. The soils are very slowly permeable. They formed in a loamy mantle and in clayey material below an iron pan. The slope ranges from 2 to 40 percent.

The Wilmonton Variant soils are commonly adjacent to the Du Page, Millington, and Terril soils. The Du Page and Millington soils are on the flood plains. The Terril soils are on footslopes.

Typical pedon of Wilmonton Variant loam, 2 to 12 percent slopes, 600 feet east and 1,800 feet south of the northwest corner of sec. 35, T. 109 N., R. 36 W.

Ap—0 to 12 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 5 percent coarse fragments consisting of ironstone fragments; neutral; gradual wavy boundary.

A—12 to 19 inches; black (10YR 2/1) loam, very dark grayish brown (10YR 3/2) dry; weak fine subangular blocky structure; friable; about 10 percent coarse fragments consisting of ironstone fragments becoming nearly continuous in the lower part; neutral; clear wavy boundary.

2Bt1—19 to 23 inches; brown (10YR 4/3) clay; strong fine and medium angular blocky structure; firm; dark grayish brown (10YR 4/2) ped faces; common moderately thick clay films line pores; about 4 percent coarse fragments; neutral; clear wavy boundary.

2Bt2—23 to 29 inches; dark grayish brown (2.5Y 4/2) clay; few fine faint yellowish brown (2.5Y 5/4) mottles; strong fine and medium angular blocky structure; firm; common moderately thick clay films line pores; about 2 percent coarse fragments; neutral; gradual wavy boundary.

2Bt3—29 to 41 inches; dark grayish brown (2.5Y 4/2) clay; common medium distinct yellowish brown (10YR 5/6) mottles; moderate medium and coarse angular blocky structure; firm; few moderately thick clay films on faces of peds; about 2 percent coarse fragments; fine irregularly shaped soft masses of calcium carbonate; slight effervescence; mildly alkaline; clear smooth boundary.

2Cg—41 to 60 inches; dark gray (5Y 4/1) clay; common medium distinct yellowish brown (10YR 5/6) mottles; weak medium and coarse angular blocky structure; firm; about 3 percent coarse fragments; about 2 percent gypsum crystals 2 to 5 millimeters in size; large irregularly shaped soft masses of calcium carbonate; strong effervescence; mildly alkaline.

The solum is 26 to 60 inches thick. The loamy mantle is 12 to 36 inches thick. The upper part of the mantle is 2 to 10 percent coarse fragments. In some areas, a cemented layer is between the loamy material and the clayey material. The A horizon is 12 to 20 inches thick, and the 2B horizon is 14 to 40 inches thick. The 2B and the 2C horizons are 2 to 8 percent coarse fragments. Gypsum powder and crystals range from a trace to 10 percent in the 2B and 2C horizons.

The A horizon has value of 2 or 3 and chroma of 1 or 2. Its texture is sandy clay loam or loam. In a few pedons, a Bw horizon is in the upper part of the loamy mantle. It has hue of 10YR or 2.5Y, value of 3 or 4, and chroma of 2 through 4. It is loam, clay loam, sandy clay loam, or sandy loam. The 2B horizon has hue of 10YR, 2.5Y, or 5Y, value of 4 or 5, and chroma of 1 through 3. It is clay or silty clay. The 2C horizon has hue of 2.5Y or 5Y, value of 4 or 5, and chroma of 1 through 3. It is clay or silty clay.

Zumbro Series

The Zumbro series consists of deep, moderately well drained soils on alluvial fans. The soils are rapidly permeable. They formed in stream-deposited sandy alluvium. The slope ranges from 0 to 2 percent.

Zumbro soils in this county have a coarse textured control section. This is outside the defined range for the Zumbro series but does not affect the use or behavior of the soils.

Zumbro soils are commonly adjacent to Du Page and Oshawa soils. Du Page soils have more clay in the solum than Zumbro soils. Du Page and Zumbro soils are in similar positions on the landscape. Oshawa soils are very poorly drained and are in oxbows and swales on the flood plains.

Typical pedon of Zumbro loamy sand in an area of Du Page-Zumbro complex, about 950 feet east and 350 feet north of the center of sec. 30, T. 114 N., R. 36 W.

Ap—0 to 10 inches; very dark brown (10YR 2/2) loamy sand, very dark grayish brown (10YR 3/2) dry; weak very fine subangular blocky structure; very friable; slight effervescence; mildly alkaline; clear smooth boundary.

A—10 to 50 inches; very dark grayish brown (10YR 3/2) sand, dark grayish brown (10YR 4/2) dry; single grained; loose; slight effervescence; mildly alkaline; gradual smooth boundary.

Bw—50 to 60 inches; dark brown (10YR 3/3) sand; single grained; loose; strong effervescence; mildly alkaline.

The solum is 26 to 60 inches thick. The mollic epipedon is 24 to 50 inches thick. The solum and the C horizon are 0 to 15 percent coarse fragments.

The A horizon has value of 2 and chroma of 1 or 2 in the upper part and value of 3 and chroma of 2 in the lower part. Its texture is loamy sand, loamy fine sand, or fine sandy loam. The B horizon has value and chroma of 2 through 4. It is sand, fine sand, loamy sand, or loamy fine sand. If there is a C horizon, it has value of 5 to 6 and chroma of 2 through 5. Its texture is fine sand, coarse sand, or sand.

Formation of the Soils

This section discusses the factors of soil formation, relates them to the formation of the soils in Redwood County, and explains the process of soil formation.

Soil is produced by soil-forming processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given place are determined by the physical and mineralogical composition of the parent material; the climate under which the soil material accumulated and has existed since accumulation; the plant and animal life on and in the soil; the relief, or lay of the land; and the length of time the processes of soil formation have acted on the soil material.

Climate and plant and animal life, chiefly plants, are the active factors of soil formation. They act on the parent material that has accumulated through the weathering of rocks and slowly change it to a natural body that has genetically related horizons. The effects of climate and plant and animal life are conditioned by relief. The parent material also affects the kind of soil profile that forms and can determine it almost entirely. Finally, time is needed for the parent material to change into a soil profile. It may be much or little, but some time is always required for differentiation of soil horizons. Usually, a long time is required for the development of distinct horizons.

The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent Material

The soils in Redwood County formed in several kinds of parent material, all of glacial origin. The major parent materials in the county are glacial till, glacial outwash and meltwater channel deposits, alluvial deposits, and colluvium. About 85 percent of the soils in this county formed in glacial till, and about 15 percent formed in other kinds of parent material.

Glacial till from the Des Moines lobe of the Wisconsin glaciation covers Redwood County *(4, 11)*. This lobe consists of the Coteau des Prairies phase, which is south of the Cottonwood River, and the New Ulm phase, which is north of the Cottonwood River. The meltwater from the Des Moines lobe carried glacial outwash and meltwater channel deposits and the alluvial deposits on the flood plains. Runoff deposited colluvium at the base of the slopes.

South of the Cottonwood River, the glacial till of the Coteau des Prairies phase is thicker, has a low shale content, and has a well developed drainage system. These nearly parallel drainageways, some of which are 10 to 50 feet deep, dissect this area at intervals of 1/2 to 3 miles. The Coteau des Prairies extends diagonally across the southern part of the county from northwest to southeast. The highest elevation is in the southwest corner of the county, and the Coteau des Prairies gradually slopes down toward the Cottonwood River. South of the Cottonwood River Valley, the elevation increases from about 10 to 50 feet per mile. Many of the soils are underlain by firm till. The Everly, Wilmonton, and Letri soils are examples of these soils.

The New Ulm phase, which is the youngest glacial till in the county, contains unweathered shale fragments. This till plain mostly consists of low knolls that are irregularly shaped. These knolls rise from 1 to 10 feet above the lowland till plain. The inherent fertility of the till soils is moderate or high. The Ves, Storden, Normania, Canisteo, Glencoe, and Okoboji soils are examples of these glacial till soils.

Glacial outwash and meltwater channel deposits from the Des Moines lobe consisted of sandy and gravelly material on stream terraces. This outwash material was deposited along the Minnesota, Redwood, and Cottonwood Rivers and along Sleepy Eye and Ramsey Creeks. The Estherville, Salida, and Wadena soils are the main soils that formed in these deposits. In some less extensive areas, outwash material, mostly from the meltwater channels, was deposited in the crevass-filled hills that run mostly southeasterly through the county. The Storden, Estherville, Ves, and Salida soils are the principal soils on these hills. Outwash materials make up about 4 percent of the county.

Alluvial materials have been deposited on the flood plains along the streams and rivers in Redwood County. In most places, these sediments are many feet thick and are dark and calcareous. Their texture ranges from sand to clay loam. The Du Page, Millington, Oshawa, and Zumbro soils formed in these alluvial materials. In some areas of the flood plain where the gradient is low, clayey lacustrine sediments were deposited. These sediments are covered in some places by a thin layer of loamy alluvium deposited by the rivers. The Nishna soils are an example of soils that formed in these lacustrine sediments.

In drainageways, on alluvial fans, and near the base of the steeper slopes, colluvium from the slopes above has accumulated. Colluvial material is similar to alluvial material but is generally not calcareous. The Terril and Delft soils are examples of soils that formed in colluvium.

Climate

Redwood County has a subhumid continental climate that is characterized by cold winters and hot summers. The climate has had a pronounced effect on the soil formation. Freezing of the soil in winter slows the soil-forming processes. Alternate freezing and thawing, especially in the spring, plays a part in the development of the soil's structure. Freezing and thawing also help to disintegrate parts of the glacial debris. Frost heaving mixes the soil materials. Rainfall in the area has affected the leaching of the lime in the soil. The thickness of the layer from which free lime has been leached has largely determined the thickness of the solum.

The climate of the county is responsible, to a large degree, for the native vegetation being grasses instead of trees. The grass vegetation has produced soils that have a dark surface layer. The grass vegetation and the cool temperature have caused the accumulation of organic matter. Consequently, most of the soils in the county are high in organic matter. Details about the climate are given in the section "General Nature of the Survey Area."

Plant and Animal Life

The growth of plants was the start of soil formation in Redwood County. Plant roots loosened the soil and brought minerals up to the surface. The plants died and decayed, returning organic matter and plant nutrients to the soil. The native vegetation in this county consisted mainly of tall and mid prairie grasses, depending on the soil, the drainage, and other site factors.

Man also has influenced soil formation in Redwood County. Farming has affected most of the soil-forming processes and has increased the action of some of them. Accelerated erosion of the surface layer has occurred on some of the sloping soils. Some of the lower-lying soils have received colluvial deposits of eroded material. The strong, granular structure has been weakened or destroyed in the surface layer of many of these soils. The color of the surface layer of most of the well drained soils has become more brown because the surface layer has been mixed with the subsoil and because the organic matter content has decreased. Leaching of many of the soils has been slowed as a result of increased runoff and reduced water infiltration. Man's activities, particularly in altering the drainage condition, maintaining fertility, and changing the kinds of vegetation, continue to have an important effect on the rate and direction of soil formation.

Relief

In Redwood County, relief varies from nearly level to very steep. It is the most important factor in the development of different soils in uniform parent materials. Soils that have a fairly mature soil profile and distinct horizons developed wherever drainage was good and wherever the slope was gentle. Steep soils show little development because they mostly are subject to excessive runoff. Runoff reduces the amount of moisture that plants can use. Many steep soils are droughty, have indistinct horizons, and support a poor plant cover.

Topographic position is a partial key to the kind of soil and to the soil drainage class at any place on the landscape. For example, the location of the Storden, Ves, Normania, Canisteo, and Okoboji soils, which make up a drainage sequence, can be predicted in a general way. Each of these soils is in a particular position on the landscape. The Storden soils are steep and are well drained. They are on hilltops and convex side slopes. The Ves soils are gently undulating and are well drained. They are on more gentle slopes. The Normania soils are nearly level and are moderately well drained. They are at a lower elevation than the Ves soils or are in slightly concave, nearly level areas surrounded by the Ves soils. The Canisteo soils are poorly drained. They are on rims of depressions and on nearly flat lowlands. The Okoboji soils are very poorly drained. They are in closed depressions and in very wet drainageways.

Time

The time required for soil development depends to a large extent on the other factors of soil formation. Wherever favorable relief and drainage exist, there has been enough time for soils to develop mature profiles. The soils on steep slopes have immature or thin profiles because the soil forming processes have not been effective. Soils in alluvium along stream and rivers are immature or weakly developed because the alluvial material is young. Fresh deposits are added to the surface when the streams and rivers overflow, so distinct mature horizons have not had time to develop.

In a geological sense, all of the soil material in Redwood County is very young. The alluvium and colluvium materials are the youngest. The oldest material is on the Coteau des Prairies south of the Cottonwood River.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Curtiss, Wedge. 1916. History of Redwood County. 1016 pp.

(4) Matsch, Charles L. 1972. Quaternary geology of southwestern Minnesota. *In* Geology of Minnesota: a centennial volume. Minn. Geol. Surv., pp. 548-560.

(5) Minnesota Department of Agriculture. 1981. Minnesota agricultural statistics. Minn. Dep. Agric., pp. 27-63.

(6) Redwood Soil and Water Conservation District. 1970. An appraisal of potentials for outdoor recreational developments in the Redwood Soil and Water Conservation District. 14 pp.

(7) Thiel, George A. 1956. Geology and underground waters of southern Minnesota. Minn. Geol. Surv. Bull. 31, 506 pp., illus.

(8) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus.

(9) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(10) United States Department of Agriculture. 1975. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(11) Wright, H. E., Jr. 1972. Quaternary history of Minnesota. *In* Geology of Minnesota: a centennial volume. Minn. Geol. Surv. pp. 515-546.

Glossary

ABC soil. A soil having an A, a B, and a C horizon.

AC soil. A soil having only an A and a C horizon. Commonly such soil formed in recent alluvium or on steep rocky slopes.

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

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

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	more than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

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

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

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.

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 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.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15 to 38 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Colluvium. Soil material, 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 constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Complex, soil. A map unit of two or more kinds of soil 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 are somewhat similar in all areas.

Congeliturbate. Soil material disturbed by frost action.

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

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

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

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

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

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

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

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

Cemented.—Hard; little affected by moistening.

Conservation tillage. A tillage system that does not invert the soil and that leaves all or part of the crop residue on the surface throughout the year.

Coprogenous earth (sedimentary peat). Fecal material deposited in water by aquatic organisms.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or resting grazing land for a prescribed period.

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

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

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

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

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

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Excess fines (in tables). Excess silt and clay in the soil. The soil is not 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.

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.

Fine textured soil. Sandy clay, silty clay, and clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 39 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

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 (geology). 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 (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. 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 and mottles.

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 up to 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, up to 3 inches (7.6 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

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 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, any plowed or disturbed surface layer.

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 O, A, or E horizon. The B horizon is in part a layer of transition from the overlying horizon 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) granular, 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 horizon. 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 an Arabic numeral, commonly a 2, precedes the letter C.

Cr horizon. —Soft, consolidated bedrock beneath the soil.

R layer.—Hard, consolidated bedrock beneath the soil. The bedrock commonly underlies a C horizon, but can be directly below an A or a B horizon.

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.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

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.

Low strength. The soil is not strong enough to support loads.

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, and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

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. Mottling generally indicates poor aeration and impeded drainage. 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).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma.

For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

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. In this survey area, the terms describing the content of organic matter in the upper 10 inches of the soil are:

	Percent
Low	less than 2
Moderate	2 to 4
High	4 to 8
Very high	more than 8

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

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.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting 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. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, 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.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

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 degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

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.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

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 ground-water runoff or seepage flow from ground water.

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-size particles.

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.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. 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.

Shrink-swell. 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.

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.

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.

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 (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

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 of separates recognized in the United States are as follows:

	Millimeters
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 underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter if rounded and 6 to 15 inches (15 to 38 centimeters) in length if flat.

Stony. Refers to a soil containing stones in numbers that interfere with or prevent tillage.

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 grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

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

Subsurface layer. Any horizon (A, E, AB, 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. Includes all subdivisions of these horizons.

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

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.

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 plain. An extensive flat to undulating area underlain by glacial till.

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; part of a foot slope.

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.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

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

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

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.

Tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Data recorded in the period 1961-75 at Lamberton, Minnesota]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days*	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F		In	In	In		In
January----	21.9	1.7	11.8	48	-27	0	0.67	0.15	1.08	2	7.8
February---	27.6	6.5	17.1	52	-22	0	.70	.19	1.11	2	9.3
March------	39.3	20.0	29.7	73	-14	40	1.05	.56	1.43	3	6.7
April------	56.0	33.9	45.0	89	14	50	2.80	1.60	3.76	6	2.1
May--------	70.7	45.5	58.1	95	24	269	3.29	1.80	4.50	8	.0
June-------	80.8	56.1	68.4	98	39	552	3.52	2.16	4.73	7	.0
July-------	84.1	60.0	72.1	98	43	685	4.06	1.68	5.98	6	.0
August-----	82.2	57.3	69.8	96	40	614	1.88	1.18	2.51	4	.0
September--	72.4	47.3	59.9	93	27	302	3.06	1.31	4.48	7	.0
October----	63.3	38.7	51.0	87	16	139	2.23	.75	3.40	4	.4
November---	43.5	24.6	34.1	70	-4	0	1.15	.34	1.79	3	2.9
December---	27.0	9.0	18.0	55	-22	0	.77	.30	1.14	2	8.8
Year-----	55.7	33.4	44.6	100	-29	2,651	25.18	20.86	29.30	54	38.0

* 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 (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Data recorded in the period 1961-75 at Lamberton, Minnesota]

Probability	Temperature		
	24^{o} F or lower	28^{o} F or lower	32^{o} F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 30	May 13	May 23
2 years in 10 later than--	April 25	May 8	May 18
5 years in 10 later than--	April 15	April 27	May 8
First freezing temperature in fall:			
1 year in 10 earlier than--	October 3	September 20	September 11
2 years in 10 earlier than--	October 9	September 27	September 17
5 years in 10 earlier than--	October 20	October 10	September 29

TABLE 3.--GROWING SEASON

[Data recorded in the period 1961-75 at Lamberton, Minnesota]

Probability	Daily minimum temperature during growing season		
	Higher than 24^{o} F	Higher than 28^{o} F	Higher than 32^{o} F
	Days	Days	Days
9 years in 10	163	138	124
8 years in 10	171	147	130
5 years in 10	187	165	143
2 years in 10	203	183	155
1 year in 10	212	192	161

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
27A	Dickinson fine sandy loam, 0 to 2 percent slopes	610	0.1
27B	Dickinson fine sandy loam, 2 to 6 percent slopes	1,075	0.2
31E	Storden loam, 18 to 25 percent slopes	835	0.1
31F	Storden loam, 25 to 40 percent slopes	1,400	0.2
39A	Wadena loam, 0 to 2 percent slopes	2,395	0.4
39B	Wadena loam, 2 to 6 percent slopes	1,415	0.2
41A	Estherville sandy loam, 0 to 2 percent slopes	7,410	1.3
41B	Estherville sandy loam, 2 to 6 percent slopes	7,110	1.3
42C	Salida gravelly sandy loam, 2 to 12 percent slopes	320	0.1
42E	Salida gravelly sandy loam, 12 to 35 percent slopes	310	0.1
86	Canisteo clay loam	133,690	23.9
94B	Terril loam, 2 to 6 percent slopes	2,680	0.5
94C	Terril loam, 6 to 12 percent slopes	465	0.1
113	Webster clay loam	47,100	8.4
114	Glencoe silty clay loam	19,900	3.5
128A	Grogan loam, 0 to 2 percent slopes	255	*
128B	Grogan loam, 2 to 6 percent slopes	480	0.1
134	Okoboji silty clay loam	41,230	7.4
149B	Everly clay loam, 2 to 4 percent slopes	13,480	2.4
149B2	Everly clay loam, 3 to 6 percent slopes, eroded	2,400	0.4
227	Lemond loam	2,645	0.5
241	Letri clay loam	7,875	1.4
247	Linder loam	4,235	0.8
255	Mayer loam	7,890	1.4
269	Millington loam	12,500	2.2
282	Hanska fine sandy loam	890	0.2
313	Spillville loam, occasionally flooded	900	0.2
317	Oshawa silty clay loam	550	0.1
321	Tilfer clay loam	350	0.1
327A	Dickman sandy loam, 0 to 2 percent slopes	2,035	0.4
327B	Dickman sandy loam, 2 to 6 percent slopes	3,160	0.6
345	Wilmonton clay loam	10,815	1.9
390	Spillville loam, frequently flooded	580	0.1
392	Biscay loam	1,050	0.2
399	Biscay loam, depressional	2,040	0.4
421B	Ves loam, 1 to 4 percent slopes	50,955	9.1
421B2	Ves loam, 3 to 6 percent slopes, eroded	15,325	2.7
423	Seaforth loam	19,715	3.5
446	Normania loam	41,300	7.4
562	Knoke silty clay loam	3,835	0.7
574	Du Page loam	2,640	0.5
575	Nishna clay loam	1,560	0.3
654	Revere clay loam	5,040	0.9
818	Lemond-Linder-Estherville complex	230	*
882	Millington-Zumbro complex	5,560	1.0
883	Du Page-Zumbro complax	1,760	0.3
884	Delft-Webster complex	4,025	0.7
894B2	Everly-Storden complex, 3 to 6 percent slopes, eroded	1,555	0.3
894C2	Storden-Everly complex, 6 to 12 percent slopes, eroded	555	0.1
894D2	Storden-Everly complex, 12 to 18 percent slopes, eroded	335	0.1
954B2	Ves-Storden loams, 3 to 6 percent slopes, eroded	29,925	5.3
954C2	Storden-Ves loams, 6 to 12 percent slopes, eroded	8,640	1.5
954D2	Storden-Ves loams, 12 to 18 percent slopes, eroded	890	0.2
992E	Rock outcrop-Copaston complex, 2 to 40 percent slopes	3,315	0.6
999B2	Ves-Estherville-Storden complex, 3 to 6 percent slopes, eroded	5,450	1.0
999C2	Storden-Estherville-Ves complex, 6 to 12 percent slopes, eroded	3,160	0.6
999D2	Storden-Estherville-Ves complex, 12 to 18 percent slopes, eroded	495	0.1
1016	Udorthents, loamy	230	*
1029	Pits, gravel	720	0.1
1053	Aquolls, ponded	2,170	0.4
1833	Coland clay loam, occasionally flooded	540	0.1
1834	Coland clay loam, frequently flooded	540	0.1
1850	Oshawa Variant stony clay loam	345	0.1
1851B	Blue Earth mucky clay loam, sloping	700	0.1
1852F	Terril-Swanlake loams, 25 to 70 percent slopes	2,500	0.4
1853A	Wadena Variant loam, 0 to 2 percent slopes	500	0.1
1853B	Wadena Variant loam, 2 to 6 percent slopes	860	0.2
1897	Seaforth-Wilmonton clay loams	800	0.1
1899B	Wilmonton Variant loam, 2 to 12 percent slopes	895	0.2
1899E	Wilmonton Variant sandy clay loam, 12 to 40 percent slopes	220	*
	Total	559,360	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
27A----------------------- Dickinson	65	25	62	3.0	2.7	5.0	---
27B----------------------- Dickinson	60	22	60	3.0	2.7	5.0	---
31E----------------------- Storden	---	---	---	2.5	2.0	3.7	---
31F----------------------- Storden	---	---	---	---	1.5	---	---
39A----------------------- Wadena	70	27	60	3.5	3.6	5.2	---
39B----------------------- Wadena	65	24	55	3.2	3.4	4.8	---
41A----------------------- Estherville	55	22	40	2.0	2.0	3.0	---
41B----------------------- Estherville	50	19	35	2.0	2.0	2.5	---
42C----------------------- Salida	35	14	30	2.5	1.5	3.7	---
42E----------------------- Salida	---	---	---	---	0.8	---	---
86------------------------ Canisteo	110	34	75	3.5	3.0	5.2	---
94B----------------------- Terril	110	36	80	4.5	4.0	7.3	---
94C----------------------- Terril	100	32	75	4.4	3.8	7.3	---
113----------------------- Webster	120	40	80	4.4	4.0	7.3	---
114----------------------- Glencoe	100	34	75	3.5	3.3	5.2	5.5
128A---------------------- Grogan	95	32	70	4.0	3.2	6.0	---
128B---------------------- Grogan	90	30	65	4.0	2.8	6.0	---
134----------------------- Okoboji	100	34	70	3.4	3.3	5.6	6.0
149B---------------------- Everly	95	35	80	4.4	3.3	6.6	---
149B2--------------------- Everly	85	32	75	4.0	3.0	6.0	---
227----------------------- Lemond	85	32	60	3.5	3.0	5.0	---
241----------------------- Letri	115	40	80	4.4	4.0	7.3	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
247: Linder	70	25	60	2.5	2.3	4.1	---
255: Mayer	95	32	60	3.0	3.2	5.0	---
269: Millington	115	36	75	4.5	3.5	7.3	---
282: Hanska	90	28	60	3.5	3.3	5.2	---
313: Spillville	105	36	80	4.5	4.2	7.3	---
317: Oshawa	---	---	---	---	---	---	7.5
321: Tilfer	85	30	60	3.6	3.4	5.6	---
327A: Dickman	60	22	50	2.5	1.2	3.7	---
327B: Dickman	55	20	45	2.5	1.2	3.7	---
345: Wilmonton	110	37	80	4.5	3.5	7.3	---
390: Spillville	---	---	---	---	3.8	---	---
392: Biscay	100	33	65	3.5	3.5	5.2	---
399: Biscay	85	30	55	3.0	3.0	4.5	6.0
421B: Ves	95	32	80	4.5	3.0	6.5	---
421B2: Ves	85	30	75	4.2	3.0	6.0	---
423: Seaforth	105	32	75	4.3	3.5	6.7	---
446: Normania	110	35	80	4.5	3.5	7.3	---
562: Knoke	100	34	70	3.5	3.3	5.5	6.0
574: Du Page	110	35	70	3.5	3.5	5.6	---
575: Nishna	100	35	65	3.6	3.7	6.0	6.0
654: Revere	90	25	70	4.0	3.0	6.0	---
818: Lemond-Linder-Estherville	60	22	49	2.6	3.0	3.8	---
882: Millington-Zumbro	---	---	---	---	3.0	---	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
883----------------------- Du Page-Zumbro	85	25	47	3.7	3.3	5.7	---
884----------------------- Delft-Webster	120	38	80	4.5	4.0	6.9	---
894B2--------------------- Everly-Storden	85	30	66	3.4	3.1	5.3	---
894C2--------------------- Storden-Everly	80	25	56	3.2	2.9	4.8	---
894D2--------------------- Storden-Everly	70	---	45	3.0	2.5	4.2	---
954B2--------------------- Ves-Storden	85	29	67	3.9	3.0	5.6	---
954C2--------------------- Storden-Ves	80	23	55	3.4	2.9	4.9	---
954D2--------------------- Storden-Ves	70	---	43	3.1	2.5	4.4	---
992E---------------------- Rock outcrop-Copaston	---	---	---	---	---	---	---
999B2--------------------- Ves-Estherville-Storden	70	24	56	3.3	2.7	4.6	---
999C2--------------------- Storden-Estherville-Ves	60	20	46	2.8	2.4	4.0	---
999D2--------------------- Storden-Estherville-Ves	---	---	---	2.4	2.1	3.4	---
1016. Udorthents							
1029. Pits							
1053. Aquolls							
1833---------------------- Coland	105	35	75	4.5	4.1	7.3	---
1834---------------------- Coland	---	---	---	---	4.0	---	---
1850---------------------- Oshawa Variant	---	---	---	---	3.0	---	4.0
1851B--------------------- Blue Earth	---	---	---	---	---	---	---
1852F--------------------- Terril-Swanlake	---	---	---	---	2.0	---	---
1853A--------------------- Wadena Variant	65	23	60	3.4	3.2	4.8	---
1853B--------------------- Wadena Variant	60	20	55	3.2	3.0	4.6	---
1897---------------------- Seaforth-Wilmonton	110	34	75	4.5	3.5	7.3	---

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Soybeans	Oats	Grass-legume hay	Kentucky bluegrass	Bromegrass-alfalfa	Reed canarygrass
	Bu	Bu	Bu	Ton	AUM*	AUM*	AUM*
1899B Wilmonton Variant	80	25	55	3.5	3.5	5.2	---
1899E Wilmonton Variant	---	---	---	---	1.5	---	---

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

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
27A, 27B---------- Dickinson	---	Lilac, Tatarian honeysuckle, Siberian peashrub.	Eastern redcedar, red pine, Russian-olive, hackberry, Manchurian crabapple.	Eastern white pine, Norway spruce, honeylocust, green ash.	---
31E, 31F---------- Storden	American plum-----	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm------	---
39A, 39B---------- Wadena	Lilac-------------	Eastern redcedar, Siberian peashrub, Tatarian honeysuckle, Manchurian crabapple.	Russian-olive, hackberry, bur oak, green ash, eastern white pine, honeylocust.	Siberian elm------	---
41A, 41B---------- Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, Austrian pine, red pine.	Eastern white pine, Siberian elm.	---
42C, 42E. Salida					
86---------------- Canisteo	---	Siberian peashrub, Tatarian honeysuckle, lilac, northern white-cedar.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
94B, 94C---------- Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Hackberry, Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar.	Eastern white pine, green ash.	---
113--------------- Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
114--------------- Glencoe	---	Redosier dogwood	Tall purple willow, black ash.	Golden willow, black willow, white willow.	---
128A, 128B-------- Grogan	---	Redosier dogwood, gray dogwood, Siberian peashrub, lilac.	Northern white-cedar, blue spruce, Russian-olive, hackberry, Amur maple, eastern redcedar.	Eastern white pine, green ash.	---
134--------------- Okoboji	---	Redosier dogwood	Tall purple willow	Golden willow, black willow, white willow.	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
149B, 149B2. Everly	---	American plum, lilac, Siberian peashrub, Tatarian honeysuckle.	Northern white-cedar, Russian-olive, eastern redcedar, blue spruce, hackberry, Amur maple.	Green ash, eastern white pine.	---
227. Lemond	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
241. Letri	---	Redosier dogwood, Tatarian honeysuckle, American plum.	Tall purple willow, hackberry, white spruce, northern white-cedar, Amur maple.	Green ash, golden willow.	Eastern cottonwood, silver maple.
247. Linder	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.
255. Mayer	---	Tatarian honeysuckle, northern white-cedar, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, green ash, honeylocust.	Eastern cottonwood.
269. Millington	---	Northern white-cedar, Tatarian honeysuckle, lilac, Siberian peashrub.	Hackberry, white spruce, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
282. Hanska	---	Tatarian honeysuckle, American plum, redosier dogwood.	Northern white-cedar, white spruce, tall purple willow, Amur maple, hackberry.	Golden willow, green ash.	Eastern cottonwood, silver maple.
313. Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
317. Oshawa					
321. Tilfer	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Hackberry, bur oak, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
327A, 327B. Dickman	Siberian peashrub	Eastern redcedar, Tatarian honey-suckle, lilac.	Green ash, honeylocust, jack pine, Russian-olive, Austrian pine, red pine.	Eastern white pine, Siberian elm.	---
345. Wilmonton	---	Tatarian honeysuckle, redosier dogwood, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, green ash, eastern white pine, Austrian pine.	Silver maple.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
390---------------- Spillville	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Hackberry, eastern white pine, Austrian pine, green ash.	Silver maple.
392, 399---------- Biscay	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Northern white-cedar, Amur maple, white spruce, hackberry, tall purple willow.	Green ash, golden willow.	Eastern cottonwood, silver maple.
421B, 421B2------- Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
423---------------- Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Tatarian honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry.	Green ash, honeylocust, golden willow.	Eastern cottonwood.
446---------------- Normania	---	Lilac, redosier dogwood, Tatarian honeysuckle.	Northern white-cedar, white spruce, blue spruce, Amur maple.	Eastern white pine, Austrian pine, hackberry, green ash.	Silver maple.
562---------------- Knoke	---	Redosier dogwood	Tall purple willow, black ash.	Golden willow, black willow, white willow.	---
574---------------- Du Page	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, bur oak, eastern redcedar, white spruce.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
575---------------- Nishna	Lilac-------------	Tatarian honeysuckle, Siberian peashrub, lilac, northern white-cedar.	Eastern redcedar, hackberry, bur oak, white spruce.	Honeylocust, green ash, golden willow.	Eastern cottonwood.
654---------------- Revere	---	Siberian peashrub, lilac, Tatarian honeysuckle, northern white-cedar.	Eastern redcedar, bur oak, white spruce, hackberry.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
818:					
Lemond-----------	---	Northern white-cedar, Tatarian honeysuckle, Siberian peashrub, lilac.	Bur oak, hackberry, white spruce, eastern redcedar.	Golden willow, honeylocust, green ash.	Eastern cottonwood.
Linder-----------	---	Redosier dogwood, Tatarian honeysuckle, lilac.	Blue spruce, Amur maple, white spruce, northern white-cedar.	Eastern white pine, Austrian pine, green ash, hackberry.	Silver maple.

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
818: Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, Austrian pine, red pine.	Eastern white pine, Siberian elm.	---
882: Millington	---	Northern white-cedar, Tatarian honeysuckle, lilac, Siberian peashrub.	Hackberry, white spruce, bur oak, eastern redcedar.	Honeylocust, golden willow, green ash.	Eastern cottonwood.
Zumbro	Siberian peashrub	Lilac, Tatarian honeysuckle, eastern redcedar.	Austrian pine, green ash, honeylocust, jack pine, Russian-olive, red pine.	Eastern white pine, Siberian elm.	---
883: Du Page	---	Northern white-cedar, Siberian peashrub, lilac, Tatarian honeysuckle.	Hackberry, bur oak, eastern redcedar, white spruce.	Green ash, golden willow, honeylocust.	Eastern cottonwood.
Zumbro	Siberian peashrub	Lilac, Tatarian honeysuckle, eastern redcedar.	Austrian pine, green ash, honeylocust, jack pine, red pine, Russian-olive.	Eastern white pine, Siberian elm.	---
884: Delft	---	Tatarian honeysuckle, redosier dogwood, American plum.	Hackberry, Amur maple, white spruce, tall purple willow, northern white-cedar.	Green ash, golden willow.	Silver maple, eastern cottonwood.
Webster	---	Redosier dogwood, American plum, Tatarian honeysuckle.	Hackberry, Amur maple, northern white-cedar, tall purple willow, white spruce.	Golden willow, green ash.	Eastern cottonwood, silver maple.
894B2, 894C2, 894D2: Everly	---	Lilac, Siberian peashrub, redosier dogwood, gray dogwood.	Russian-olive, eastern redcedar, blue spruce, hackberry, northern white-cedar, Amur maple.	Green ash, eastern white pine.	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
954B2, 954C2, 954D2:					
Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
992E:					
Rock outcrop.					
Copaston.					
999B2, 999C2, 999D2:					
Ves	---	Siberian peashrub, redosier dogwood, gray dogwood, lilac.	Eastern redcedar, northern white-cedar, Amur maple, blue spruce, hackberry, Russian-olive.	Green ash, eastern white pine.	---
Estherville	Siberian peashrub	Eastern redcedar, lilac, Tatarian honeysuckle.	Honeylocust, jack pine, green ash, Russian-olive, Austrian pine, red pine.	Eastern white pine, Siberian elm.	---
Storden	American plum	Eastern redcedar, hackberry, Tatarian honeysuckle, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
1016. Udorthents					
1029. Pits					
1053. Aquolls					
1833, 1834 Coland	---	Redosier dogwood, Tatarian honeysuckle, American plum.	White spruce, hackberry, northern white-cedar, tall purple willow, Amur maple.	Golden willow, green ash.	Eastern cottonwood, silver maple.
1850. Oshawa Variant					
1851B. Blue Earth					

TABLE 6.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
1852F:					
Terril	---	Gray dogwood, Siberian peashrub, redosier dogwood, lilac.	Russian-olive, Amur maple, blue spruce, northern white-cedar, eastern redcedar, hackberry.	Eastern white pine, green ash.	---
Swanlake	American plum	Eastern redcedar, Tatarian honeysuckle, hackberry, Siberian peashrub.	Honeylocust, green ash, Russian-olive.	Siberian elm	---
1853A, 1853B Wadena Variant	Siberian peashrub, lilac, Tatarian honeysuckle.	Eastern redcedar, hackberry, Manchurian crabapple.	Honeylocust, Russian-olive, bur oak, green ash, eastern white pine, jack pine.	---	---
1897:					
Seaforth	---	Siberian peashrub, lilac, northern white-cedar, Tatarian honeysuckle.	Eastern redcedar, white spruce, bur oak, hackberry.	Green ash, honeylocust, golden willow.	Eastern cottonwood.
Wilmonton	---	Tatarian honeysuckle, redosier dogwood, lilac.	Amur maple, blue spruce, white spruce, northern white-cedar.	Hackberry, green ash, eastern white pine, Austrian pine.	Silver maple.
1899B, 1899E Wilmonton Variant	---	Eastern redcedar, Tatarian honeysuckle, lilac, Siberian peashrub, northern white-cedar.	Austrian pine, bur oak, hackberry, Russian-olive, white spruce.	Eastern white pine, green ash.	---

TABLE 7.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
27A: Dickinson	Slight	Slight	Slight	Slight	Slight.
27B: Dickinson	Slight	Slight	Moderate: slope.	Slight	Slight.
31E: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
31F: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
39A: Wadena	Slight	Slight	Moderate: small stones.	Slight	Slight.
39B: Wadena	Slight	Slight	Moderate: slope, small stones.	Slight	Slight.
41A: Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
41B: Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
42C: Salida	Moderate: small stones.	Moderate: small stones.	Severe: slope, small stones.	Slight	Severe: droughty.
42E: Salida	Severe: slope.	Severe: slope.	Severe: slope, small stones.	Moderate: slope.	Severe: droughty, slope.
86: Canisteo	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
94B: Terril	Slight	Slight	Moderate: slope.	Slight	Slight.
94C: Terril	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
113: Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
114: Glencoe	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
128A: Grogan	Slight	Slight	Slight	Slight	Slight.
128B: Grogan	Slight	Slight	Moderate: slope.	Slight	Slight.
134: Okoboji	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
149B, 149B2: Everly	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
227: Lemond	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
241 Letri	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
247 Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
255 Mayer	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
269 Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
282 Hanska	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
313 Spillville	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
317 Oshawa	Severe: flooding, ponding.	Severe: ponding.	Severe: ponding, flooding.	Severe: ponding.	Severe: ponding, flooding.
321 Tilfer	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
327A Dickman	Slight	Slight	Slight	Slight	Moderate: droughty.
327B Dickman	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
345 Wilmonton	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
390 Spillville	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
392 Biscay	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
399 Biscay	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
421B, 421B2 Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
423 Seaforth	Slight	Slight	Moderate: slope.	Slight	Slight.
446 Normania	Slight	Slight	Slight	Slight	Slight.
562 Knoke	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.
574 Du Page	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
575 Nishna	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: flooding, wetness.
654 Revere	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
818:					
Lemond	Severe: wetness.	Severe: wetness.	Severe: small stones, wetness.	Severe: wetness.	Severe: wetness.
Linder	Moderate: wetness.	Moderate: wetness.	Moderate: wetness.	Slight	Slight.
Estherville	Slight	Slight	Moderate: small stones.	Slight	Moderate: droughty.
882:					
Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness, flooding.	Severe: wetness.	Severe: wetness, flooding.
Zumbro	Severe: flooding.	Moderate: flooding.	Severe: flooding.	Moderate: flooding.	Severe: flooding.
883:					
Du Page	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Zumbro	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
884:					
Delft	Severe: wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
Webster	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
894B2:					
Everly	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
894C2:					
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Everly	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
894D2:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Everly	Severe: slope.	Severe: slope.	Severe: slope.	Slight	Severe: slope.
954B2:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
954C2:					
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
954C2:					
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
954D2:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
992E:					
Rock outcrop.					
Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Slight	Severe: thin layer.
999B2:					
Ves	Slight	Slight	Moderate: slope.	Slight	Slight.
Estherville	Slight	Slight	Moderate: slope, small stones.	Slight	Moderate: droughty.
Storden	Slight	Slight	Moderate: slope.	Slight	Slight.
999C2:					
Storden	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Estherville	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: droughty, slope.
Ves	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
999D2:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Estherville	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
1016. Udorthents					
1029. Pits					
1053. Aquolls					
1833 Coland	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
1834 Coland	Severe: flooding, wetness.	Moderate: flooding, wetness.	Severe: wetness, flooding.	Moderate: wetness, flooding.	Severe: flooding.

TABLE 7.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
1850------------------- Oshawa Variant	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.
1851B------------------ Blue Earth	Severe: wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness.	Severe: wetness, excess humus.	Severe: wetness.
1852F:					
Terril----------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Swanlake--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1853A------------------ Wadena Variant	Slight----------	Slight----------	Slight----------	Slight------------	Moderate: thin layer.
1853B------------------ Wadena Variant	Slight----------	Slight----------	Moderate: slope, depth to rock.	Slight------------	Moderate: thin layer.
1897:					
Seaforth--------------	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
Wilmonton-------------	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight------------	Slight.
1899B------------------ Wilmonton Variant	Severe: percs slowly.	Severe: percs slowly.	Severe: slope, percs slowly.	Slight------------	Moderate: large stones.
1899E------------------ Wilmonton Variant	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope, percs slowly.	Severe: slope.	Severe: slope.

TABLE 8.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
27A, 27B------------ Dickinson	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
31E, 31F------------ Storden	Poor	Fair	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
39A, 39B------------ Wadena	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
41A, 41B------------ Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
42C----------------- Salida	Poor	Poor	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
42E----------------- Salida	Very poor.	Very poor.	Poor	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.	Very poor.
86------------------ Canisteo	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
94B----------------- Terril	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
94C----------------- Terril	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
113----------------- Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
114----------------- Glencoe	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
128A, 128B---------- Grogan	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
134----------------- Okoboji	Fair	Fair	Fair	Fair	Very poor.	Good	Good	Fair	Fair	Good.
149B, 149B2--------- Everly	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
227----------------- Lemond	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
241----------------- Letri	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
247----------------- Linder	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
255----------------- Mayer	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
269----------------- Millington	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Poor.
282----------------- Hanska	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
313----------------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
317----------------- Oshawa	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
321----------------- Tilfer	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
327A, 327B---------- Dickman	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
345----------------- Wilmonton	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
390----------------- Spillville	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
392----------------- Biscay	Good	Good	Good	Good	Fair	Good	Good	Good	Fair	Good.
399----------------- Biscay	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
421B, 421B2--------- Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
423----------------- Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
446----------------- Normania	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
562----------------- Knoke	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
574----------------- Du Page	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
575----------------- Nishna	Fair	Fair	Fair	Poor	Very poor.	Good	Good	Fair	Poor	Good.
654----------------- Revere	Fair	Fair	Fair	Fair	Poor	Good	Good	Fair	Fair	Good.
818:										
Lemond-------------	Good	Good	Fair	Fair	Fair	Good	Good	Good	Fair	Good.
Linder-------------	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Estherville--------	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
882:										
Millington---------	Good	Good	Good	Good	Fair	Good	Good	Good	Good	Poor.
Zumbro-------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
883:										
Du Page------------	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
Zumbro-------------	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Poor.
884:										
Delft--------------	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herba-ceous plants	Hardwood trees	Conif-erous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
884: Webster	Good	Good	Good	Fair	Poor	Good	Good	Good	Fair	Good.
894B2: Everly	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
894C2: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Everly	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
894D2: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Everly.										
954B2: Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
954C2: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
954D2: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
992E: Rock outcrop.										
Copaston	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
999B2: Ves	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
Storden	Good	Good	Good	Fair	Poor	Very poor.	Very poor.	Good	Fair	Very poor.
999C2: Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Estherville	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

TABLE 8.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife
999C2:										
Ves	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
999D2:										
Storden	Fair	Good	Good	Fair	Poor	Very poor.	Very poor.	Fair	Fair	Very poor.
Estherville	Poor	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
Ves	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
1016. Udorthents										
1029. Pits										
1053. Aquolls										
1833 Coland	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
1834 Coland	Poor	Fair	Fair	Poor	Poor	Good	Good	Poor	Poor	Good.
1850 Oshawa Variant	Poor	Fair	Poor	Poor	Poor	Fair	Fair	Poor	Poor	Fair.
1851B Blue Earth	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
1852F:										
Terril	Poor	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.
Swanlake.										
1853A, 1853B Wadena Variant	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
1897:										
Seaforth	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Wilmonton	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
1899B Wilmonton Variant	Good	Good	Good	Fair	Fair	Poor	Poor	Good	Good	Poor.
1899E Wilmonton Variant	Poor	Fair	Good	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.

TABLE 9.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
27A---------------- Dickinson	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Moderate: frost action.	Slight.
27B---------------- Dickinson	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Moderate: frost action.	Slight.
31E, 31F----------- Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
39A---------------- Wadena	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Slight.
39B---------------- Wadena	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
41A---------------- Estherville	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Slight----------	Moderate: droughty.
41B---------------- Estherville	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight----------	Moderate: droughty.
42C---------------- Salida	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Slight----------	Severe: droughty.
42E---------------- Salida	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: droughty, slope.
86----------------- Canisteo	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
94B---------------- Terril	Slight----------	Slight----------	Slight----------	Moderate: slope.	Severe: low strength.	Slight.
94C---------------- Terril	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: low strength.	Moderate: slope.
113---------------- Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
114---------------- Glencoe	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding.	Severe: ponding, low strength.	Severe: ponding, low strength, frost action.	Severe: ponding.
128A--------------- Grogan	Severe: cutbanks cave.	Slight----------	Slight----------	Slight----------	Severe: frost action.	Slight.
128B--------------- Grogan	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Severe: frost action.	Slight.
134---------------- Okoboji	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: low strength, ponding, frost action.	Severe: ponding.
149B--------------- Everly	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.	Slight.
149B2-------------- Everly	Slight----------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.	Slight.
227---------------- Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
241 Letri	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
247 Linder	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
255 Mayer	Severe: wetness, cutbanks cave.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: wetness.
269 Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness.
282 Hanska	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Severe: wetness.
313 Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
317 Oshawa	Severe: ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: low strength, ponding, flooding.	Severe: ponding, flooding.
321 Tilfer	Severe: depth to rock, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness, depth to rock.	Severe: flooding, wetness.	Severe: flooding, frost action, wetness.	Severe: wetness.
327A Dickman	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
327B Dickman	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
345 Wilmonton	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
390 Spillville	Moderate: flooding, wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Severe: flooding.
392 Biscay	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
399 Biscay	Severe: cutbanks cave, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Severe: low strength, ponding, frost action.	Severe: ponding.
421B Ves	Slight	Slight	Slight	Slight	Moderate: low strength, frost action.	Slight.
421B2 Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
423 Seaforth	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.
446 Normania	Moderate: wetness.	Slight	Moderate: wetness.	Slight	Severe: frost action.	Slight.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
562: Knoke	Severe: ponding.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, shrink-swell.	Severe: ponding, low strength, shrink-swell.	Severe: ponding.
574: Du Page	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
575: Nishna	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: shrink-swell, wetness, flooding.	Severe: flooding, low strength, shrink-swell.	Moderate: flooding, wetness.
654: Revere	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
818:						
Lemond	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Severe: wetness.
Linder	Severe: cutbanks cave, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Severe: frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Slight	Slight	Moderate: droughty.
882:						
Millington	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, flooding.	Severe: wetness, flooding.
Zumbro	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.
883:						
Du Page	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding.	Moderate: flooding.
Zumbro	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: flooding.
884:						
Delft	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: low strength, frost action.	Moderate: wetness.
894B2:						
Everly	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Severe: low strength.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
894C2:						
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
894C2:						
Everly	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
894D2:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Everly	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength.	Severe: slope.
954B2:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
954C2:						
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
954D2:						
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
992E:						
Rock outcrop.						
Copaston	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: thin layer.
999B2:						
Ves	Slight	Slight	Slight	Moderate: slope.	Moderate: low strength, frost action.	Slight.
Estherville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Moderate: droughty.
Storden	Slight	Slight	Slight	Moderate: slope.	Moderate: frost action.	Slight.
999C2:						
Storden	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Estherville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: droughty, slope.
Ves	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.

TABLE 9.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
999D2:						
Storden----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Estherville------	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ves--------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1016. Udorthents						
1029. Pits						
1053. Aquolls						
1833-------------- Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
1834-------------- Coland	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Severe: flooding.
1850-------------- Oshawa Variant	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: low strength, wetness, frost action.	Severe: wetness.
1851B------------- Blue Earth	Severe: excess humus, wetness.	Severe: wetness, low strength.	Severe: wetness.	Severe: wetness, low strength.	Severe: wetness, frost action.	Severe: wetness.
1852F:						
Terril-----------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Swanlake---------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
1853A------------- Wadena Variant	Moderate: depth to rock.	Slight---------	Moderate: depth to rock.	Slight---------	Slight---------	Moderate: thin layer.
1853B------------- Wadena Variant	Moderate: depth to rock.	Slight---------	Moderate: depth to rock.	Moderate: slope.	Slight---------	Moderate: thin layer.
1897:						
Seaforth---------	Moderate: wetness.	Slight---------	Moderate: wetness.	Slight---------	Severe: frost action.	Slight.
Wilmonton--------	Moderate: wetness.	Moderate: shrink-swell.	Moderate: wetness, shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
1899B------------- Wilmonton Variant	Severe: wetness.	Severe: shrink-swell.	Severe: wetness, shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action.	Moderate: large stones.
1899E------------- Wilmonton Variant	Severe: wetness, slope.	Severe: shrink-swell, slope.	Severe: wetness, slope, shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, slope, frost action.	Severe: slope.

TABLE 10.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
27A, 27B: Dickinson	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
31E, 31F: Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
39A, 39B: Wadena	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
41A, 41B: Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
42C: Salida	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
42E: Salida	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
86: Canisteo	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: wetness.
94B: Terril	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
94C: Terril	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
113: Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
114: Glencoe	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding, excess humus.	Severe: ponding.	Poor: ponding, hard to pack.
128A, 128B: Grogan	Slight	Severe: seepage.	Severe: seepage.	Severe: seepage.	Good.
134: Okoboji	Severe: ponding, percs slowly.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: hard to pack, ponding.
149B, 149B2: Everly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
227: Lemond	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
241: Letri	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
247----------------- Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
255----------------- Mayer	Severe: wetness, poor filter.	Severe: wetness, seepage.	Severe: wetness, seepage, too sandy.	Severe: wetness, seepage.	Poor: wetness, too sandy, seepage.
269----------------- Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
282----------------- Hanska	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
313----------------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
317----------------- Oshawa	Severe: flooding, ponding, percs slowly.	Severe: flooding, ponding.	Severe: flooding, ponding.	Severe: flooding, ponding.	Poor: ponding.
321----------------- Tilfer	Severe: flooding, depth to rock, wetness.	Severe: depth to rock, flooding, wetness.	Severe: flooding, depth to rock, wetness.	Severe: flooding, depth to rock, wetness.	Poor: area reclaim, wetness.
327A, 327B---------- Dickman	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
345----------------- Wilmonton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
390----------------- Spillville	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, seepage, flooding.	Severe: wetness, flooding.	Fair: wetness.
392----------------- Biscay	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, small stones.
399----------------- Biscay	Severe: ponding, poor filter.	Severe: seepage, ponding.	Severe: seepage, ponding, too sandy.	Severe: seepage, ponding.	Poor: seepage, too sandy, small stones.
421B, 421B2--------- Ves	Slight-----------	Moderate: seepage, slope.	Slight-----------	Slight-----------	Good.
423----------------- Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
446----------------- Normania	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
562----------------- Knoke	Severe: percs slowly, ponding.	Severe: ponding.	Severe: ponding.	Severe: ponding.	Poor: ponding.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
574: Du Page	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding.	Good.
575: Nishna	Severe: flooding, percs slowly, wetness.	Slight	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: wetness, hard to pack.
654: Revere	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
818:					
Lemond	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, too sandy, wetness.
Linder	Severe: wetness, poor filter.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: seepage, wetness.	Poor: seepage, small stones, too sandy.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
882:					
Millington	Severe: flooding, wetness.	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Poor: wetness.
Zumbro	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: too sandy, thin layer.
883:					
Du Page	Severe: flooding.	Severe: seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: flooding.	Good.
Zumbro	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage.	Severe: flooding, seepage.	Fair: too sandy, thin layer.
884:					
Delft	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
Webster	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Poor: wetness.
894B2:					
Everly	Severe: percs slowly.	Moderate: slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
894C2:					
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
894C2:					
Everly	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
894D2:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Everly	Severe: percs slowly.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
954B2:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
954C2:					
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
954D2:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
992E:					
Rock outcrop.					
Copaston	Severe: depth to rock.	Severe: seepage, depth to rock, slope.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
999B2:					
Ves	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Estherville	Severe: poor filter.	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Storden	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
999C2:					
Storden	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Estherville	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy, small stones.
Ves	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.

TABLE 10.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
999D2:					
Storden	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Estherville	Severe: poor filter, slope.	Severe: seepage, slope.	Severe: seepage, slope, too sandy.	Severe: seepage, slope.	Poor: seepage, too sandy, small stones.
Ves	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1016. Udorthents					
1029. Pits					
1053. Aquolls					
1833, 1834 Coland	Severe: flooding, wetness.	Severe: seepage, flooding, wetness.	Severe: flooding, seepage, wetness.	Severe: flooding, wetness.	Poor: hard to pack, wetness.
1850 Oshawa Variant	Severe: wetness, percs slowly.	Severe: flooding, wetness.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
1851B Blue Earth	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness, excess humus.	Severe: wetness.	Poor: hard to pack, wetness.
1852F:					
Terril	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Swanlake	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
1853A, 1853B Wadena Variant	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: depth to rock, seepage.	Severe: depth to rock, seepage.	Poor: area reclaim.
1897:					
Seaforth	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Wilmonton	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: too clayey, wetness.
1899B Wilmonton Variant	Severe: wetness, percs slowly.	Severe: slope, wetness.	Severe: too clayey.	Moderate: wetness.	Poor: too clayey, hard to pack.
1899E Wilmonton Variant	Severe: wetness, percs slowly, slope.	Severe: slope, wetness.	Severe: slope, too clayey.	Severe: slope.	Poor: too clayey, hard to pack, slope.

TABLE 11.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
27A, 27B-----------------Dickinson	Good------------------	Probable-------------	Improbable: too sandy.	Good.
31E-----------------Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
31F-----------------Storden	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
39A, 39B-----------------Wadena	Good------------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
41A, 41B-----------------Estherville	Good------------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim.
42C-----------------Salida	Good------------------	Probable-------------	Probable-------------	Poor: small stones, area reclaim, too sandy.
42E-----------------Salida	Fair: slope.	Probable-------------	Probable-------------	Poor: small stones, area reclaim, too sandy.
86-----------------Canisteo	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
94B-----------------Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
94C-----------------Terril	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
113-----------------Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
114-----------------Glencoe	Poor: wetness, low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
128A, 128B-----------------Grogan	Good------------------	Improbable: excess fines.	Improbable: excess fines.	Good.
134-----------------Okoboji	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
149B, 149B2-----------------Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
227-----------------Lemond	Poor: wetness.	Probable-------------	Improbable: too sandy.	Poor: wetness.
241-----------------Letri	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
247: Linder	Fair: wetness.	Probable	Improbable: too sandy.	Poor: small stones, area reclaim.
255: Mayer	Fair: wetness.	Probable	Probable	Fair: area reclaim, thin layer.
269: Millington	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
282: Hanska	Poor: wetness.	Probable	Improbable: too sandy.	Poor: wetness.
313: Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
317: Oshawa	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
321: Tilfer	Poor: area reclaim, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
327A, 327B: Dickman	Good	Probable	Improbable: too sandy.	Poor: thin layer.
345: Wilmonton	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
390: Spillville	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
392: Biscay	Fair: wetness.	Probable	Probable	Poor: area reclaim.
399: Biscay	Poor: wetness.	Probable	Probable	Poor: area reclaim, wetness.
421B, 421B2: Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
423: Seaforth	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
446: Normania	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
562: Knoke	Poor: wetness, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
574: Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
575: Nishna	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
654: Revere	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
818:				
Lemond	Poor: wetness.	Improbable: thin layer.	Improbable: too sandy.	Poor: small stones, wetness.
Linder	Fair: wetness.	Probable	Improbable: too sandy.	Poor: small stones, area reclaim.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
882:				
Millington	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: wetness.
Zumbro	Good	Probable	Improbable: too sandy.	Poor: too sandy.
883:				
Du Page	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Zumbro	Good	Probable	Improbable: too sandy.	Fair: too sandy.
884:				
Delft	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, area reclaim.
Webster	Fair: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
894B2:				
Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
894C2:				
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
894D2:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Everly	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
954B2:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
954C2:				
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
954D2:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
992E: Rock outcrop.				
Copaston	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim.
999B2:				
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
999C2:				
Storden	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
Estherville	Good	Probable	Probable	Poor: small stones, area reclaim.
Ves	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
999D2:				
Storden	Fair: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Estherville	Fair: slope.	Probable	Probable	Poor: small stones, area reclaim, slope.
Ves	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1016. Udorthents				
1029. Pits				
1053. Aquolls				

TABLE 11.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
1833, 1834------------ Coland	Fair: wetness.	Improbable: excess fines.	Improbable: excess fines.	Good.
1850------------------ Oshawa Variant	Poor: low strength, wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
1851B----------------- Blue Earth	Poor: wetness.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones, wetness.
1852F:				
Terril----------------	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Swanlake--------------	Poor: slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
1853A, 1853B---------- Wadena Variant	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Fair: area reclaim, small stones, thin layer.
1897:				
Seaforth--------------	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Wilmonton-------------	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
1899B----------------- Wilmonton Variant	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer.
1899E----------------- Wilmonton Variant	Poor: low strength, slope, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, slope.

TABLE 12.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
27A------------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing	Soil blowing, too sandy.	Favorable.
27B------------- Dickinson	Severe: seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy.	Favorable.
31E, 31F---------- Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
39A------------- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Favorable-----	Too sandy-----	Favorable.
39B------------- Wadena	Severe: seepage.	Severe: seepage, piping.	Deep to water	Slope----------	Too sandy-----	Favorable.
41A------------- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
41B------------- Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
42C------------- Salida	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, fast intake, slope.	Too sandy-----	Droughty.
42E------------- Salida	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, fast intake, slope.	Slope, too sandy.	Slope, droughty.
86-------------- Canisteo	Severe: seepage.	Severe: wetness.	Frost action	Wetness--------	Wetness--------	Wetness.
94B------------- Terril	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Favorable-----	Favorable.
94C------------- Terril	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope----------	Slope.
113------------- Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness--------	Wetness--------	Wetness.
114------------- Glencoe	Moderate: seepage.	Severe: hard to pack, excess humus, ponding.	Frost action, ponding.	Ponding--------	Ponding--------	Wetness.
128A------------ Grogan	Severe: seepage.	Severe: piping.	Deep to water	Favorable-----	Erodes easily	Erodes easily.
128B------------ Grogan	Severe: seepage.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
134------------- Okoboji	Moderate: seepage.	Severe: ponding.	Ponding, frost action.	Ponding--------	Not needed----	Not needed.
149B, 149B2------- Everly	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope----------	Favorable-----	Favorable.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
227: Lemond	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
241: Letri	Moderate: seepage.	Severe: piping, wetness.	Frost action	Wetness	Wetness	Wetness.
247: Linder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Droughty.
255: Mayer	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
269: Millington	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
282: Hanska	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness, soil blowing.	Wetness, too sandy, soil blowing.	Wetness.
313: Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
317: Oshawa	Slight	Severe: ponding.	Ponding, flooding, frost action.	Ponding, flooding.	Ponding	Wetness.
321: Tilfer	Moderate: seepage, depth to rock.	Severe: thin layer, wetness.	Depth to rock, flooding, frost action.	Wetness, depth to rock, flooding.	Depth to rock, wetness.	Wetness, depth to rock.
327A: Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
327B: Dickman	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
345: Wilmonton	Slight	Moderate: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
390: Spillville	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Flooding	Favorable	Favorable.
392: Biscay	Severe: seepage.	Severe: seepage, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
399: Biscay	Severe: seepage.	Severe: seepage, piping, ponding.	Ponding, frost action, cutbanks cave.	Ponding	Ponding, too sandy.	Wetness.
421B: Ves	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Erodes easily	Erodes easily.
421B2: Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
423: Seaforth	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Favorable	Favorable.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for--		Features affecting--			
	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
446 Normania	Moderate: seepage.	Moderate: piping, wetness.	Deep to water	Favorable	Erodes easily	Erodes easily.
562 Knoke	Slight	Severe: hard to pack, ponding.	Ponding, frost action.	Ponding	Ponding, erodes easily.	Wetness, erodes easily.
574 Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Flooding	Favorable	Favorable.
575 Nishna	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly.	Wetness, percs slowly, flooding.	Wetness, percs slowly, erodes easily.	Wetness, percs slowly, erodes easily.
654 Revere	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
818:						
Lemond	Severe: seepage.	Severe: seepage, piping, wetness.	Frost action, cutbanks cave.	Wetness	Wetness, too sandy.	Wetness.
Linder	Severe: seepage.	Severe: seepage, piping.	Frost action, cutbanks cave.	Wetness, droughty.	Wetness, too sandy.	Droughty.
Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing.	Too sandy, soil blowing.	Droughty.
882:						
Millington	Moderate: seepage.	Severe: piping, wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Soil blowing, flooding.	Too sandy, soil blowing.	Favorable.
883:						
Du Page	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Flooding	Favorable	Favorable.
Zumbro	Severe: seepage.	Severe: seepage, piping.	Deep to water	Fast intake, soil blowing, flooding.	Too sandy, soil blowing.	Favorable.
884:						
Delft	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
Webster	Moderate: seepage.	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
894B2:						
Everly	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Favorable	Favorable.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
894C2, 894D2:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Everly	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
954B2:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
954C2, 954D2:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
992E: Rock outcrop.						
Copaston	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, depth to rock.	Slope, depth to rock.
999B2:						
Ves	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
Estherville	Severe: seepage.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Too sandy, soil blowing.	Droughty.
Storden	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
999C2:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, slope.	Slope, too sandy.	Slope, droughty.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
999D2:						
Storden	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Estherville	Severe: seepage, slope.	Severe: seepage.	Deep to water	Droughty, soil blowing, slope.	Slope, too sandy, soil blowing.	Slope, droughty.
Ves	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
1016. Udorthents						

TABLE 12.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
1029. Pits						
1053. Aquolls						
1833, 1834 Coland	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Wetness, flooding.	Wetness	Wetness.
1850 Oshawa Variant	Slight	Severe: wetness.	Frost action	Wetness	Wetness	Wetness.
1851B Blue Earth	Slight	Severe: piping, excess humus, wetness.	Frost action	Wetness	Wetness	Wetness.
1852F: Terril	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
Swanlake	Severe: slope.	Severe: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
1853A Wadena Variant	Severe: seepage.	Severe: piping.	Deep to water	Depth to rock	Depth to rock	Depth to rock.
1853B Wadena Variant	Severe: seepage.	Severe: piping.	Deep to water	Depth to rock, slope.	Depth to rock	Depth to rock.
1897: Seaforth	Moderate: seepage.	Moderate: piping.	Deep to water	Favorable	Favorable	Favorable.
Wilmonton	Slight	Moderate: piping, wetness.	Frost action	Wetness	Erodes easily, wetness.	Erodes easily.
1899B Wilmonton Variant	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Wetness, percs slowly.	Percs slowly.
1899E Wilmonton Variant	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly, slope.	Slope, wetness, percs slowly.	Slope, percs slowly.

TABLE 13.--ENGINEERING INDEX PROPERTIES

[The symbol < means less than; > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
27A, 27B--------- Dickinson	0-17	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-95	30-50	15-30	NP-10
	17-36	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4	0	100	100	85-95	35-50	15-30	NP-10
	36-60	Sand, loamy fine sand, fine sand.	SM, SP-SM	A-3, A-2	0	100	100	70-90	5-20	---	NP
31E, 31F--------- Storden	0-10	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
39A, 39B--------- Wadena	0-13	Loam-------------	ML	A-4	0	95-100	80-100	75-95	50-65	25-40	2-10
	13-29	Loam, sandy loam, sandy clay loam.	SM, ML, CL, SC	A-4, A-6	0	95-100	80-100	75-95	40-60	25-40	5-12
	29-60	Very gravelly coarse sand, gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1, A-3, A-2	0-5	45-100	40-95	10-80	2-10	---	NP
41A, 41B--------- Estherville	0-9	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	9-19	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	19-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
42C, 42E--------- Salida	0-8	Gravelly sandy loam.	SM, SP-SM	A-2, A-1	0-5	85-95	60-75	30-60	12-20	---	NP
	8-60	Very gravelly coarse sand, very gravelly sand, gravelly coarse sand.	SP, SW, GP, GP-GM	A-1	0-5	20-70	10-60	5-30	0-5	---	NP
86--------------- Canisteo	0-18	Clay loam--------	OL, CL	A-7	0	98-100	95-100	85-98	60-90	40-50	15-20
	18-29	Clay loam, loam, silty clay loam.	CL	A-6, A-7	0	98-100	90-100	85-95	65-85	38-50	25-35
	29-60	Clay loam, loam	CL	A-6	0-5	95-100	90-98	80-95	60-75	30-40	12-20
94B, 94C--------- Terril	0-34	Loam-------------	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	34-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
113-------------- Webster	0-19	Clay loam--------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	19-33	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	33-60	Loam, clay loam	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
114-------------- Glencoe	0-26	Silty clay loam	OL, OH, MH, ML	A-7	0	100	95-100	85-98	75-90	45-60	10-20
	26-33	Loam, clay loam, silty clay loam.	CL	A-7, A-6	0	100	95-100	85-98	75-90	35-50	15-25
	33-60	Loam, clay loam	CL	A-6, A-7	0	98-100	90-98	80-98	70-85	35-50	15-25
128A, 128B------- Grogan	0-15	Loam-------------	ML	A-4	0	100	100	95-100	70-90	20-40	NP-10
	15-34	Loam, silt loam	ML	A-4	0	100	100	95-100	70-95	20-40	NP-10
	34-60	Stratified loamy very fine sand to silt loam.	ML	A-4	0	100	100	90-100	65-95	20-30	NP-5
134-------------- Okoboji	0-8	Silty clay loam	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	8-48	Silty clay loam, silty clay.	CH	A-7	0	100	100	90-100	80-95	55-65	30-40
	48-60	Stratified loam to silty clay loam.	CL, CH	A-7	0-5	95-100	90-100	90-100	75-90	40-55	20-30

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
149B, 149B2------ Everly	0-14	Clay loam--------	CL	A-6, A-7	0	100	95-100	85-95	65-80	30-45	10-20
	14-40	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	85-95	70-90	35-50	15-25
	40-60	Loam, clay loam	CL	A-6	0-5	90-100	85-95	75-85	60-80	30-40	10-20
227-------------- Lemond	0-12	Loam-------------	ML, SM, CL, SC	A-4	0	98-100	95-100	80-95	40-65	<25	2-10
	12-32	Sandy loam, loamy sand.	SM, SM-SC	A-2, A-4	0	98-100	95-100	65-80	25-40	<25	NP-7
	32-60	Sand, coarse sand, loamy coarse sand.	SP-SM, SP	A-3, A-1, A-2	0	90-100	85-100	35-85	2-10	---	NP
241-------------- Letri	0-18	Clay loam--------	CL	A-7	0	95-100	95-100	95-100	80-95	40-50	15-25
	18-28	Clay loam, silty clay loam.	CL	A-7	0	95-100	90-100	85-95	75-85	40-50	15-25
	28-60	Loam, clay loam	CL, ML	A-6, A-7, A-4	0-5	95-100	85-98	85-95	65-75	30-50	7-25
247-------------- Linder	0-18	Loam-------------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	18-28	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	28-60	Gravelly sand, gravelly loamy sand, coarse sand.	SP, SP-SM	A-1	0-5	75-95	60-95	25-50	2-12	---	NP
255-------------- Mayer	0-22	Loam-------------	CL, ML	A-6, A-4	0-2	95-100	85-100	70-90	50-85	30-40	5-15
	22-32	Loam, sandy clay loam, silt loam.	CL, SC, ML, SM	A-6, A-4	0-5	90-100	85-100	70-90	40-85	30-40	5-15
	32-60	Gravelly coarse sand, coarse sand, gravelly loamy sand.	SP, SW, SP-SM	A-1	0-10	65-95	45-85	20-45	2-10	<20	NP
269-------------- Millington	0-36	Loam-------------	ML, CL, OL	A-6, A-7, A-4	0	90-100	90-100	80-100	70-95	30-45	8-17
	36-60	Stratified sandy loam to silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	80-100	80-100	80-100	60-95	20-45	5-20
282-------------- Hanska	0-18	Fine sandy loam	SM, SM-SC	A-4	0	98-100	95-100	80-95	35-50	<25	NP-5
	18-38	Sandy loam, coarse sandy loam, loam.	SM, SM-SC, SC	A-4	0	98-100	95-100	65-80	35-50	<20	2-8
	38-60	Sand, coarse sand	SP-SM	A-3, A-1, A-2	0	95-100	85-100	45-70	5-10	<20	NP
313-------------- Spillville	0-48	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	48-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
317-------------- Oshawa	0-10	Silty clay loam	MH, CH	A-7	0	95-100	95-100	95-100	90-100	50-70	20-40
	10-30	Clay loam--------	MH, CH	A-7	0	95-100	95-100	95-100	90-100	50-70	20-40
	30-60	Loam, silt loam, silty clay loam.	CL	A-6	0	95-100	95-100	90-100	85-95	30-40	10-15
321-------------- Tilfer	0-19	Clay loam--------	CL, OL, ML	A-6	0	90-95	85-95	80-90	65-75	20-40	10-25
	19-32	Loam, clay loam, silty clay loam.	CL, ML	A-6	0-2	95-100	95-100	80-90	60-85	20-40	11-25
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
327A, 327B------- Dickman	0-12	Sandy loam-------	SM, SM-SC	A-2, A-4	0	95-100	95-100	55-95	25-40	20-30	2-8
	12-19	Sandy loam, fine sandy loam.	SM, SM-SC	A-2, A-4	0	95-100	85-100	55-95	25-45	15-25	2-8
	19-60	Stratified loamy sand to coarse sand.	SP-SM	A-3, A-2	0	95-100	75-100	50-80	5-10	---	NP

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
345---------------- Wilmonton	0-14	Clay loam--------	CL	A-6, A-7	0	100	92-100	85-97	60-90	30-50	12-25
	14-39	Clay loam, silty clay loam.	CL	A-6, A-7	0	95-100	90-100	80-90	60-80	30-50	15-25
	39-60	Clay loam, loam	CL	A-6	0-5	95-100	87-97	75-85	55-75	25-40	10-25
390---------------- Spillville	0-50	Loam-------------	CL	A-6	0	100	95-100	85-95	60-80	25-40	10-20
	50-60	Sandy clay loam, loam, sandy loam.	CL, CL-ML, SM-SC, SC	A-6, A-4	0	100	95-100	80-90	35-75	20-40	5-15
392---------------- Biscay	0-22	Loam-------------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	22-30	Loam, clay loam, sandy clay loam.	CL, ML	A-6, A-7	0	95-100	90-100	70-90	50-75	30-50	10-20
	30-33	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	33-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1, A-3	0-5	60-95	45-95	25-65	2-10	---	NP
399---------------- Biscay	0-31	Loam-------------	CL, ML	A-7, A-6	0	95-100	95-100	70-90	50-75	35-50	10-25
	31-35	Gravelly loam, sandy loam, gravelly sandy loam.	SM, SM-SC, SC	A-4	0-5	95-100	70-95	50-80	35-50	15-30	2-10
	35-60	Stratified loamy sand to gravelly coarse sand.	SP, SP-SM, GP, GP-GM	A-1	0-5	45-95	35-95	20-45	2-10	---	NP
421B, 421B2------ Ves	0-10	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-25	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	25-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
423---------------- Seaforth	0-15	Loam-------------	ML, OL	A-7, A-6, A-4	0-5	95-100	90-100	80-100	60-80	35-45	8-15
	15-21	Loam, clay loam	CL, ML	A-6, A-4	0-5	95-100	95-100	80-95	55-80	30-40	8-15
	21-60	Loam-------------	CL, ML	A-6, A-4	0-5	95-100	85-100	80-90	55-80	30-40	8-15
446---------------- Normania	0-17	Loam-------------	CL	A-6, A-4	0-5	95-100	90-100	80-100	60-80	30-40	8-15
	17-28	Loam, clay loam	CL	A-6, A-4	0-5	95-100	90-100	80-95	55-85	25-40	8-20
	28-60	Loam-------------	CL	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15
562---------------- Knoke	0-15	Silty clay loam	MH, OH	A-7	0	100	100	90-100	80-95	55-90	15-40
	15-60	Silty clay loam, silty clay, clay loam.	MH, CH	A-7	0	95-100	95-100	90-100	80-95	55-70	25-40
574---------------- Du Page	0-32	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	32-60	Sandy loam, loam, gravelly sandy clay loam.	CL	A-4, A-6, A-7	0	85-100	85-100	65-100	55-95	25-45	7-20
575---------------- Nishna	0-14	Clay loam--------	CH, MH	A-6, A-7	0	100	100	95-100	90-100	55-65	25-35
	14-45	Silty clay-------	CH, MH	A-7	0	100	100	95-100	90-100	55-65	25-35
	45-60	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	60-70	30-40
654---------------- Revere	0-15	Clay loam--------	CL	A-6, A-7	0	95-100	95-100	75-95	60-80	30-45	12-20
	15-35	Clay loam, loam	CL	A-6	0	95-100	95-100	65-90	60-80	25-40	10-20
	35-60	Loam, clay loam	CL	A-6	0-2	95-100	90-100	65-90	55-80	25-40	10-18
818: Lemond----------	0-17	Gravelly sandy loam.	SM, SC, SM-SC	A-4	0-5	80-95	60-80	50-70	35-50	<25	NP-7
	17-28	Sandy loam, loamy sand.	SM, SM-SC	A-2, A-4	0-2	95-100	90-100	65-80	25-40	<25	NP-7
	28-44	Loamy sand, sand, coarse sand.	SP, SP-SM	A-3, A-1, A-2	0-2	90-100	85-100	35-85	2-10	---	NP
	44-60	Sandy loam, loam	CL, CL-ML, SC, SM-SC	A-4, A-6	0-5	90-100	85-100	75-90	40-70	25-40	5-15

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
818:											
Linder----------	0-18	Sandy loam-------	CL, SC	A-4, A-6	0	100	95-100	80-95	35-80	25-40	8-15
	18-28	Sandy loam-------	SC, SM-SC	A-2, A-4	0	95-100	80-100	45-75	30-45	20-30	5-10
	28-60	Gravelly sand, gravelly loamy sand, loamy coarse sand.	SP, SP-SM	A-1	0-5	75-95	30-95	25-50	2-12	---	NP
Estherville-----	0-9	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	9-19	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	19-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
882:											
Millington------	0-38	Loam-------------	ML, CL, OL	A-6, A-7, A-4	0	90-100	90-100	80-100	70-95	30-45	8-17
	38-60	Stratified sandy loam to silty clay loam.	CL, CL-ML	A-6, A-7, A-4	0	80-100	80-100	80-100	60-95	20-45	5-20
Zumbro----------	0-10	Fine sandy loam	SM	A-4	0	100	95-100	70-95	35-50	<20	NP
	10-42	Loamy sand, loamy fine sand.	SM	A-2	0	100	95-100	60-95	15-30	<20	NP
	42-60	Sand, fine sand, loamy sand.	SP, SM, SP-SM	A-2, A-3	0	95-100	85-100	60-95	4-30	<20	NP
883:											
Du Page---------	0-40	Loam-------------	CL	A-6, A-7	0	95-100	95-100	90-100	70-95	30-45	11-21
	40-60	Stratified loam to gravelly sandy clay loam.	CL-ML, CL	A-4, A-6	0	95-100	95-100	90-100	70-95	10-40	5-20
Zumbro----------	0-10	Loamy sand-------	SM	A-2	0	100	95-100	60-95	15-35	<20	NP
	10-50	Sand, fine sand, loamy sand.	SP, SM, SP-SM	A-2, A-3	0	95-100	85-100	60-95	4-30	<20	NP
	50-60	Sand, fine sand, coarse sand.	SP, SM, SP-SM	A-2, A-3	0	90-100	75-100	50-80	4-20	<20	NP
884:											
Delft-----------	0-28	Loam-------------	CL	A-6, A-7	0	95-100	95-100	85-95	60-75	30-45	12-20
	28-47	Loam, clay loam, silt loam.	CL	A-6, A-4	0	95-100	95-100	85-95	70-90	25-40	7-15
	47-60	Loam, clay loam	CL, ML, CL-ML	A-6, A-4	0-5	90-100	90-100	80-95	70-90	20-40	3-15
Webster---------	0-20	Clay loam--------	CL, CH	A-7, A-6	0-5	100	95-100	85-95	70-90	35-60	15-30
	20-49	Clay loam, silty clay loam, loam.	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	35-50	15-30
	49-60	Loam, sandy loam, clay loam.	CL	A-6	0-5	95-100	90-100	75-85	50-75	30-40	10-20
894B2:											
Everly----------	0-10	Clay loam--------	CL	A-6, A-7	0	100	95-100	85-95	65-80	30-45	10-20
	10-35	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	85-95	70-90	35-50	15-25
	35-60	Loam, clay loam	CL	A-6	0-5	90-100	85-95	75-85	60-80	30-40	10-20
Storden---------	0-10	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	10-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
894C2, 894D2:											
Storden---------	0-7	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	7-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
894C2, 894D2:											
Everly----------	0-10	Clay loam--------	CL	A-6, A-7	0	100	95-100	85-95	65-80	30-45	10-20
	10-24	Clay loam, loam	CL	A-6, A-7	0	95-100	95-100	85-95	70-90	35-50	15-25
	24-60	Loam, clay loam	CL	A-6	0-5	90-100	85-95	75-85	60-80	30-40	10-20
954B2:											
Ves-------------	0-10	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-24	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	24-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Storden---------	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
954C2, 954D2:											
Storden---------	0-8	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	8-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Ves-------------	0-10	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-24	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	24-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
992E: Rock outcrop.											
Copaston--------	0-14	Sandy loam-------	SM	A-2, A-4	0	95-100	90-100	60-70	30-50	20-40	NP-10
	14-18	Sandy loam, gravelly sandy loam.	SM	A-2	0-5	90-100	70-100	50-70	20-35	---	NP
	18	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
999B2:											
Ves-------------	0-10	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-22	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	22-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
Estherville-----	0-10	Sandy loam-------	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	10-19	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	19-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Storden---------	0-11	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	11-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
999C2:											
Storden---------	0-11	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	11-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15
Estherville-----	0-10	Loam-------------	CL-ML, CL	A-4, A-6	0-5	90-100	80-100	50-75	50-60	25-40	4-15
	10-19	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	19-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Ves-------------	0-10	Loam-------------	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-22	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	22-60	Loam-------------	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
999D2:											
Storden---------	0-11	Loam-------------	ML, CL	A-4, A-6	0-5	95-100	95-100	70-85	55-70	30-40	5-15
	11-60	Loam-------------	CL-ML, CL	A-4, A-6	0-5	95-100	85-97	70-85	55-70	20-40	5-15

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
999D2:											
Estherville	0-10	Sandy loam	SM, SM-SC, SC	A-2, A-4	0-5	90-100	80-100	50-75	25-50	20-30	2-10
	10-19	Sandy loam, loam, coarse sandy loam.	SM, SM-SC, SC	A-2, A-4, A-1	0-5	85-100	80-95	40-75	15-45	20-30	2-8
	19-60	Coarse sand, gravelly coarse sand, loamy coarse sand.	SP, SP-SM, SM	A-1	0-10	55-90	50-85	10-40	2-25	---	NP
Ves	0-10	Loam	CL, OL	A-6, A-4	0-5	95-100	95-100	80-100	60-80	30-40	7-15
	10-22	Loam, clay loam	CL	A-6	0-5	95-100	95-100	80-95	55-75	30-40	10-20
	22-60	Loam	CL, ML	A-6, A-4	0-5	90-100	90-95	80-90	55-80	30-40	7-15
1016. Udorthents											
1029. Pits											
1053. Aquolls											
1833, 1834 Coland	0-10	Clay loam	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	10-39	Clay loam, silty clay loam.	CL, CH	A-7	0	100	100	95-100	65-80	45-55	20-30
	39-60	Loam, sandy loam, sandy clay loam.	CL, SC, CL-ML, SM-SC	A-4, A-6	0	100	90-100	60-70	40-60	20-40	5-15
1850 Oshawa Variant	0-13	Stony clay loam	CH, CL	A-6, A-7	10-20	90-100	75-90	70-85	60-80	35-60	20-40
	13-42	Loam, clay loam, silty clay loam.	CL, CH	A-6, A-7	0-10	90-100	75-90	70-85	55-80	30-55	15-30
	42-60	Silty clay loam, loam, clay loam.	CL	A-6, A-7	0-5	95-100	85-95	80-95	70-90	30-45	10-20
1851B Blue Earth	0-10	Mucky clay loam	OL, ML	A-5, A-7	0	95-100	95-100	90-100	80-95	40-50	2-12
	10-52	Mucky clay loam, mucky silty clay loam, mucky silt loam.	OL, ML	A-5, A-6, A-7	0	95-100	60-100	60-100	55-95	35-50	2-12
	52-60	Clay loam, silty clay loam, silt loam.	CL, ML	A-6, A-7	0	95-100	60-100	60-95	55-90	35-50	11-20
1852F:											
Terril	0-36	Loam	CL	A-6	0-5	100	95-100	70-90	60-80	30-40	10-20
	36-60	Clay loam, loam	CL	A-6	0-5	100	100	85-95	65-85	25-40	10-20
Swanlake	0-9	Loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	75-90	50-70	20-35	5-15
	9-17	Loam	CL-ML, CL	A-4, A-6	0	90-100	85-98	70-90	50-70	20-35	5-15
	17-60	Loam	ML, CL, SM, SC	A-4, A-6	0	70-95	65-90	60-85	40-70	20-35	3-15
1853A, 1853B Wadena Variant	0-11	Loam	CL, ML, CL-ML	A-6, A-4	0	100	98-100	70-95	50-70	25-40	5-15
	11-18	Loam	CL, ML, CL-ML	A-6, A-4	0	100	98-100	65-95	50-70	25-40	5-15
	18-32	Loam, sandy loam	CL, ML, SC, SM	A-6, A-4	0-2	85-100	80-100	60-95	40-70	25-40	5-15
	32	Weathered bedrock	---	---	---	---	---	---	---	---	---
1897:											
Seaforth	0-12	Clay loam	ML, OL	A-7, A-6, A-4	0-5	95-100	90-100	80-100	60-80	35-45	8-15
	12-30	Loam, clay loam	CL, ML	A-6, A-4	0-5	90-100	85-100	80-95	55-80	30-40	8-15
	30-60	Loam	CL, ML	A-6, A-4	0-5	90-100	85-95	80-90	55-80	30-40	8-15

TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
1897: Wilmonton-------	0-14	Clay loam--------	CL	A-6, A-7	0	100	92-100	85-97	60-90	30-50	12-25
	14-37	Clay loam, loam	CL	A-6, A-7	0-5	95-100	87-97	80-90	60-80	30-50	15-25
	37-60	Clay loam, loam	CL	A-6	0-5	95-100	87-97	75-85	55-75	25-40	10-25
1899B------------ Wilmonton Variant	0-19	Loam-------------	CL, SC, SL-ML, SM-SC	A-4, A-6	1-8	85-100	85-100	80-90	40-75	20-40	5-15
	19-41	Clay, silty clay	CH, MH	A-7	0	95-100	90-100	85-95	75-95	55-80	30-45
	41-60	Clay, silty clay	CH, MH	A-7	0	95-100	90-100	85-95	75-95	55-80	30-45
1899E------------ Wilmonton Variant	0-9	Sandy clay loam	CL, SC, SL-ML, SM-SC	A-4, A-6	1-8	85-100	85-100	80-90	40-75	20-40	5-15
	9-29	Clay, silty clay	CH, MH	A-7	0	95-100	90-100	85-95	75-95	55-80	30-45
	29-60	Clay, silty clay	CH, MH	A-7	0	95-100	90-100	85-95	75-95	55-80	30-45

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	mmhos/cm					Pct
27A, 27B Dickinson	0-17	10-18	1.50-1.55	2.0-6.0	0.12-0.15	5.6-7.3	<2	Low	0.20	4	3	2-4
	17-36	10-15	1.45-1.55	2.0-6.0	0.12-0.15	5.1-7.3	<2	Low	0.20			
	36-60	4-10	1.60-1.70	6.0-20	0.02-0.04	5.6-7.3	<2	Low	0.15			
31E, 31F Storden	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L	1-2
	10-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
39A, 39B Wadena	0-13	18-30	1.30-1.50	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	0.24	4	5	2-4
	13-29	18-30	1.35-1.50	0.6-2.0	0.14-0.19	5.6-7.3	<2	Low	0.32			
	29-60	1-5	1.55-1.65	>6.0	0.02-0.04	6.6-8.4	<2	Low	0.10			
41A, 41B Estherville	0-9	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low	0.20	3	3	2-4
	9-19	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low	0.20			
	19-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low	0.10			
42C, 42E Salida	0-8	5-15	1.35-1.45	2.0-6.0	0.10-0.12	6.1-8.4	<2	Low	0.10	3	8	.5-1
	8-60	0-5	1.50-1.65	>20	0.02-0.04	7.4-8.4	<2	Low	0.10			
86 Canisteo	0-18	22-32	1.25-1.35	0.6-2.0	0.18-0.22	7.4-8.4	<2	Moderate	0.24	5	4L	4-8
	18-29	20-35	1.35-1.50	0.6-2.0	0.15-0.19	7.4-8.4	<2	Moderate	0.32			
	29-60	22-32	1.45-1.60	0.6-2.0	0.14-0.16	7.4-8.4	<2	Low	0.32			
94B, 94C Terril	0-34	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	0.24	5	6	4-5
	34-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low	0.32			
113 Webster	0-19	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	<2	Moderate	0.24	5	6	6-7
	19-33	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32			
	33-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
114 Glencoe	0-26	25-35	1.35-1.45	0.2-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	6	5-8
	26-33	25-35	1.35-1.50	0.2-2.0	0.15-0.19	6.6-7.8	<2	Moderate	0.28			
	33-60	22-32	1.35-1.50	0.6-2.0	0.15-0.19	7.4-7.8	<2	Moderate	0.28			
128A, 128B Grogan	0-15	8-18	1.25-1.40	2.0-6.0	0.22-0.24	5.6-7.3	<2	Low	0.32	5	5	2-4
	15-34	8-18	1.40-1.50	2.0-6.0	0.17-0.19	6.1-7.8	<2	Low	0.43			
	34-60	5-15	1.50-1.60	2.0-6.0	0.17-0.19	7.4-8.4	<2	Low	0.43			
134 Okoboji	0-8	35-42	1.25-1.30	0.2-0.6	0.21-0.23	6.1-7.8	<2	High	0.37	5	4	9-18
	8-48	35-42	1.30-1.35	0.2-0.6	0.18-0.20	6.6-7.8	<2	High	0.37			
	48-60	20-30	1.40-1.50	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.28			
149B, 149B2 Everly	0-14	25-30	1.40-1.45	0.6-2.0	0.17-0.19	5.6-7.3	<2	Moderate	0.24	5-4	6	2-5
	14-40	25-35	1.45-1.55	0.6-2.0	0.15-0.17	6.1-7.8	<2	Moderate	0.32			
	40-60	22-32	1.55-1.80	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
227 Lemond	0-12	6-18	1.30-1.40	2.0-6.0	0.20-0.22	7.4-7.8	<2	Low	0.28	5	4L	4-8
	12-32	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-7.8	<2	Low	0.28			
	32-60	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	<2	Low	0.15			
241 Letri	0-18	27-35	1.20-1.30	0.6-2.0	0.18-0.22	6.1-7.8	<2	Moderate	0.28	5	7	4-8
	18-28	27-35	1.25-1.35	0.6-2.0	0.15-0.19	6.1-7.8	<2	Moderate	0.28			
	28-60	22-32	1.40-1.70	0.2-0.6	0.17-0.19	6.6-8.4	<2	Moderate	0.28			
247 Linder	0-18	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.8	<2	Low	0.24	4	5	4-6
	18-28	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low	0.24			
	28-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	<2	Low	0.10			
255 Mayer	0-22	18-27	1.25-1.35	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	4	4L	4-8
	22-32	18-27	1.25-1.35	0.6-2.0	0.16-0.19	7.4-8.4	<2	Low	0.28			
	32-60	1-5	1.55-1.65	6.0-20	0.02-0.04	7.4-8.4	<2	Low	0.15			
269 Millington	0-36	20-27	1.40-1.60	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low	0.28	5	5	4-6
	36-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	<2	Moderate	0.28			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	mmhos/cm					Pct
282--------------- Hanska	0-18	6-18	1.30-1.40	2.0-6.0	0.15-0.18	6.1-7.8	<2	Low--------	0.28	4	3	4-8
	18-38	6-18	1.35-1.50	2.0-6.0	0.10-0.13	6.1-7.3	<2	Low--------	0.28			
	38-60	1-10	1.50-1.60	6.0-20	0.03-0.05	6.6-7.8	<2	Low--------	0.17			
313--------------- Spillville	0-48	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	<2	Moderate	0.28	5	6	4-6
	48-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	<2	Low--------	0.28			
317--------------- Oshawa	0-10	28-35	1.15-1.30	0.2-0.6	0.18-0.22	7.4-8.4	<2	Moderate	0.28	5	8	4-8
	10-30	28-35	1.35-1.40	0.2-0.6	0.20-0.22	7.4-8.4	<2	Moderate	0.28			
	30-60	18-35	1.30-1.35	0.2-0.6	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
321--------------- Tilfer	0-19	24-32	1.35-1.40	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.28	4	4L	5-6
	19-32	16-30	1.40-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.28			
	32	---	---	---	---	---	---	-----------	----			
327A, 327B-------- Dickman	0-12	6-18	1.30-1.40	2.0-6.0	0.13-0.15	5.6-6.5	<2	Low--------	0.20	3	3	2-4
	12-19	6-18	1.35-1.50	2.0-6.0	0.12-0.14	5.6-7.3	<2	Low--------	0.20			
	19-60	1-10	1.50-1.60	6.0-20	0.02-0.07	5.6-7.8	<2	Low--------	0.15			
345--------------- Wilmonton	0-14	25-35	1.25-1.35	0.6-2.0	0.20-0.26	6.1-7.3	<2	Moderate	0.28	5	6	4-8
	14-39	25-32	1.30-1.45	0.2-0.6	0.15-0.19	6.1-8.4	<2	Moderate	0.28			
	39-60	22-32	1.45-1.70	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
390--------------- Spillville	0-50	18-26	1.45-1.55	0.6-2.0	0.19-0.21	5.6-7.3	<2	Moderate	0.28	5	6	4-6
	50-60	14-24	1.55-1.70	0.6-6.0	0.15-0.18	5.6-7.3	<2	Low--------	0.28			
392--------------- Biscay	0-22	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	<2	Moderate	0.28	4	6	4-8
	22-30	18-30	1.25-1.35	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.28			
	30-33	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-8.4	<2	Low--------	0.28			
	33-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low--------	0.10			
399--------------- Biscay	0-31	18-30	1.20-1.30	0.6-2.0	0.20-0.22	6.1-7.8	<2	Moderate	0.28	4	6	4-8
	31-35	10-28	1.35-1.55	2.0-6.0	0.11-0.17	6.6-7.8	<2	Low--------	0.28			
	35-60	1-6	1.55-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low--------	0.10			
421B, 421B2------- Ves	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.24	5	6	2-6
	10-25	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	25-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
423--------------- Seaforth	0-15	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.28	5	4L	4-6
	15-21	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
	21-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
446--------------- Normania	0-17	22-32	1.20-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.24	5	6	4-8
	17-28	22-32	1.30-1.40	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	28-60	22-27	1.40-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
562--------------- Knoke	0-15	27-36	1.30-1.40	0.2-0.6	0.21-0.23	7.4-8.4	<2	High-------	0.37	5	7	8-15
	15-60	35-45	1.35-1.45	0.2-0.6	0.18-0.20	7.4-8.4	<2	High-------	0.37			
574--------------- Du Page	0-32	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	<2	Moderate	0.28	5	6	4-6
	32-60	18-27	1.45-1.65	0.6-2.0	0.10-0.20	7.4-8.4	<2	Low--------	0.28			
575--------------- Nishna	0-14	28-35	1.35-1.40	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.28	5	8	4-6
	14-45	36-44	1.30-1.35	0.06-0.2	0.12-0.14	7.4-8.4	<2	High-------	0.37			
	45-60	38-46	1.35-1.40	0.06-0.2	0.11-0.13	7.4-8.4	<2	High-------	0.28			
654--------------- Revere	0-15	22-35	1.10-1.40	0.6-2.0	0.18-0.22	7.4-8.4	2-4	Moderate	0.24	5	4L	4-8
	15-35	22-35	1.35-1.55	0.6-2.0	0.15-0.19	7.4-8.4	2-4	Moderate	0.32			
	35-60	18-32	1.35-1.65	0.6-2.0	0.14-0.16	7.4-8.4	2-4	Moderate	0.32			
818:												
Lemond-----------	0-17	6-18	1.30-1.40	2.0-6.0	0.14-0.18	7.4-7.8	<2	Low--------	0.24	5	4L	4-8
	17-28	6-18	1.35-1.50	2.0-6.0	0.10-0.13	7.4-7.8	<2	Low--------	0.24			
	28-44	1-10	1.50-1.70	6.0-20	0.05-0.07	7.4-8.4	<2	Low--------	0.15			
	44-60	12-27	1.60-1.80	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Linder-----------	0-18	14-18	1.40-1.45	0.6-2.0	0.20-0.22	5.6-7.8	<2	Low--------	0.24	4	5	4-6
	18-28	10-18	1.45-1.55	2.0-6.0	0.15-0.17	6.1-7.8	<2	Low--------	0.24			
	28-60	2-8	1.55-1.75	>20	0.02-0.04	7.4-8.4	<2	Low--------	0.10			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	mmhos/cm					Pct
818:												
Estherville-----	0-9	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low--------	0.20	3	3	2-4
	9-19	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low--------	0.20			
	19-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low--------	0.10			
882:												
Millington------	0-38	20-27	1.40-1.60	0.6-2.0	0.20-0.24	7.4-8.4	<2	Low--------	0.28	5	5	4-6
	38-60	18-35	1.50-1.70	0.6-2.0	0.14-0.20	7.4-8.4	<2	Moderate	0.28			
Zumbro-----------	0-10	5-18	1.35-1.45	2.0-6.0	0.13-0.16	5.6-7.8	<2	Low--------	0.17	5	3	2-4
	10-42	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	<2	Low--------	0.17			
	42-60	0-10	1.45-1.60	6.0-20	0.05-0.12	6.1-7.8	<2	Low--------	0.17			
883:												
Du Page----------	0-40	18-27	1.40-1.60	0.6-2.0	0.22-0.24	6.6-8.4	<2	Moderate	0.28	5	6	4-6
	40-60	6-20	1.50-1.70	0.6-6.0	0.08-0.20	7.9-8.4	<2	Low--------	0.28			
Zumbro-----------	0-10	2-10	1.45-1.55	6.0-20	0.10-0.12	5.6-7.8	<2	Low--------	0.17	5	2	1-2
	10-50	0-10	1.45-1.60	6.0-20	0.05-0.12	6.1-7.8	<2	Low--------	0.17			
	50-60	0-5	1.55-1.65	6.0-20	0.05-0.08	6.1-7.8	<2	Low--------	0.17			
884:												
Delft------------	0-28	24-35	1.20-1.35	0.2-0.6	0.18-0.20	5.6-7.8	<2	Moderate	0.24	5	6	4-8
	28-47	18-32	1.30-1.40	0.2-0.6	0.19-0.22	6.6-7.8	<2	Low--------	0.32			
	47-60	15-32	1.40-1.55	0.2-0.6	0.15-0.19	7.4-8.4	<2	Low--------	0.32			
Webster----------	0-20	26-36	1.35-1.40	0.6-2.0	0.19-0.21	6.6-7.3	<2	Moderate	0.24	5	6	6-7
	20-49	25-35	1.40-1.50	0.6-2.0	0.16-0.18	6.6-7.8	<2	Moderate	0.32			
	49-60	18-29	1.50-1.70	0.6-2.0	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
894B2:												
Everly-----------	0-10	25-30	1.40-1.45	0.6-2.0	0.17-0.19	5.6-7.3	<2	Moderate	0.24	5-4	6	2-4
	10-35	25-35	1.45-1.55	0.6-2.0	0.15-0.17	6.1-7.3	<2	Moderate	0.32			
	35-60	22-32	1.55-1.80	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
Storden----------	0-10	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	10-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
894C2, 894D2:												
Storden----------	0-7	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	7-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Everly-----------	0-10	25-30	1.40-1.45	0.6-2.0	0.17-0.19	5.6-7.3	<2	Moderate	0.24	5-4	6	2-4
	10-24	25-35	1.45-1.55	0.6-2.0	0.15-0.17	6.1-7.3	<2	Moderate	0.32			
	24-60	22-32	1.55-1.80	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.32			
954B2:												
Ves--------------	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.24	5	6	2-4
	10-24	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	24-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Storden----------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
954C2, 954D2:												
Storden----------	0-8	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low--------	0.28	5	4L	1-2
	8-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
Ves--------------	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low--------	0.24	5	6	2-4
	10-24	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	24-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.37			
992E:												
Rock outcrop.												
Copaston---------	0-14	10-20	1.40-1.60	0.6-2.0	0.18-0.20	6.1-7.3	<2	Low--------	0.28	2	5	2-4
	14-18	14-30	1.45-1.65	0.6-6.0	0.12-0.14	5.6-7.3	<2	Low--------	0.28			
	18	---	---	---	---	---	---	-----------	----			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	mmhos/cm					Pct
999B2:												
Ves	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low	0.24	5	6	2-4
	10-22	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	22-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
Estherville	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low	0.20	3	3	2-4
	10-19	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low	0.20			
	19-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low	0.10			
Storden	0-11	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L	1-2
	11-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
999C2:												
Storden	0-11	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L	1-2
	11-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
Estherville	0-10	10-18	1.35-1.45	2.0-6.0	0.19-0.22	5.6-7.3	<2	Low	0.20	3	5	2-4
	10-19	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low	0.20			
	19-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low	0.10			
Ves	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low	0.24	5	6	2-4
	10-22	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	22-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
999D2:												
Storden	0-11	18-27	1.35-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Low	0.28	5	4L	1-2
	11-60	18-27	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
Estherville	0-10	5-15	1.25-1.35	2.0-6.0	0.13-0.18	5.6-7.3	<2	Low	0.20	3	3	2-4
	10-19	10-18	1.35-1.60	2.0-6.0	0.09-0.14	5.6-7.3	<2	Low	0.20			
	19-60	0-8	1.50-1.65	6.0-20	0.02-0.04	6.6-8.4	<2	Low	0.10			
Ves	0-10	20-28	1.35-1.45	0.6-2.0	0.20-0.22	6.1-7.8	<2	Low	0.24	5	6	2-4
	10-22	20-32	1.30-1.45	0.6-2.0	0.17-0.19	6.6-7.8	<2	Moderate	0.24			
	22-60	20-28	1.35-1.65	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
1016. Udorthents												
1029. Pits												
1053. Aquolls												
1833, 1834 Coland	0-10	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	<2	High	0.28	5	7	5-7
	10-39	27-35	1.40-1.50	0.6-2.0	0.20-0.22	6.1-7.3	<2	High	0.28			
	39-60	12-26	1.50-1.65	0.6-6.0	0.13-0.17	6.1-7.8	<2	Low	0.28			
1850 Oshawa Variant	0-13	27-35	1.20-1.50	0.2-0.6	0.18-0.22	7.4-8.4	<2	Moderate	0.28	5	8	4-8
	13-42	18-35	1.25-1.55	0.2-0.6	0.18-0.22	7.4-8.4	<2	Moderate	0.28			
	42-60	18-35	1.50-1.60	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.28			
1851B Blue Earth	0-10	27-35	0.60-1.30	0.2-0.6	0.18-0.24	7.4-8.4	<2	Moderate	0.28	5	8	10-25
	10-52	18-35	0.60-1.30	0.2-0.6	0.18-0.24	7.4-8.4	<2	Moderate	0.28			
	52-60	18-35	1.30-1.60	0.2-0.6	0.14-0.16	7.4-8.4	<2	Moderate	0.28			
1852F:												
Terril	0-36	18-26	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Low	0.24	5	6	4-5
	36-60	22-30	1.45-1.70	0.6-2.0	0.16-0.18	6.1-7.8	<2	Low	0.32			
Swanlake	0-9	18-27	1.25-1.45	0.6-2.0	0.18-0.22	7.4-7.8	<2	Low	0.28	5	4L	2-4
	9-17	18-27	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
	17-60	18-27	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low	0.37			
1853A, 1853B Wadena Variant	0-11	16-27	1.30-1.55	0.6-6.0	0.18-0.22	6.6-7.3	<2	Low	0.24	4	6	2-4
	11-18	18-27	1.35-1.60	0.6-2.0	0.17-0.19	6.6-7.3	<2	Low	0.32			
	18-32	18-27	1.35-1.65	0.6-6.0	0.12-0.18	7.4-8.4	<2	Low	0.32			
	32	---	---	---	---	---	---	---	---			

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm^3	In/hr	In/in	pH	mmhos/cm					Pct
1897:												
Seaforth--------	0-12	20-27	1.30-1.45	0.6-2.0	0.20-0.22	7.4-8.4	<2	Moderate	0.28	5	4L	4-6
	12-30	20-30	1.30-1.50	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
	30-60	20-27	1.35-1.60	0.6-2.0	0.17-0.19	7.4-8.4	<2	Low--------	0.28			
Wilmonton-------	0-14	25-35	1.25-1.35	0.6-2.0	0.20-0.26	6.1-7.3	<2	Moderate	0.28	5	6	4-8
	14-37	25-32	1.30-1.45	0.2-0.6	0.15-0.19	6.1-7.8	<2	Moderate	0.28			
	37-60	22-32	1.45-1.70	0.2-0.6	0.14-0.19	7.4-8.4	<2	Moderate	0.37			
1899B------------ Wilmonton Variant	0-19	18-27	1.30-1.50	0.6-2.0	0.18-0.20	6.6-7.3	<2	Low--------	0.32	4	6	4-6
	19-41	50-70	1.40-1.60	<0.06	0.10-0.16	4.0-8.4	<2	High------	0.32			
	41-60	50-70	1.40-1.60	<0.06	0.09-0.15	4.0-8.4	<2	High------	0.32			
1899E------------ Wilmonton Variant	0-9	18-27	1.30-1.50	0.6-2.0	0.18-0.20	6.6-7.3	<2	Low--------	0.32	4	6	2-4
	9-29	50-70	1.40-1.60	<0.06	0.10-0.16	4.0-8.4	<2	High------	0.32			
	29-60	50-70	1.40-1.60	<0.06	0.09-0.15	4.0-8.4	<2	High------	0.32			

TABLE 15.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol < means less than; > means more than. Absence of an entry indicates that the feature is not a concern or that data were not estimated]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
27A, 27B----------- Dickinson	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Moderate.
31E, 31F----------- Storden	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low-------	Low.
39A, 39B----------- Wadena	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
41A, 41B----------- Estherville	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
42C, 42E----------- Salida	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.
86----------------- Canisteo	C/D	None---------	---	---	1.0-3.0	Apparent	Oct-Jul	>60	---	High------	High------	Low.
94B, 94C----------- Terril	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
113---------------- Webster	B/D	None---------	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
114*--------------- Glencoe	B/D	None---------	---	---	+1-1.0	Apparent	Oct-Jun	>60	---	High------	High------	Low.
128A, 128B--------- Grogan	B	None---------	---	---	>6.0	---	---	>60	---	High------	Low-------	Low.
134*--------------- Okoboji	B/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
149B, 149B2-------- Everly	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
227---------------- Lemond	B/D	None---------	---	---	0-3.0	Apparent	Nov-May	>60	---	High------	High------	Low.
241---------------- Letri	B/D	None---------	---	---	0.5-2.0	Perched	Apr-Jun	>60	---	High------	High------	Low.
247---------------- Linder	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High------	Moderate	Low.
255---------------- Mayer	B/D	None---------	---	---	1.0-3.0	Apparent	Oct-Jun	>60	---	High------	High------	Low.
269---------------- Millington	B/D	Occasional	Brief------	Apr-Jun	0-2.0	Apparent	Mar-Jul	>60	---	High------	High------	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
282----------------- Hanska	C	None---------	---	---	0-3.0	Apparent	Nov-Jun	>60	---	High------	High------	Low.
313----------------- Spillville	B	Occasional	Very brief	Apr-Jun	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Moderate.
317*---------------- Oshawa	C/D	Frequent----	Long------	Apr-Jul	+1-1.0	Apparent	Apr-Jul	>60	---	High------	High------	Low.
321----------------- Tilfer	B/D	Occasional	Brief-----	Feb-Nov	0-2.0	Apparent	Nov-Jul	20-40	Hard	High------	High------	Low.
327A, 327B--------- Dickman	A	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Moderate.
345----------------- Wilmonton	B	None---------	---	---	2.5-5.0	Apparent	Mar-Jun	>60	---	High------	Moderate	Low.
390----------------- Spillville	B	Frequent----	Very brief	Apr-Jun	3.0-5.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Moderate.
392----------------- Biscay	B/D	None---------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High------	Moderate	Low.
399*---------------- Biscay	B/D	None---------	---	---	+1-1.0	Apparent	Jan-Dec	>60	---	High------	Moderate	Low.
421B, 421B2-------- Ves	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
423----------------- Seaforth	B	None---------	---	---	3.0-6.0	Apparent	Mar-Jun	>60	---	High------	High------	Low.
446----------------- Normania	B	None---------	---	---	3.0-6.0	Apparent	Mar-Jun	>60	---	High------	Moderate	Low.
562*---------------- Knoke	B/D	None---------	---	---	+1-1.0	Apparent	Nov-Jul	>60	---	High------	High------	Low.
574----------------- Du Page	B	Occasional	Brief-----	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	---	Moderate	Low-------	Low.
575----------------- Nishna	C/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High------	Low.
654----------------- Revere	B/D	None---------	---	---	1.0-3.0	Apparent	Mar-Jun	>60	---	High------	High------	Moderate.
818:												
Lemond-------------	B/D	None---------	---	---	0-3.0	Apparent	Nov-May	>60	---	High------	High------	Low.
Linder-------------	B	None---------	---	---	2.0-4.0	Apparent	Nov-Jul	>60	---	High------	Moderate	Low.
Estherville--------	B	None---------	---	---	>6.0	---	---	>60	---	Low-------	Low-------	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
882:												
Millington	B/D	Frequent	Brief	Apr-Jun	0-2.0	Apparent	Mar-Jul	>60	---	High	High	Low.
Zumbro	A	Frequent	Brief	Apr-Jun	>6.0	---	---	>60	---	Low	Low	Low.
883:												
Du Page	B	Occasional	Brief	Apr-Jun	4.0-6.0	Apparent	Feb-Jun	>60	---	Moderate	Low	Low.
Zumbro	A	Occasional	Brief	Apr-Jun	>6.0	---	---	>60	---	Low	Low	Low.
884:												
Delft	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jun	>60	---	High	High	Low.
Webster	B/D	None	---	---	1.0-2.0	Apparent	Nov-Jul	>60	---	High	High	Low.
894B2:												
Everly	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
894C2, 894D2:												
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
Everly	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
954B2:												
Ves	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
954C2, 954D2:												
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
Ves	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
992E:												
Rock outcrop.												
Copaston	D	None	---	---	>6.0	---	---	12-20	Hard	Moderate	Low	Low.
999B2:												
Ves	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Estherville	B	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
999C2, 999D2:												
Storden	B	None	---	---	>6.0	---	---	>60	---	Moderate	Low	Low.
Estherville	B	None	---	---	>6.0	---	---	>60	---	Low	Low	Low.
Ves	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.

See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
1016. Udorthents												
1029. Pits												
1053. Aquolls												
1833------------- Coland	B/D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1834------------- Coland	B/D	Frequent----	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Low.
1850------------- Oshawa Variant	D	Rare--------	---	---	0-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
1851B------------ Blue Earth	D	None--------	---	---	0-1.0	Apparent	Jan-Dec	>60	---	High-----	High-----	Low.
1852F:												
Terril-----------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Swanlake---------	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
1853A, 1853B------ Wadena Variant	B	None--------	---	---	>6.0	---	---	20-40	Hard	Low------	Low------	Low.
1897:												
Seaforth---------	B	None--------	---	---	3.0-6.0	Apparent	Mar-Jun	>60	---	High-----	High-----	Low.
Wilmonton--------	B	None--------	---	---	2.5-5.0	Apparent	Mar-Jun	>60	---	High-----	Moderate	Low.
1899B, 1899E------ Wilmonton Variant	B	None--------	---	---	2.0-3.0	Perched	Mar-Jun	>60	---	High-----	High-----	High.

* In the High water table--Depth column, a + sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

TABLE 16.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Aquolls	Loamy, mixed, mesic Haplaquolls
*Biscay	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Blue Earth	Fine-silty, mixed (calcareous), mesic Mollic Fluvaquents
Canisteo	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Coland	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Copaston	Loamy, mixed, mesic Lithic Hapludolls
Delft	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dickman	Sandy, mixed, mesic Typic Hapludolls
Du Page	Fine-loamy, mixed, mesic Cumulic Hapludolls
Estherville	Sandy, mixed, mesic Typic Hapludolls
*Everly	Fine-loamy, mixed, mesic Typic Hapludolls
Glencoe	Fine-loamy, mixed, mesic Cumulic Haplaquolls
Grogan	Coarse-silty, mixed, mesic Typic Hapludolls
Hanska	Coarse-loamy, mixed, mesic Typic Haplaquolls
Knoke	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Lemond	Coarse-loamy, mixed (calcareous), mesic Typic Haplaquolls
Letri	Fine-loamy, mixed, mesic Typic Haplaquolls
Linder	Coarse-loamy, mixed, mesic Aquic Hapludolls
Mayer	Fine-loamy over sandy or sandy-skeletal, mixed (calcareous), mesic Typic Haplaquolls
Millington	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
*Nishna	Fine, montmorillonitic (calcareous), mesic Cumulic Haplaquolls
Normania	Fine-loamy, mixed, mesic Aquic Haplustolls
Okoboji	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Oshawa	Fine-loamy, mixed (calcareous), mesic Cumulic Haplaquolls
Oshawa Variant	Fine-loamy, mixed, (calcareous), mesic Cumulic Haplaquolls
Revere	Fine-loamy, mesic Typic Calciaquolls
Salida	Sandy-skeletal, mixed, mesic Entic Hapludolls
Seaforth	Fine-loamy, mixed, mesic Aquic Calciustolls
Spillville	Fine-loamy, mixed, mesic Cumulic Hapludolls
Storden	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Swanlake	Fine-loamy, mixed, mesic Entic Hapludolls
Terril	Fine-loamy, mixed, mesic Cumulic Hapludolls
*Tilfer	Fine-loamy, mixed (calcareous), mesic Typic Haplaquolls
Udorthents	Sandy and loamy, mixed, nonacid, mesic Udorthents
Ves	Fine-loamy, mixed, mesic Udic Haplustolls
Wadena	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludolls
Wadena Variant	Fine-loamy, mixed, mesic Typic Hapludolls
Webster	Fine-loamy, mixed, mesic Typic Haplaquolls
Wilmonton	Fine-loamy, mixed, mesic Aquic Hapludolls
Wilmonton Variant	Fine, mixed, mesic Aquic Argiudolls
*Zumbro	Sandy, mixed, mesic Entic Hapludolls

* The soil is a taxadjunct to the series. See text for description of those characteristics of the soil that are outside the range of the series.

Accessibility Statement